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Connections, culture and environments around 100 000 years ago at Klasies River main site

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ABSTRACT

In this paper the new excavations at Klasies River main site are introduced and the first results presented and linked with previous work, establishing a baseline for future reporting. Data from the earliest phase of the SAS member, comprising the basal SASU and SASL sub-members from caves 1 and 1A are discussed. A new U-Th date of 126.0 ± 1.5 ka on flowstone associated with fallen tufa material within the base of the SASU sub-member provides a maximum age for this part of the sequence. The lowermost SASU sub-member formed most likely around 100 000 years ago during a period associated with increased precipitation whereas the age of the underlying SASL sub-member is uncertain. The SASU sub-member contains *in situ* deposits that include hearths, in contrast to the underlying SASL sub-member that was subject to post depositional disturbance. Despite the different site formation processes the lithic industry of both sub-members is similar although quartz utilization is somewhat more prominent in the SASL sub-member. The main reduction strategy involves a parallel unidirectional convergent method to produce quartzite blade and point blanks with rare retouch. Relatively more browsing fauna and riparian species, indicating more closed environments, occur in the SASU layers. The older SASL sub-member, not previously described as an independent unit, contains relatively more grazers suggesting drier and more open habitats. It is vital to link evidence from coastal sites such as Klasies River to data from the interior to promote insight into modern human origins from a wider landscape perspective. The work of James Brink, to whom this paper is dedicated, is invaluable in developing this connection.

1. Introduction

James Brink's association with Klasies River has been long and fruitful. Two of the authors of this paper (Wurz and Van Pletzen-Vos) shared a supervisor with James Brink, the late Professor Hilary Deacon. Even though we both studied Klasies River material for our post graduate degrees, our discussions with Hilary invariably included emphasis on the data from Florisbad as this is where James was based. We also benefitted directly from our interaction with James. He taught Liezl van Pletzen-Vos how to analyse faunal material at the Florisbad Quaternary research centre. His discussions with Sarah Wurz on the link of Klasies River to interior sites like Florisbad and Erfkroon, and advice on research strategies are highly appreciated. This connection with James inspired holistic thinking on modern human origins at Klasies River, outside of the southern Cape box.

Between 120 000 and 55 000 (abbreviated to ka) years ago modern human populations inhabited numerous cave sites along the coastal and near-coastal region of the contemporary continental edge of southern Africa. Klasies River main site (Fig. 1, Singer and Wymer, 1982; Deacon, 1995; Deacon and Wurz, 2005), the subject of this paper, is one of the most intensively occupied sites within this area and is associated with abundant cultural and subsistence remains of Middle Stone Age (MSA) hunter-gatherer-fishers. Investigations at Klasies River main site have led to many significant discoveries. For example, analyses of the recovered human remains have contributed to our understanding of the evolution of modern human anatomy (e.g., Rightmire and Deacon,

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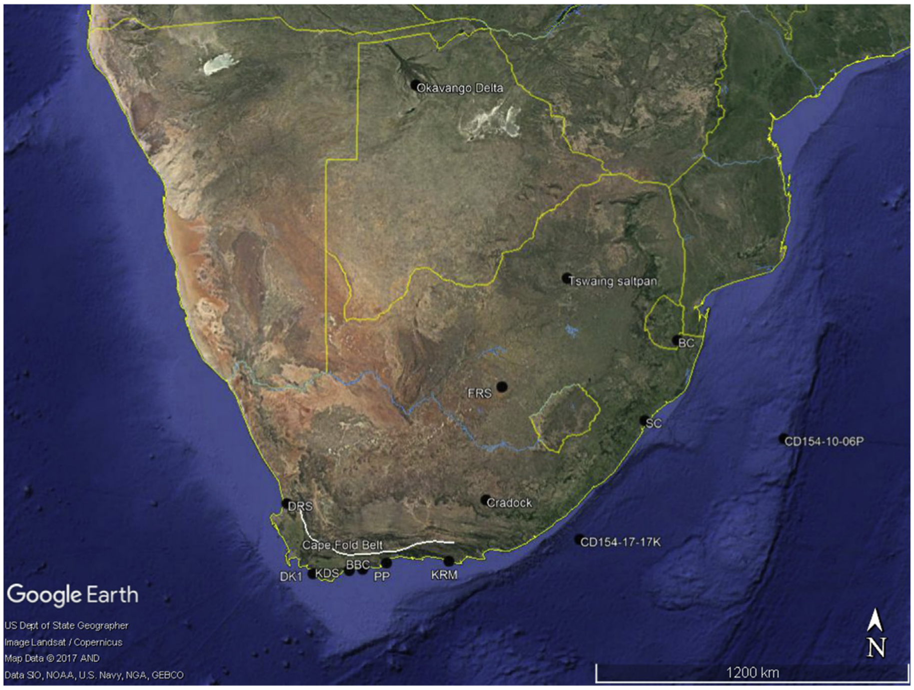

Fig. 1. Sites and places mentioned in the text. Abbreviations used: BC = Border Cave; SC = Sibudu Cave; FRS = Florisbad Research Station; KRM = Klasies River main site; PP = Pinnacle Point cave complex; BBC = Blombos Cave; KDS = Klipdrift Shelter; DK1 = Die Kelders Cave 1; and DRS = Diepkloof Rock Shelter.

1991; Churchill et al., 1996; Grine et al., 1998; Rightmire and Deacon, 2001; Grine et al., 2017). The shellfish and fish remains from the site provided notable information on early exploitation of coastal resources (Thackeray, 1988; Von den Driesch, 2004; Van Niekerk, 2011; Langejans et al., 2012, 2017), and lithic analyses contributed towards understanding of MSA technological strategies (Thackeray, 1989; Wurz, 1999, 2002; 2012, 2013; Wurz et al., 2003; Villa et al., 2010). The faunal data have been discussed in the context of subsistence behavior (Klein, 1976, 1989; Milo, 1998) and palaeoenvironmental reconstructions (e.g. Klein, 1976; Avery, 1987; Van Pletzen, 2000; Hillestad-Nel et al. 2018).

During the Middle Stone Age the Cape coastal area was characterized by unique endemic mammal fauna (e.g. Klein, 1983, 1984; Klein et al., 2007; Faith, 2013) adapted to vegetation types from the Cape Fynbos and Albany thicket biomes (Mucina and Rutherford, 2006). In contrast some areas of the interior of South Africa, for example the region around Florisbad, were associated with savanna and grasslands (Mucina and Rutherford, 2006). Such grasslands were fully established during the Florisian Land Mammal Age (FMLA) that lasted from 600 to 10 ka (Brink, 2016). During this time fluctuating perennial lakes, leaving their traces in today's pans (Brink, 1987, 2005), occurred in this area. The “Old Collection” from the Florisbad Spring reflects the faunal composition of the FLMA. It is also at Florisbad that evidence for the earliest Middle Stone Age assemblage in South Africa, dating to ca. 279 ka (Grün et al., 1996; Kuman et al., 1999), and a *Homo sapiens* root species, *Homo helmei*, occurs. The Florisbad skull, dating to ca. 259 ka has obtained new significance for understanding modern human origins as recent genetic analyses estimated modern human divergence to between 350 ka and 260 ka (Schlebusch et al., 2017). The aim of this paper is to present the first results from new excavations at Klasies River and to link this to the existing data generated by the Singer and Wymer and Deacon excavations. The lowermost part of the 10 m Shell and Sand (SAS) member, the basal SASU and SASL sub-members from Klasies River main site from caves 1 and cave 1A are discussed. The new findings are presented and thereafter integrated with the existing body of knowledge generated by the previous research. The wider implications of the Klasies River data from the basal SASU and SASL sub-members are further discussed from a broader landscape perspective by exploring connections to contemporaneous coastal assemblages on the Palaeo-Agulhas plain and the interior.

2. Klasies River main site and the basal SASU and SASL deposits

Klasies River main site is part of a cultural landscape that has been declared a National Heritage Site. The heritage landscape is situated in the Eastern Cape region of South Africa, and encompasses a ca. 2 km stretch along the beach between the Klasies River in the west and Druipkelder point towards the east. Klasies River main site consists of two caves (caves 1 and 2) and associated overhangs (named caves 1A and 1B). The caves face the Indian Ocean and are cut into cliffs that form the seaward edge of a 13 km coastal platform running along the Tsitsikamma mountain range. Caves 1 and 1A, discussed in this article, are currently 6 m above sea level, but prehistoric fluctuations in sea levels would have led to new areas opening as the sea retreated or areas becoming submerged as the sea rose (e.g., Bateman et al., 2004; Fisher et al., 2010; Bateman et al., 2011; Compton, 2011; Cawthra et al., 2014; Carr et al., 2016). Klasies River is situated at the easternmost extent of the Palaeo-Agulhas plain (Van Andel, 1989; Marean et al., 2014). The coastal plain is less extensive in this area than at Blombos Cave and Pinnacle Point further to the west on the southern Cape coast. During MIS 5c (ca.106 - 93 ka, Lisiecki and Raymo, 2005), the time period discussed here, Klasies River would have been within 2 km from the coast (Langejans et al., 2012). Table Mountain Group sandstone and quartzite with slate and shale and Bokkeveld metashales form part of the landscape around the Klasies River main site (e.g., Butzer, 1978; Marker and Holmes, 2010). The site is located within the broad Fynbos Biome, but the vegetation is in fact a complex mosaic of thicket, forest, and coastal vegetation. This densely interdigitated vegetation provides a wide variety of useful resources (Van Wijk et al., 2017).

Klasies River main site is the largest archaeological feature in the heritage landscape and comprises 21 m of archaeologically significant deposits. The site was first excavated by Singer and Wymer in 1967–68 (Singer and Wymer, 1982, Fig. 2). “Singer and Wymer” is hereafter abbreviated as S-W when referring to the stratigraphy. The excavation

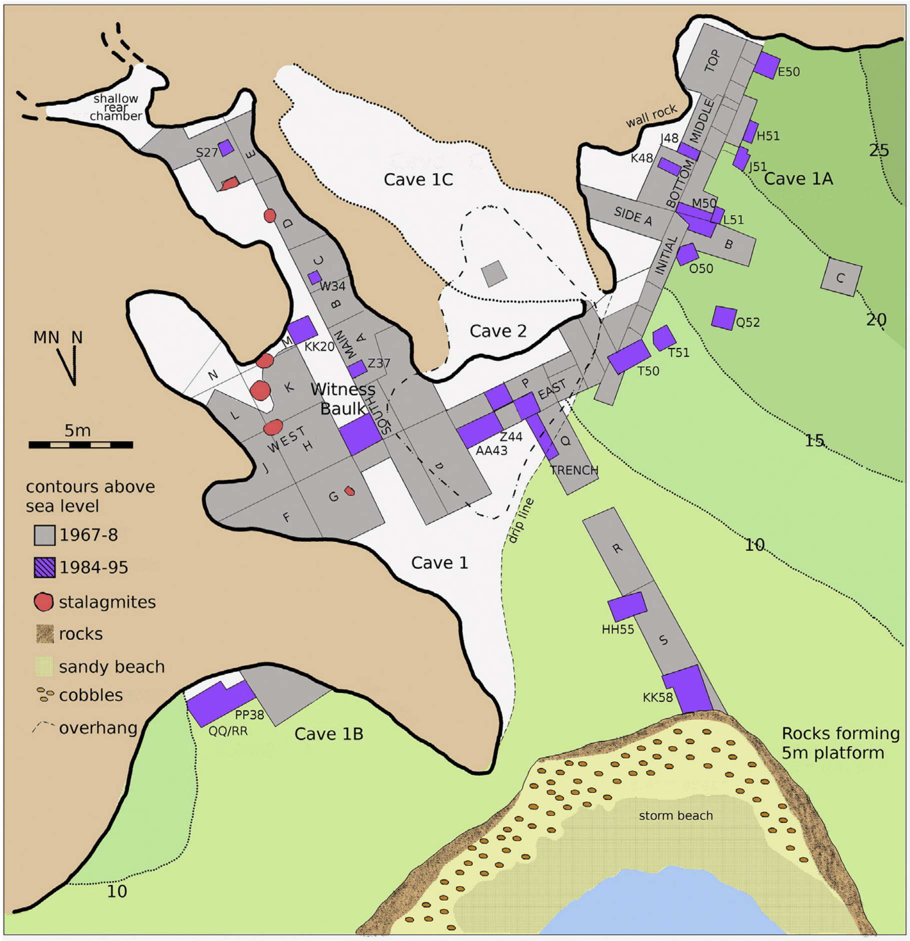

Fig. 2. Plan of main site, Klasies River.

was extensive and removed most of the deposits from caves 1 and 1A (Fig. 2, light grey/purple areas). Hilary Deacon (e.g. Deacon and Geleijnse, 1988; Deacon, 1995) subsequently excavated Klasies River main site, including caves 1, 2, 1A and 1B, from 1984 to 1995 (Fig. 2, dark grey/purple areas). He excavated the Witness Baulk in cave 1 between 1991 and 1995, but did not reach bedrock. The Witness Baulk is a ca. 12 m baulk of sediment occupying the central area of cave 1 that was left behind following the Singer and Wymer excavations. The current excavation phase at Klasies River main site is led by Sarah Wurz and started in 2015 by continuing the Deacon excavation of the Witness Baulk (Fig. 3). The other area from which results are discussed is from the intersection of cave 1/1A where Deacon excavated Squares AA43/Z44 in the late 1980's. The Singer and Wymer excavations removed the connection between the Witness Baulk and Squares AA43/Z44, but the top layers from this area are stratigraphically equivalent to the new layers excavated by Wurz in the Witness Baulk (see discussion below). The current excavation follows the same protocols as those established by Deacon. In general, sediments are carefully removed around the archaeological remains with wooden implements. Objects > 2 cm are given unique ID numbers and their coordinates are captured with a Nikon Nivo total station before each object is removed and bagged separately. Sediments are sieved in stacks of sieves with mesh sizes of 3 and 2 mm. Soil samples are routinely collected from each layer and other samples, such as wood ash samples, are collected when needed. The excavation surfaces are regularly photographed for digital reconstruction.

Deacon classified the MSA deposits in the main site into different lithological members, a system continued by Wurz. These include the lowest member, Light Brown Sand (LBS), followed by the Rubble Brown Sand (RBS), Shell and Sand (SAS), Rock Fall (RF), Upper as well as the White Sand (WS) members (Fig. 4). The uppermost part of the sequence, represented by the RF and Upper members, occurs only in caves 1A and 2. The underlying SAS member is the thickest unit and comprises ca. 10 m in cave 1A, 3 m in cave 1 and 1.5 m in cave 1B (Deacon and Geleijnse, 1988, Fig. 6). The SAS sub-member, the focus of this paper, is divided into sub-members, from top to bottom, the SAS Rubble (SASR), SAS Wedge (SAS-W) that is only present in cave 1 and the SAS Upper (SASU) and SAS Lower (SASL) sub-members that are present in caves 1, 1A and 1B. The areas under discussion in this paper are the Witness Baulk in cave 1 that preserves the SAS to LBS members, and the easternmost section where cave 1 and 1A intersect where only the SASL sub-member to the LBS member remains.

The lowermost layers (OHO–HHH) in the Witness Baulk excavated by Deacon in the 1990's represent the base of the SASU sub-member and form part of Singer and Wymer's layer 16. The immediately underlying SASL sub-member in the Witness Baulk of cave 1 was not excavated by Deacon and this is where the new Wurz excavations started (layers HHH Base and SMONE). The uppermost layers from Squares AA43/Z44 that were excavated by Deacon in the late 1980's correspond to the SASL sub-member in the Witness Baulk excavated by Wurz. The SASL sub-member discussed here forms part of Singer and Wymer's layer 17a. In the following section the stratigraphy of the Deacon material from the base of SASU in the Witness Baulk and SASL in AA43/Z44 is discussed, followed by the description of layer SMONE excavated by Wurz. In both these sections the stratigraphy is integrated with information from Singer and Wymer (1982). In Table 1 the stratigraphy of all three generations of excavations are presented in addition to the volume of deposit for the Deacon and Wurz excavations.

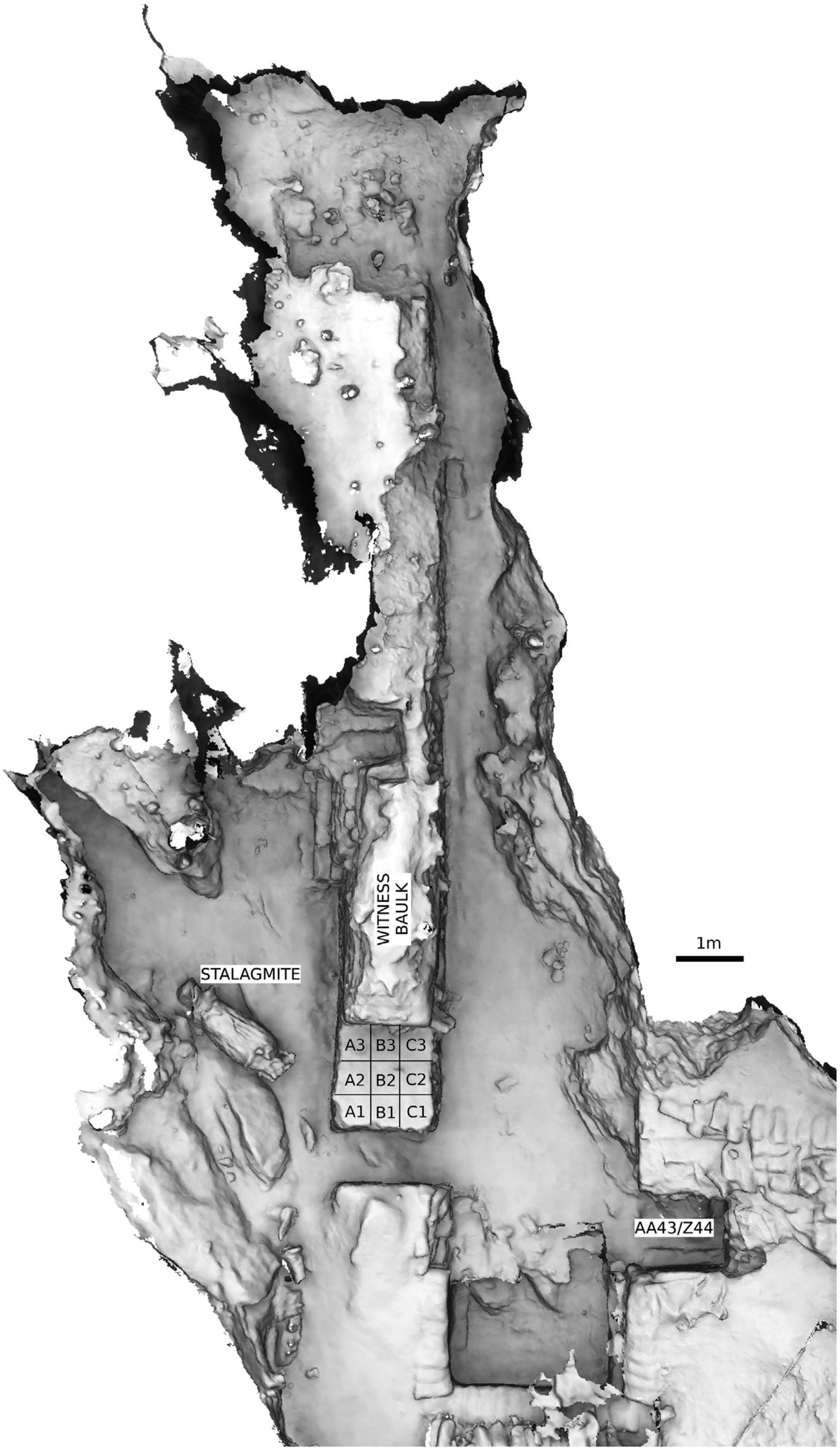

Fig. 3. Plan of cave 1 indicating the excavated areas of the Witness Baulk and AA43/Z44.

2.1. The SASU sub-member in Squares A1-C3 from the Witness Baulk in cave 1 (S-W layer 16), Deacon Excavation

The SASU-sub-member in the Witness Baulk of cave 1 contains several layers (HHH-D2, Fig. 5), but only the basal part consisting of layers OHO (Over Hearth Over) and HHH (Hearth Hearth Hearth) (Fig. 5 a and b) are discussed in this paper. The deposits from these layers comprise rubble with pebbles, angular rock fragments, large lumps of soft and hard calcite as well as broken stalagmites in association with well-preserved fauna and stone artefacts (Deacon site notes and photographs; Deacon and Geleijnse, 1988). This content is similar to that noted by Singer and Wymer (1982, pp. 14) for layer 16, the equivalent of SASU. Layers HHH and OHO, like the rest of SASU, contain remnants of multiple fires in the form of black sediments with carbonised material (possibly plant material) and ash. These combustion features are superimposed and interleaved (Deacon and Geleijnse, 1988), bearing witness to intensive occupations. Combustion features in similarly aged levels in cave 1B were described by Henderson (1990, 1992) as ash patches less than 0.5 m in diameter, and interpreted by Deacon (1995) as small domestic hearths used by family units for the

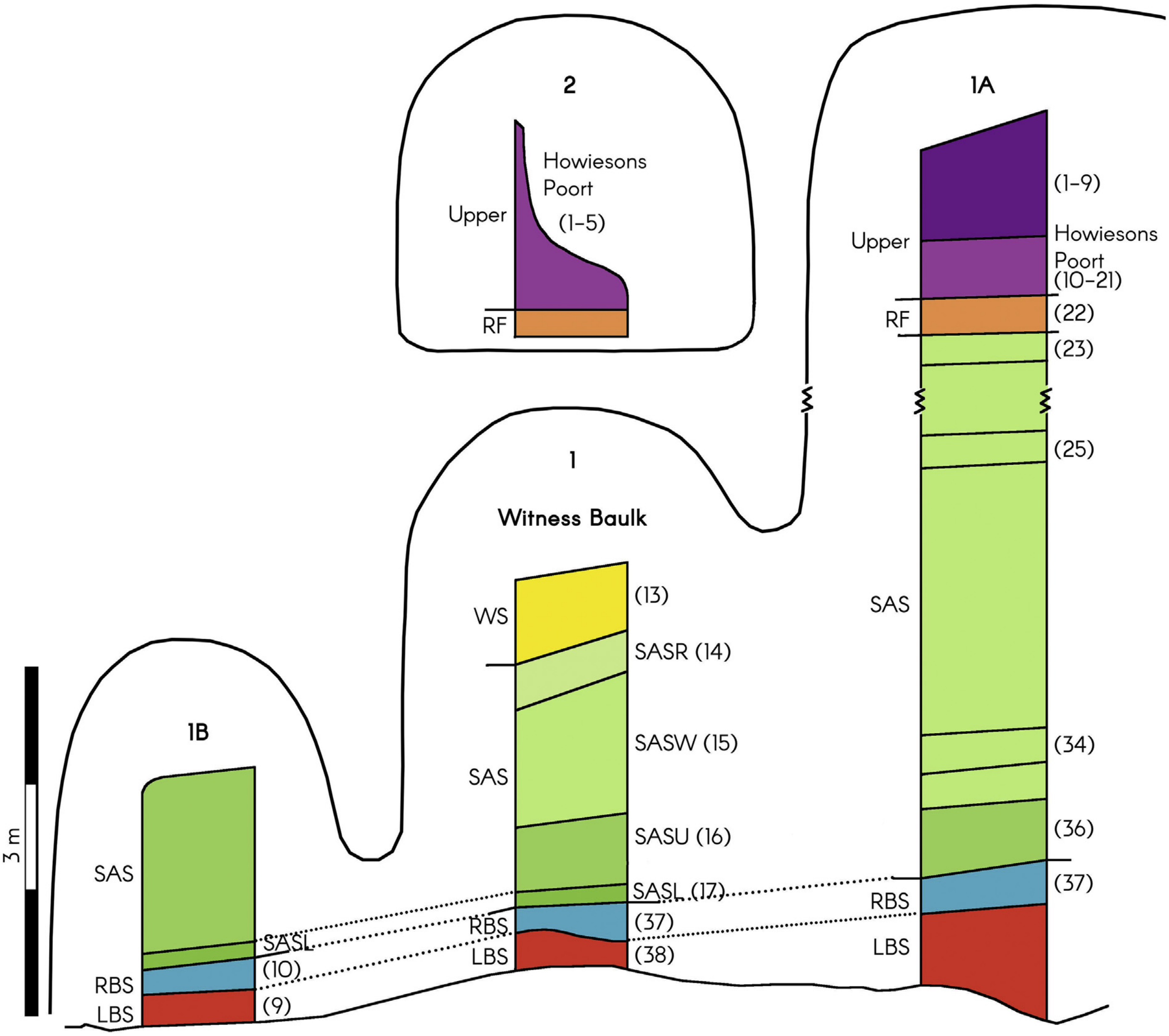

Fig. 4. Generalized stratigraphy of main site (updating Fig. 4 from Grine et al., 2017 and Fig. 2 of Hillestad-Nel et al., 2018).

Table 1
Stratigraphy and volume of deposit excavated of the SASU and SASL sub-members for the Deacon and Wurz excavations.

Sub-Member	S-W Layer Designations	Cave 1 Witness Baulk	Volume of deposit excavated (m^3)*	Cave 1/ 1A AA43/ Z44	Volume of deposit excavated (m^3)
SASU	Layer 16	OHO HHH HHH Base	0.2690 0.2345 0.007		
SASL	Layer 17a	SMONE	0.05315		
				SM1 – BS2	0.0532

*The volume of deposit excavated comprises nine 50 × 50 cm squares, numbered A1-C3.

processing of shellfish and possibly other foods. The combustion features as well as the trampled microfauna from layers OHO and HHH (Hillestad Nel et al., 2018) indicate that these layers represent primary occupation debris. The shell from the Deacon excavation is in the process of being analysed by Richard Klein, but the site notes and raw data indicate the abundance of brown mussel (*Perna perna*).

2.2. The SASL sub-member in squares AA43/Z44 from cave 1/1A (S-W layer 17a), Deacon excavation

The SASL sub-member excavated by Deacon occurs in squares AA43/Z44, to the east of the Witness Baulk (Deacon and Geleijnse, 1988, Fig. 8). The SASL sub-member comprises layers SM1 (Shell Midden 1) to BS2 (Brown Sand 2) (Table 1, Fig. 6a). This group of layers is equivalent to layer 17a of Singer and Wymer (1982). Our hypothesis is that one or more of these layers link to layer SMONE (Shell Midden ONE) in the Witness Baulk (see below), but relating the individual layers of AA43/Z44 to the Witness Baulk is not straightforward as Singer and Wymer's cuttings a and A (see Fig. 2) removed the connection between these areas. Our observations of the remaining AA43/Z44 profiles indicate that there are lateral changes in the defining characteristics of the layers, including the abundance of coarse rubble. Furthermore, it is highly likely that anthropogenic features related to primary activities, such as ash lenses, are not evenly distributed throughout the cave and these therefore cannot be used to link the profiles. We acknowledge the possibility that further analyses (e.g. micromorphology, radiometric dating) of the AA43/Z44 deposits may prompt redefinition of layer groupings. Layers SM1-BS2 consist of soil and rubble with artefacts and other finds lying at all angles (Deacon site notes), thus they do not represent *in situ* deposits. Brown mussel is also the most abundant shell fish species in these layers (Deacon site

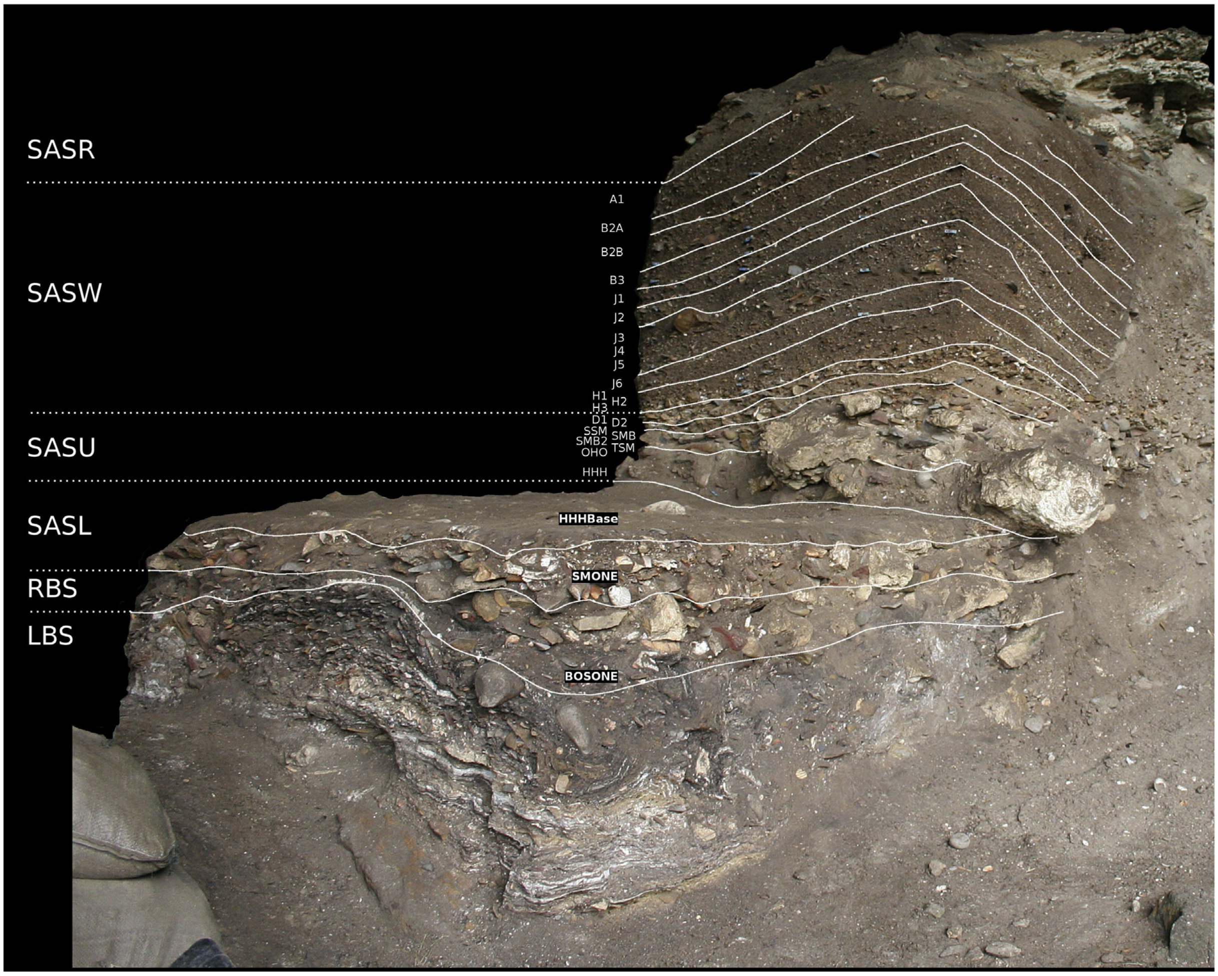

Fig. 5. Stratigraphy of the Witness Baulk indicating the origin of the U-Th dating sample.

records; see also Thackeray, 1988).

2.3. The SASL sub-member in squares A1-C3 from the Witness Baulk in cave 1 (S-W layer 17a), Wurz excavation

The new excavations targeted the Witness Baulk where the very base of the SASU sub-member was left unexcavated by Deacon in 1995. A thin layer designated as HHH Base was removed in 2015. The SASL sub-member comprises the SMONE unit, equivalent to Singer and Wymer's layer 17a (1982, Fig. 3). This unit could not be excavated in individual layers as the artefacts and other finds from this soil and rubble matrix occurred at all angles with overprinting evident. The SMONE unit varied from 5 mm thick in the west to 15 cm thick in the eastern part of the Witness Baulk. The matrix included many disintegrated tufa blocks, leached ash, and small charcoal pieces. No *in situ* combustion features were observed, but 82 quartzite rocks, including lithics, displayed color changes, fractures and other signs of being exposed to fire. Fish scales occurred, and while some of the shell fish remains were well preserved, many shells were dissolved. Land snail (*Achatina* sp.) from this layer was plentiful and well preserved and ostrich egg shell has been recovered. These remains are under analysis.

2.4. Summary

This article reports on three stratigraphic units that occur at the interface of the Deacon and the Wurz excavations in caves 1 and 1A. From Squares A1- C3 in the Witness Baulk, the basal SASU sub-member excavated by Deacon and the SASL sub-member excavated by Wurz are discussed. The SASL sub-member excavated by Deacon from squares AA43/Z44 east of the Witness Baulk is discussed as well. The data from Deacon and the new excavations by Wurz are integrated by comparing and discussing this nexus of layers.

2.5. Dating

The ages of the SASU and SASL sub-members are established from past and new dating. U-Th ages of 85.2 ± 2.1 and 94.6 ± 3.2 ka for the base and top of a 30 cm long stalagmite from Singer and Wymer's layer 14, higher in the sequence than the S-W layers 16 and 17, in Square D (Fig. 2) were obtained by Vogel (2001). The exact position of the stalagmite from square D is not known as it was removed for dating (Stefan Woodborne, Wits, pers comm to Wurz, September 2017). The deposits of the Witness Baulk thin out significantly towards Squares D and E at the back of the cave and this obscures the link with deposits towards Singer and Wymer's area A (Fig. 2). The Deacon and the current excavation of the Witness Baulk are in the region of area A. A stalagmite from square M from the western side of the Witness Baulk (Fig. 2), perhaps in similar stratigraphic context to the S-W layer 14 stalagmite, provided a U-Th age of 100.8 ± 7.5 ka (Vogel, 2001, pp. 266). There is also no direct link between this stalagmite and the Witness Baulk deposits. The lack of connection between the stalagmites and the Witness Baulk complicates interpreting these ages in relation to the deposits reported in this article. As these dates relate to layer 14 or Deacon's SASR sub-member stratigraphically above the deposits discussed here, the Vogel dates provide minimum estimates for the SASU and SASL sub-members. Another age estimate from the base of layer 17

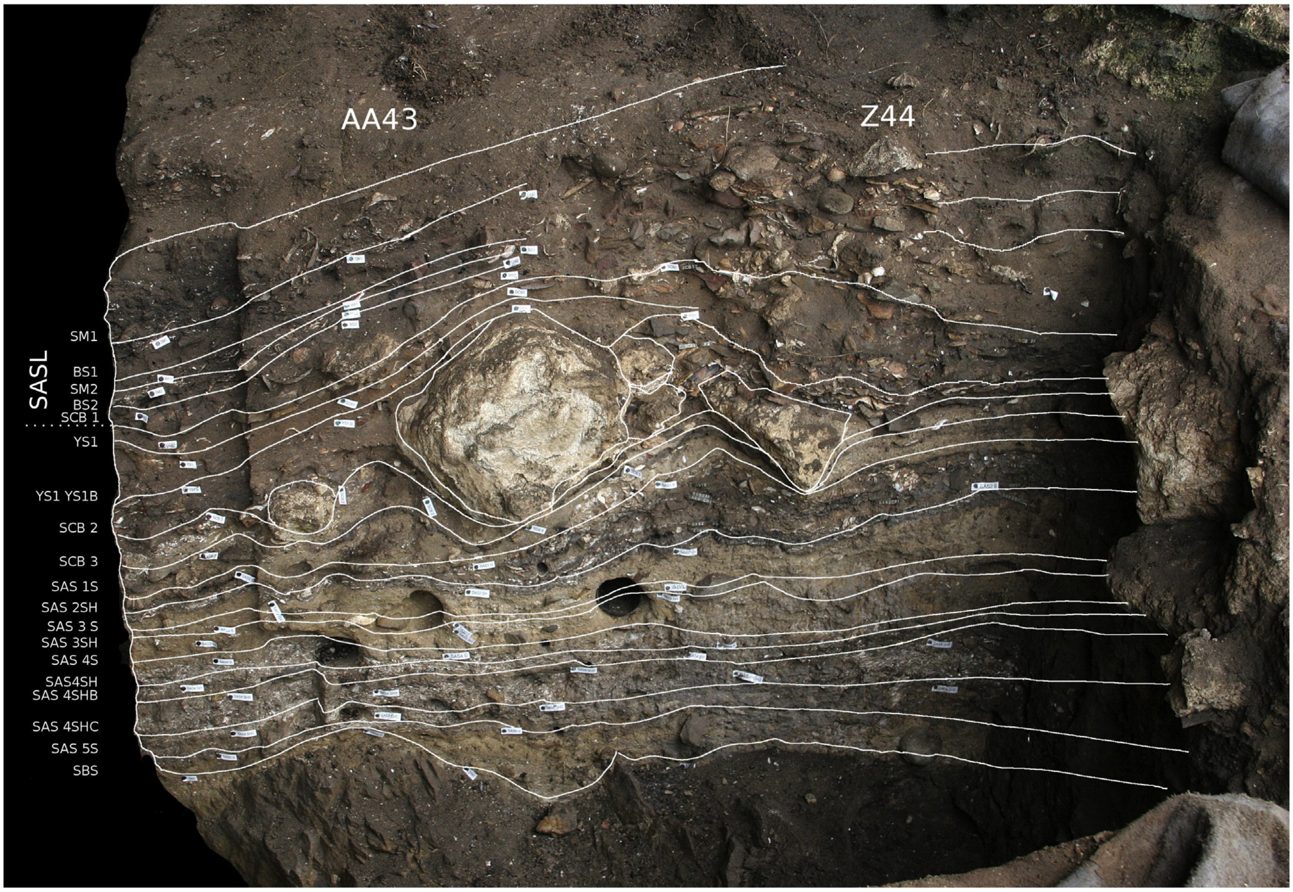

Fig. 6. Stratigraphy of squares AA43 and Z44.

of the Singer and Wymer excavation, presumably of area A, is more directly relevant. A bovid upper molar fragment from the base of layer 17 was initially dated using ESR, to between ca. 93 and 88 ka (linear uptake model (LU)), or ca 67-63 ka (early uptake model (EU)) (Grün et al., 1990). Millard (2008) revised these ESR ages to ca 102-63 (EU) and 104-64 (LU) ka. Laser ablation MC-ICPMS applied to this same bovid tooth (Eggins et al., 2005) provided an U-series/ESR estimate of 101 ± 12 ka.

New dating for the base of the SASU sub-member in the Witness Baulk of cave 1 is reported here. Robyn Pickering and Helen Green used U-Th dating on flowstone associated with tufa material that fell into layer HHH, and obtained an age of 126.0 ± 1.5 ka (see Fig. 5 and Supplemental Materials). The flowstone formed on the surface of the tufa before it fell from either the cave 1 ceiling or the cliff face above cave 1A. Speleothems from cave 1C, a closed off cave situated below cave 1A (Fig. 2) with no archaeological deposit have been dated as part of a larger palaeoenvironmental project by Kerstin Braun (2014). U-Th ages of these speleothems indicate several phases of formation, at for example 122 ± 1.2 ka, between 105 and 101 ka, and a younger phase dating to around 95 ka. This data still need to be integrated with the tufa formations from cave 1. The range of ages discussed here provides a general estimate for the base of the SASU sub-member of ca. 100 ka, MIS 5c. A hiatus occurred between the SASL sub-member and the base of the SASU sub-member, indicating that SASL formed prior to or in early MIS 5c.

3. Lithic industry

The lithics from the SASU and SASL sub-members have been placed in the MSA II lower phase and are part of the Mossel Bay techno-complex (Wurz, 2002) or the MSA 2b (Volman, 1981). The material discussed here have been analysed by three generations of researchers - Anne Thackeray (Thackeray, 1989; Thackeray and Kelly, 1988), Sarah Wurz (Wurz, 2000, 2002)) and currently Mareike Brenner for her PhD thesis (Brenner and Wurz, in prep.) The assemblage composition data for AA43 are from Anne Thackeray's records (no data for Z44 could be found), for Layers OHO-HHH from Wurz (2000, 2002) and for HHH Base and SMONE from Brenner. South African MSA analytical paradigms and reporting protocols have changed significantly from the 1980's to 2017, the time span covered by this analysis, leading to some differences in the lithic classes reported (Table 2).

The technological analysis of the assemblages was undertaken using a *chaîne opératoire* approach combined with attribute analysis. Wurz analysed the SASU material from the Deacon excavations of the Witness Baulk, and SASL artefacts from cave 1/1A while Brenner studied the Witness Baulk layers HHHBase and SMONE from the Wurz excavations. Slightly different analytical procedures have been followed in the analyses of the Deacon and Wurz artefact samples. For the Deacon sample only ‘end products’ or regular artefacts were subjected to a detailed analysis, while the details of all products have been noted for the Wurz assemblage. The primary raw material utilized in the SASU and SASL sub-members is quartzite obtained from water rounded cobbles (Table 2). When the total number of artefacts is considered, quartzite comprises more than 99% in SASU (OHO-HHH) and 93% in SASL (SMONE) (discounting HHH Base and the AA43 layers due to small sample size). Hornfels and silcrete occur in negligible amounts in both the SASU and SASL sub-members (Table 2). In OHO 0.2% and HHH 0.4% of the artefacts are in quartz, with higher numbers occurring in HHH Base (10%), and SMONE (6%). Although most of the quartz pieces (n = 131) are smaller than 20 mm, its presence may indicate an increased interest for this raw material in layers HHH Base and in SMONE.

Table 2
Assemblage composition (numbers of artefacts) of layers from the SASU and SASL sub-members (Data for OHO, HHH, and AA43 SM1-BS2 from the Deacon excavation; data for HHH Base and SMONE from the Wurz excavation).

	OHO	HHH	HHH Base	SMONE	AA43 SM1-BS2
Quartzite					
Hammerstone	0	0	1	3	
Core	16	2	1	14	2
Core rejuvenation	2	0			
Points	14	6	7	35	12
Blades	15	3		19	10
Point and blade fragments	28	16	20	67	39
Flakes			22	139	
Flake fragments			14	170	
Fragments > 10 mm incl chunks and "irregular flakes"	995	568			213
Edge damaged	82	26		94	8
Tools	60	24	5	9	6
Cobble frag	1		1	12	
Pebble frag	6		4	83	
Chunks			12*	168*	
Pieces < 20 mm			114	1325	
Chips (pieces < 10 mm)	377	277			
TOTAL for Quartzite	**1596**	**922**	**201**	**2034**	**290**
Non -quartzite (pieces < 20 mm)					
Quartz	3	4	23	131	2
Hornfels	2	2	1		
Silcrete				5	1
TOTAL for non quartzite	5	6	24	136	3
GRAND TOTAL	**1601**	**928**	**225**	**2170**	**293**

*2 in quartz.

A uniform reduction strategy was used in the SASU and SASL sub-members (Fig. 7). The cores for both sub-members are in an advanced reduction stage and many had point scars as last removal. In the SASU sub-member some of the core blanks consist of split quartzite cobbles, a phenomenon also observed for layer SMONE. These cores show clear crushing at the impact point and prominent striations radiating from this area. It is likely that a bipolar on anvil technique (see e.g. Shott and Tostevin, 2015) has been used, and two anvils found in SMONE support this inference.

In both the SASU and SASL sub-members the dominant technique used was free-hand hard hammer percussion as indicated by the prominent bulbs of percussion. For SMONE 62% of the flaked products (n = 191/310) had prominent bulbs of percussion accompanied by ring cracks at the point of impact (65%, n = 201/310). In SASU the cores conform to criteria typical of a unipolar convergent Levallois reduction method (Wurz, 2002, pp.1008) and the same features are apparent in the SASL cores. The striking platform, or passive under surfaces of the cores, almost always carry cobble cortex, with the production surfaces' scars more organized. The production surface has been domed by the removal of elongated "debordantes", frequently retaining cortex on the back. There is little evidence for preparation of the distal part of the reduction surface with knappers taking advantage of the flatness of the split cobble face to create the appropriate angle for end product removal. Other more informal types of cores also occur, some of these resembling platform cores with one or two opposed platforms and multiple reduction surfaces (Conard et al., 2004).

The production surfaces have been exploited in a recurrent manner creating points and blades (also referred to as blanks here) with thick platforms and straight profiles. For SASU the average thickness of the platforms are 10 mm (n = 1338) and for SMONE it is 9.6 mm (n = 71). As also remarked for the SASU assemblage (Wurz, 2002), the blade forms for SASL have not been produced within a laminar production system as most have a sturdy appearance and are irregular with steeply angled lateral sides. The high incidence of points with a regular morphology suggests that they were the main intended debitage products in SASU and SASL.

The points from SASU and SASL occur in various shapes and vary from symmetrical to skewly convergent (e.g. Fig. 7b,e,f,g). They also vary in their degrees of elongatedness. The range of point shapes is similar to those produced from the parallel unidirectional convergent method in the M3 phase at Blombos cave (Douze et al., 2015, pp. 14).

In both SASU and SASL artefacts have clearly observable lateral edge damage. This type of modification is more numerous than the formal tools that consist of notched and denticulated artefacts (Table 3). This modification may relate to utilization and artefacts with this type of edge damage may have been "informal" tools (Douze et al., 2015). The notched artefacts exceed the denticulated pieces by far and represent 25.6% (51), 30.7% (1) and 1.4% (6) of the respective assemblages (Table 3). The notches are frequently restricted to one lateral edge on the dorsal side, but sometimes also occur on both the ventral and dorsal surfaces. This degree of formal retouch (notches and denticulates) is comparable to other MIS 5 assemblages from the Cape, e.g. Blombos (4.5%) and Diepkloof (2.3%) (Douze et al., 2015, pp.10, 22).

4. The large mammals from the SASL and SASU SUB-MEMBERS

The large mammal data for the basal SASU sub-member presented here are derived from layers OHO-HHH of the Deacon excavations of the Witness Baulk in cave 1. The data for the SASL sub-member originate from the Deacon excavation of AA43/Z44, layers SM1-BS2 in cave 1/1A and the 2015 Wurz excavation of layer SMONE of the Witness Baulk. The Deacon sample has been analysed by Van Pletzen Vos (Van Pletzen, 2000), and the Wurz sample by Reynard (this paper). The SASU deposits are five times larger than that from SASL and we are cognizant of this when comparing these sub-members. HHH Base yielded a very small volume of deposit and sample, and only one identifiable specimen, a Cape fur seal (*Arctocephalus pusillus*) tooth, was found. No taphonomic analysis has been undertaken, but this study is in progress. We do, however, note that – as with other MSA faunal remains from sites such as Sibudu Cave (Clark, 2017), Diepkloof Rockshelter (Steele and Klein, 2013) and Klipdrift Shelter (Reynard et al., 2016) – the assemblage is fragmented. Teeth were generally used to assign faunal material to Class, Order or Family. The cranial and post-cranial remains of bovids that could not be assigned to Family were placed in size classes based on Brain (1974). We use the number of identified specimens (NISP) instead of the minimum number of individuals (MNI) because NISP is a primary quantitative unit. Our samples are small and fragmented which is challenging to measure using MNI (Marshall and Pilgram, 1993). NISP is also not subject to aggregation effects (Grayson and Frey, 2004) and generally less contentious than MNI (e.g., Grayson, 1978; Turner, 1980; Plug and Plug, 1990).

The taxonomic composition (Table 4) shows that the most abundant taxa in the SASU and SASL sub-members are rock hyrax (*Procavia capensis*). This is not surprising, as rock hyrax is adapted to a wide variety of environments but is especially associated with rocky crevices (Maswanganye et al., 2017) that characterize the Klasies River environment. The second most abundant taxon is represented by Cape fur seals. Given that SASU and perhaps SASL are associated with the high sea level period of MIS 5c (Van Andel, 1989; Carr et al., 2016), this might correspond to a shoreline positioned relatively close to the site. Four taxa occur only in the SASU sub-member – brown hyena (*Parahyaena brunnea*), Cape dune mole rat (*Bathyergus suillus*), hippopotamus (*Hippopotamus amphibius*) and alcelaphines. Although hyena is not present in the identified species list of SMONE, there is some evidence of extreme acid-etched bone in this layer which may point to the presence of this taxon.

The presence or absence of specific ungulate taxa can be used to track changing palaeoenvironmental trends at Klasies River. Our assessments of extant ungulate diets (Fig. 8) and habitat preference are based on modern data from Skinner and Chimimba (2005). Not all groups are sensitive habitat indicators. Eland (*Tragelaphus oryx*), for

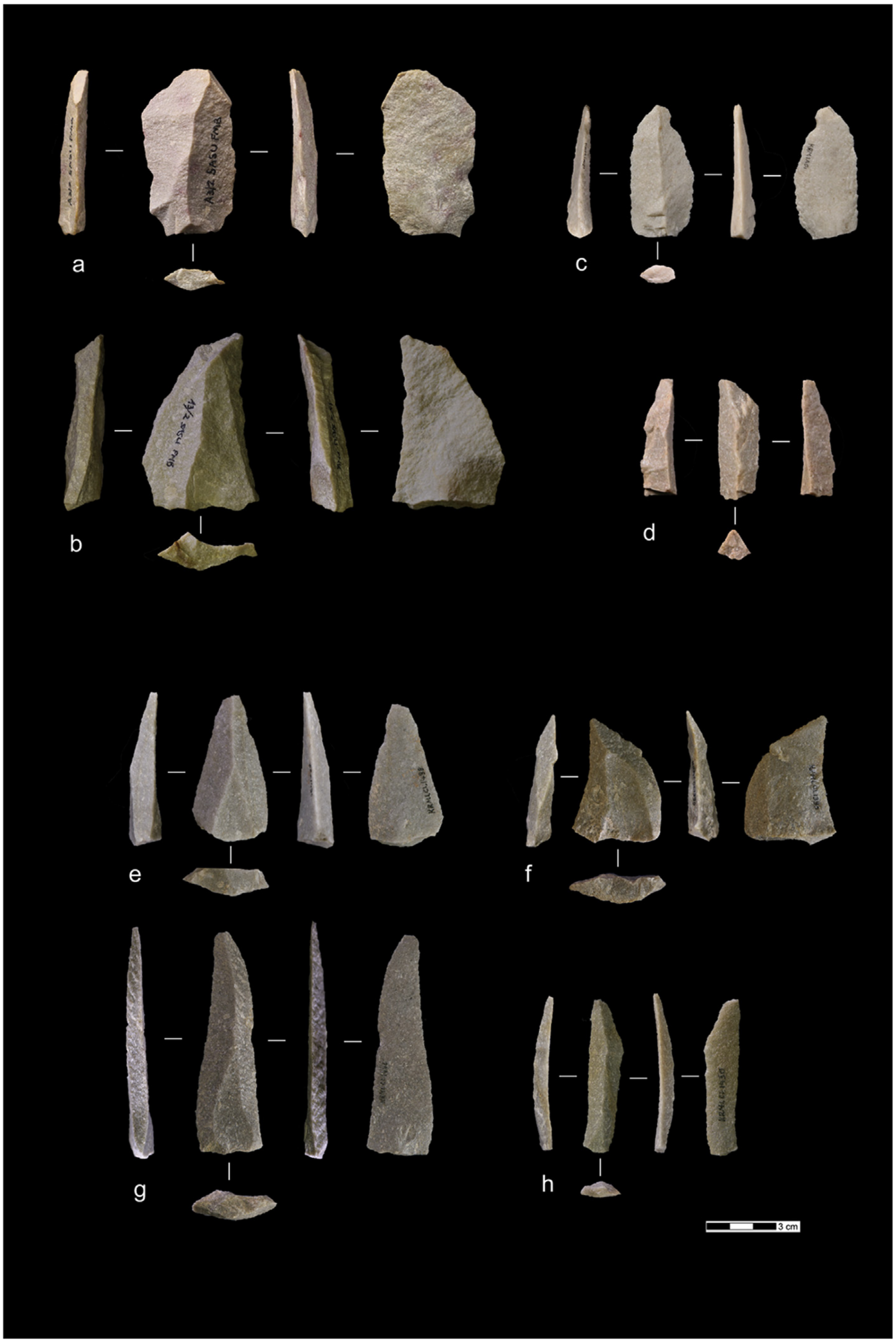

Fig. 7. Blanks from the SASU and SASL sub-members: Layer SASU: a) blade, b) point, layer HHH Base: c) point d) blade; layer SMONE: e)-g) points, h) pointed blade.

example, has been described by Thouless (2013) as a highly adaptable ruminant that once ranged over most of sub-Saharan Africa. Cape grysbok (*Raphicerus melanotis*) is primarily a browsing antelope often replaced by steenbok (*R. campestris*) when browse is less common (Skinner and Chimimba, 2005). Grysbok, however, is also able to shift its dietary habits as the dominant vegetation changes (Faith, 2011a). Research on the fossil populations at Klasies River suggests that these small bovids could successfully switch between browsing and mixed feeding (Faith, 2013). Grysbok grazing preference would likely be fresh, newly grown grass shoots since *Raphicerus* require high quality food (Skinner and Chimimba, 2005). With the exception of *Raphicerus*, diet and habitat preference are usually closely correlated. Following meso-wear analysis, the blue antelope (*Hippotragus leucopheas*), found in both SASU and the SASL sub-members, has been classified as a grazer (Faith and Thompson, 2013). Other grazers from the analysed assemblage include equids, the African buffalo (*Syncerus caffer*) and the extinct long-horn buffalo (*Syncerus antiquus*). The common duiker (*Sylvicapra grimmia*), greater kudu (*Tragelaphus strepsiceros*) and bushbuck (*T. scriptus*) are the browsers identified from SASU and SASL sub-members.

Richard Klein (1976) undertook a seminal study on all the fauna excavated by Singer and Wymer (1982). The very large sample size for S-W layers 16 and 17 relevant here allowed the use of the minimum number of individuals (MNI's) to infer palaeoenvironmental changes. Although Klein (1976) analysis of the Singer and Wymer fauna used MNI and the Deacon and Wurz studies rely on NISP, Klein's raw data (R. Klein, pers. comm., 7 May 2014) show that MNI is significantly correlated to NISP for both the MSA II ($r_s = 0.94459$; $p < 0.0001$) and MSA I ($r_s = 0.93507$; $p < 0.0001$) indicating that it is reasonable to

Table 3
Modification of blanks.

	lateral		notched		denticulate		no damage		Total	
	n =	%	n =	%	n =	%	n =	%	n =	%
OHO										
Fragment	43	21.6	23	11.6	4	2.0	28	14.1	98	49.2
Blade	8	4.0	11	5.5	3	1.5	15	7.5	37	18.6
Point	30	15.1	13	6.5	1	0.5	14	7.0	58	29.1
Flake	1	0.5	4	2.0	1	0.5	0	0.0	6	3.0
Total	82	41.2	51	25.6	9	4.5	57	28.6	199	100.0
HHH										
Fragment	12	16.0	8	10.7	0	0.0	16	21.3	36	48.0
Blade3	1	1.3	2	2.7	1	1.3	3	4.0	7	9.3
Point	8	10.7	12	16.0	0	0.0	6	8.0	26	34.7
Flake	5	6.7	1	1.3	0	0.0	0	0.0	6	8.0
Total	26	34.7	23	30.7	1	1.3	25	33.3	75	100.0
SMONE										
Fragment	50	11.6	4	1.0	0	0.0	183	42.6	237	55.1
Blade	5	1.2	1	0.2	0	0.0	13	3.0	19	4.4
Point	19	4.4	0	0.0	1	0.2	15	3.5	35	8.1
Flake	22	5.1	1	0.2	0	0.0	116	27.0	139	32.3
TOTAL	94	21.9	6	1.4	1	0.2	327	76.0	430	100.0

compare these datasets. In the Deacon and Wurz samples, equids and *Hippotragini* – obligate grazers – are especially common in the SASL sub-member. Klein (1976) analysis shows a similar trend with grazing taxa more common in layer 17 (SASL) and browsers more prevalent in layer 16 (SASU). The environment around Klasies River during the phases discussed here appears to have been a patchwork of woodland thicket interspersed with grasslands in the SASL sub-member, becoming bushier in the SASU sub-member. Given the small size of the faunal sample, in the following section we focus our discussion of palaeoenvironmental trends on the more robust data set of Klein (1976).

5. Discussion: wider connections

This paper discussed the last layers excavated by Deacon in 1995 and the first layers excavated by Wurz in 2015 in the Witness Baulk, cave 1. The Wurz data were also related to equivalent layers excavated by Deacon in the late 1980's in squares AA43/Z44, adjacent to but not connected to the Witness Baulk. This linkage between old and new excavations and datasets is vital to provide a new basis for further analysis and discussions of Klasies River. The lithics from layer SMONE from the SASL sub-member are technologically similar to that from the SASU sub-member. These lithic industries have been produced using free-hand hard hammer percussion and a unidirectional convergent core reduction strategy. Quartzite blanks with a variety of point shapes and blades were produced. The formal retouched component is small and consists mainly of notches. There are technological parallels between these Klasies River assemblages and broadly contemporaneous assemblages from Blombos Cave, Pinnacle Point 13B and Diepkloof Rockshelter (Thompson et al., 2010; Douze et al., 2015; Porraz et al., 2013), but the degree of technological convergence still needs to be further investigated, an endeavor hampered by the general absence of high resolution age estimates. MSA lithic production systems, such as these discussed here, indicate considerable planning depth in the process of designing cores to produce preformed blanks of specific shapes (Wurz, 2016). This level of complexity may also be reflected in three regularly notched bones from Singer and Wymer's layer 36 in cave 1A (equivalent to S-W layer 16 and the SASU sub-member) (Wurz, 2000).

Intact hearths have been recorded by Deacon for the SASU sub-member, but such hearths have not been documented in the Wurz excavation of SMONE. Instead the association of fire use and different activities in the form of heat-affected fauna, lithics and shellfish has been uncovered. In addition, 82 potentially heat-affected quartzite rocks were documented in layer SMONE. A detailed analysis of these is still in progress, but an analysis of 323 similar heat-affected rocks from

Table 4
Number of identified specimens (NISP) and ungulate dietary preference.

Order	Taxa	Common Name	Diet	SASU	SASL	SMONE	Total
Rodentia	*Bathyergus suillus*	Cape dune mole rat		1	0	0	1
Carnivora	*Arctocephalus pusillus*	Cape fur seal		11	16	2	29
	Parahyaena brunnea	Brown hyena		2	0	0	2
	Orycteropus afer	Aardvark		1	0	1	2
Hyracoidae	*Procavia capensis*	Rock hyrax		56	11	3	70
Perissodactyla	*Equus* sp.	Zebra/quagga	Grazer	1	6	1	8
Ruminantia	*Raphicerus cf.melanotis*	Grysbok	Mixed	9	0	1	10
	Sylvicapra grimmia	Common duiker	Browser	1	0	2	3
	Tragelaphus oryx	Eland	Mixed	6	1	2	9
	Tragelaphus strepsiceros	Greater kudu	Browser	7	1	0	8
	Tragelaphus scriptus	Bushbuck	Browser	0	0	3	3
	Hippotragus cf.		Grazer	0	4	2	6
	Hippotragus leucophaeus	Blue antelope	Grazer	2	0	1	3
	Syncerus caffer	African buffalo	Grazer	4	0	2	6
	Syncerus antiquus	Long-horned buffalo	Grazer	1	2	0	3
	Hippopotamus amphibius	Hippopotamus	Grazer	1	0	0	1
	Alcelephinae cf.	Hartebeest Wildebeest Bontebok	Grazer	1	0	0	1

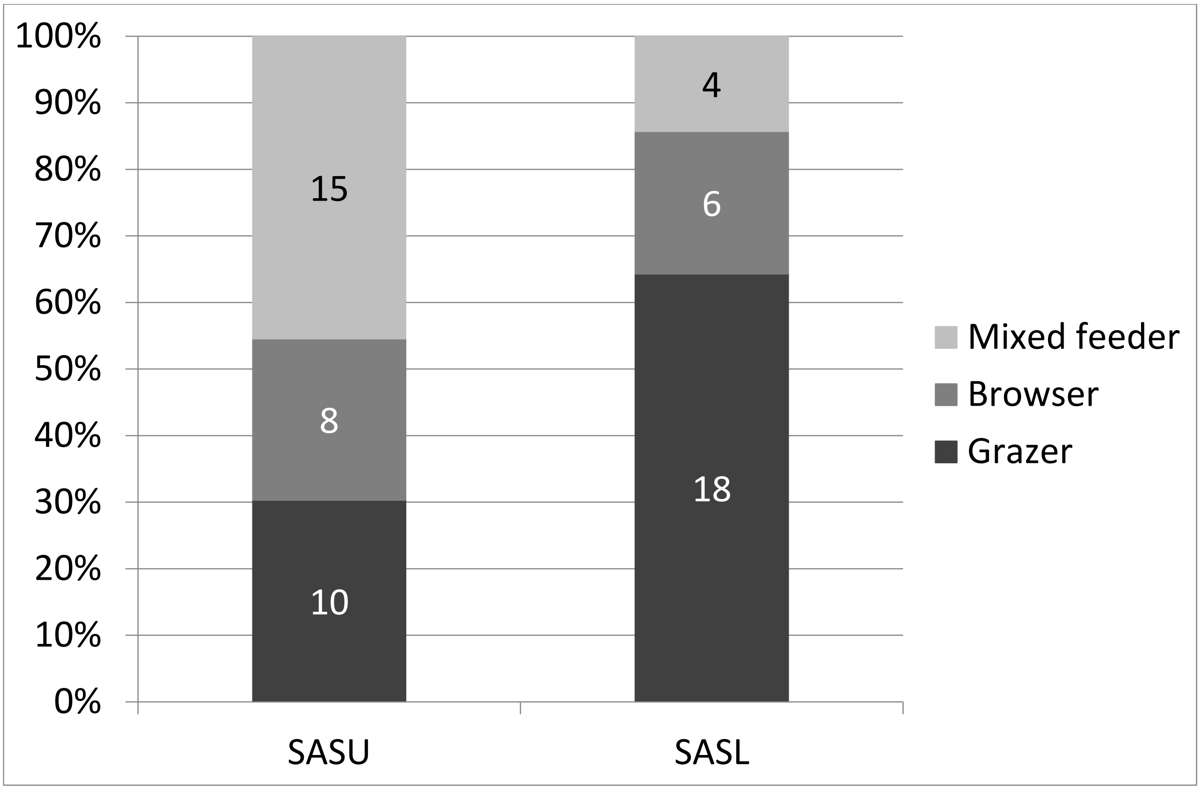

Fig. 8. Dietary preference in SASU and SASL at Klasies River. AA43 layers combined with layer SMONE. NISP in columns.

the underlying layer BOSONE (Black Occupational Soil ONE) has been conducted. A comparison of quartzite from the beach by Klasies River main site and the archaeological samples from BOSONE showed that the archaeological samples displayed fractures and color changes similar to local quartzite that was repeatedly heated in experimental fires (Bentsen and Wurz, 2017). If the rocks were intentionally heated, this could point towards the use of hearthstones or cooking with hot rocks. However, such practices have not been recorded in the MSA before (Bentsen, 2014; Bentsen and Wurz, 2017). Furthermore, intentional and repeated heating of rocks might imply long occupation phases at the site. The current micromorphological and other analyses will provide more data on fire-related behavior at the site, and we are waiting for these results to further interpret the use of fire at Klasies River.

During MIS 5c at Klasies River, the Mean Sea Surface Temperature (SST), calculated from serial $\delta\ ^{18}O$ measurements of *Turbo sarmaticus* opercula varied between 13.2° and 11.1° C, cooler than modern values of between 19.0° and 15.6° C (Loftus et al., 2017). In spite of the relatively cooler SST's, the same range of molluscan faunal species occurred at Klasies River than today (Langejans et al., 2012). The shell fish for the MSA ll Lower, of which SASU and SASL sub-members form part, is completely dominated by rocky shore species, especially the brown mussel (*Perna perna*) (Thackeray, 1988; Langejans et al., 2012, 2017). It is possible that there was an estuary close to Klasies River during periods of lower sea level (Von den Driesch, 2004; Van Niekerk, 2011; Langejans et al., 2017). Some of the foraged species and incidentals do indicate sheltered, protected conditions such as tidal pools and crevices (Langejans et al., 2017) during the time period discussed here.

Faunal data also suggest the presence of lakes, estuaries or wetlands near the site. Hippopotamus are present throughout the Klasies River sequence but are somewhat more common during SASU (Table 4; Table 1 in Klein, 1976). Klein (1976) documents other riparian-linked taxa such as water mongoose (*Atilax paludinosus*) and clawless otter (*Aonyx capensis*) at Klasies River throughout the MSA II sequence but particularly in layer 16 and above. Relatively wet conditions and a more browse-dominated environment in the SASU sub-member (S-W layer 16) are implied by an increase in the abundance of greater kudu and bushbuck (Klein, 1976). In contrast, the SASL sub-member (S-W layer 17) reflects a more open environment with grazers such as African buffalo and wildebeest (Klein, 1976) occurring more frequently. The micromammal data (Nel, 2013; Hillestad Nel et al., 2018) also suggest an increase in riparian environments during MIS 5c/d. In Hillestad-Nel's study the SASU and SASL sub-members have been lumped together in MSA II Lower, but more diverse vegetation occurred in the MSA II Lower compared to the MSA II Upper (S-W Layer 15). Evidence of an increase in moisture in MSA II Lower (containing SASU and SASL) in relation to the underlying LBS member is indicated by the presence of the African marsh rat (*Dasymys incomtus*) and vlei rat (*Otomys* sp.). These species are generally associated with wetlands, reed-beds and semi-aquatic grasses (Skinner and Chimimba, 2005). Micromammals that are linked to 'moist' grasses or waterlogged environments are also generally more abundant during the MSA II Lower period, indicating the presence of small lakes, reed-beds and wetlands, separated by herbaceous and grass covered dunes and thicket components during this period (Avery, 1987; Hillestad Nel et al., 2018).

Correlating the palaeoenvironmental conditions at Klasies River with other southern Cape sites is not straightforward, as the temporal association between sites is not clear-cut, and the sites are subject to somewhat different climatic regimes. However, at Blombos Cave in the M3 phase the prevalence of mixed-feeders such as eland and the occurrence of both grazers and browsers dated to MIS 5c, also suggests a relatively mosaic environment of bush and grasslands (Henshilwood et al., 2001; Badenhorst et al., 2016; Roberts et al., 2016). *Raphicerus* dominates the Blombos assemblages and there are also diverse numbers of grassland-linked taxa. While not particularly abundant, grazers at Blombos Cave such as hartebeest, bontebok (*Damaliscus pygargus*) and reedbuck (*Redunca arundinum*) imply a grassy environment. Extinct Florisian herbivores such as the long-horned buffalo and Cape horse

(*Equus capensis*) are also relatively common in the M3 phase at Blombos.

The SASU sub-member is younger than 126 ka (this paper) and older than ca. 94 ka, the age obtained for the base of Singer and Wymer's layer 14 (Vogel, 2001) higher in the sequence of cave 1. We postulate a date of around 100 ka for the OHO-HHH layers as the fauna and microfauna signal of this SASU phase implies relatively wetter conditions. These conditions may be related to the peak in precipitation experienced by the south eastern part of South Africa around 100 ka (Simon et al., 2015, Fig. 2). The increase in precipitation relates to inter-hemispheric see-saw mechanisms that cause a southward shift of the ITCZ and warming of the Agulhas Current during North Atlantic cooling episodes (Ziegler et al., 2013; Braun, 2014; Simon et al., 2015). Higher precipitation around 100ka is indicated in marine core CD154-10-06P, ca.160 km off the KZN coast (Fig. 1 this paper, Simon et al., 2015) and core CD154-17-17K, situated near the mouth of the Great Kei River (Fig. 1 this paper, Ziegler et al., 2013) in the Eastern Cape, some 500 km north east of Klasies River. The tufa record from Klasies River cave 1C dating to between 105 and 103 ka corroborates these wetter conditions as the peaks in the δ^{13}C values correspond to high values of Fe/K in core CD154-10-06P (Braun, 2014). It is probable that this wetter episode relates to an increase in summer rain and C4 plants (Bar-Matthews et al., 2010). The relatively moist conditions also occurred to the west of Klasies River during this period. Pollen and charcoal from a sediment core from the Vankervelsvlei wetland in the Wilderness area indicate relatively warm and moderate mesic conditions in MIS 5c/d (Quick et al., 2016). The conditions around 100 ka seemed to have been similar also in the interior. Wetter conditions are indicated in the Tswaing Pretoria Saltpan record (Partridge et al., 1997) that mirrors the changes in core CD154-10-06P (Simon et al., 2015). At Florisbad, lacustrine sands related to bodies of standing water also indicate a wetter period around ca. 100 ka (Toffolo et al., 2017, pp. 475).

Palaeoenvironmental links between the interior and the southern Cape are underexplored (Carr et al., 2016) but this connection has been tracked through the evolution of the black wildebeest (*Connochaetes gnou*) (e.g. Brink et al., 1999; Brink, 2005). Tracing the evolution of Alcelaphines, specifically the black wildebeest, is important for understanding faunal migratory patterns in the Pleistocene. Alcelaphine remains are often recovered from late Pleistocene southern Cape sites (e.g. Klein, 1976; Henshilwood et al., 2001; Van Pletzen, 2000), but it has to be noted that it is generally difficult to differentiate wildebeest from other Alcelephinae in MSA collections. Yet wildebeest – specifically black wildebeest – have been identified at Die Kelders from the MIS 4 layers (Klein and Cruz-Uribe, 2000), Klipdrift Shelter at ~ 60 ka (Reynard et al., 2016) and Pinnacle Point in the Lightly Cemented MSA Lower (LC-MSA) horizon dated to between ~153 and 174 ka (Rector and Reed, 2010). Klein (1976), (Table 1) further noted the presence of two specimens of wildebeest in layer 16 (SASU sub-member) and four more from layer 17 (SASL sub-member). These specimens indicate that this species was present in the southern Cape from the later Middle Pleistocene. Brink (Brink et al., 1999; Brink, 2005, pp. 181) has shown that before 90 ka wildebeest from the southern Cape were similar in size than those from the interior. Tali from the Klasies River MIS 5c (layers 15 and 16), for example, are of the same size as Middle Pleistocene Florisbad samples. After 90 ka the black wildebeest became isolated in the Cape area and there was a marked reduction in their size compared to contemporary groups in the interior. They also became stockier and more robust. Even though there was a reduction in size, body proportions remained similar to those from inland species, supporting the possibility that late Florisian coastal *C. gnou* populations descended from interior Florisian groups (Brink, 1993). The reduction in size culminated in the late Pleistocene until a regionally distinct population developed in the late Glacial in the southern Cape coastal zone. Research suggests that large herbivore turnover was driven by climate change in the southern Cape (Faith and Behrensmeyer, 2013). The presence of gregarious ungulates at Klasies and other southern Cape sites implies that large herbivore communities from the interior had contact with the southern Cape coastal plain. This movement would have taken place particularly during the glacial periods when grazing habitat for ungulates increased on the coastal plain (Klein, 1983, 1984; Brink, 1993, 2005; 2016; Faith, 2011b).

The migration routes would have involved crossing a major barrier, the Cape Fold Mountains that physiographically separates the interior from the Cape coastal plain (Fig. 1). Connection between the interior and the coastal plain would have been through narrow pathways or “poorts”. Poorts are steep-walled openings that cut perpendicularly across a topographic barrier, usually along river courses (Geldenhuys, 1997). Migration of people and animals between the interior and the coastal plain was probably along such natural paths, historically followed by for example elephants in the Attaquas Kloof, Outeniqua mountains (Ross, 1972). It is also a possibility that grazers migrated in an east west transect across the Palaeo-Agulhas coastal plain (Marean, 2010; Marean et al., 2014; Faith and Thompson, 2013). The coastal plain covers the area south of the Cape Fold Mountains between Bot River in the west and Port Elizabeth in the east (Marker and Holmes, 2005). Grazers may have migrated across the Paleo-Agulhas plain between fresh grass that grows in the winter in the west, and summer in the east. Strontium (^{87}Sr/^{86}Sr) isotopes from fossil mammal teeth from the Pinnacle Point area have been compared to bioavailable ^{87}Sr/^{86}Sr of plants from a wide range of areas including the Cape Fold mountains, Little Karoo and the Coastal plain (Copeland et al., 2016). Fossil ungulate teeth from 12 taxa, including the black wildebeest, dating to between MIS 6 and MIS 5c from the Pinnacle Point 13B and Pinnacle Point 30 sites indicate that the fossil strontium isotope values are in the range of the bioavailable strontium isotope ratios from the coastal plain. It is inferred that Pleistocene ungulates restricted themselves to the Paleo-Agulhas plain during the Pleistocene, and that they avoided habitats that are currently situated more than about 15 km north from the coastline. Indeed, the Palaeo-Agulhas plain could have formed a new habitat-type in the GCFR and may have been a separate ecosystem where the large grazing ungulates were based (Marean et al., 2014). The black wildebeest, though, had unusually high strontium isotope values and the highest variance between individuals of all the genera tested. It would be informative to compare strontium isotopic values of Middle and Late Pleistocene gnou from the interior and the southern Cape.

6. Conclusions

This paper focuses on the SASU and SASL sub-members at Klasies River main site. A new U-Th age of 126.0 ± 1.5 ka on flowstone associated with fallen tufa material from the base of the SASU sub-member is reported. The falling event post-dates the deposition of SMONE and pre-dates the deposition of layers OHO and HHH. The U-Th age thus provides a maximum age for the contact between layer SMONE of the SASL sub-member and layer HHH of the SASU sub-member. The SASU sub-member deposits are in primary context and were formed by multiple visits of hunter-gatherer-fisher groups whose occupation debris include many lithics, well preserved fauna and multiple superimposed hearths. The underlying SASL sub-member is also associated with a prolific lithic industry and fauna, but some post depositional disturbance occurred and no *in situ* hearths were found. There is evidence of extensive fire use in this layer though, and heat-affected fauna, lithics and shellfish associated with rubefied quartzite, potentially intentionally and repeatedly exposed to fire and heat, occur. The lithic reduction strategy used in SASU and SASL was very similar and in both sub-members quartzite cobbles were used as blanks for core reduction. A parallel unidirectional convergent method of reduction was followed to produce blade and especially pointed blanks.

The basal SASU occupation phase coincided with a wet period, most likely around 100 ka, as recorded in several marine and sediment cores, associated with increased summer rain in the Eastern Cape. This sub-member is associated with relatively more browsing fauna and a higher prevalence of seals and other riparian species, perhaps indicating relatively higher sea levels, and more closed environments. In contrast, the faunal composition of the SASL sub-member indicates a shift towards more open habitats that included relatively more grazers.

The Klasies River evidence discussed here originates from the Florisian period when there was most likely contact between the southern Cape coastal plain and the interior. New genetic research indicates deep divergence dates for modern humans, extending back to 300 ka and it thus becomes crucial to expand the modern human origins research into the Middle Pleistocene. It is also vital to consider modern human origins from a sub-continental perspective and to understand how the Klasies River early humans related and connected to populations from the interior. In doing so, it might be discovered that connections between the interior and the coastal areas were much more prevalent in the Pleistocene than hitherto appreciated.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.quaint.2018.03.039.

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