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Publication Details

Mackay, A., Jacobs, Z. & Steele, T. E. (2015). Pleistocene archaeology and chronology of putslaagte 8 (PL8) Rockshelter, Western Cape, South Africa. *Journal of African Archaeology*, 13 (1), 71-98.

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Abstract

We report on excavations of a small rock shelter - Putslaagte 8 (PL8) - located on the arid interior fringe of South Africa's Fynbos biome. The shelter preserves a long sequence of Holocene and late Pleistocene occupation dating back beyond 75,000 years BP. This paper presents data on the technological, faunal and chronological sequence. Occupation is markedly pulsed and includes three late Pleistocene Later Stone Age (LSA) units (macrolithic, Robberg and early LSA), as well as several distinct Middle Stone Age (MSA) components from Marine Isotope Stage (MIS) 3-5. Pulsing may reflect the arid and possibly marginal environments in which the shelter is situated, and to that end some elements of the sequence contrast with occupational patterns towards the coast. Viewed in a regional setting PL8 suggests: 1) complementarity of resource movements between the coast and interior in terminal MIS 2; 2) distinctions in material selection, and possibly technology, between the coast and interior in earlier MIS 2; 3) an MSA lasting to at least 40,000 years before present; 4) a weak Howiesons Poort and post-Howiesons Poort in the interior; 5) possibly distinct periods of denticulate manufacture within the MIS 5 MSA; 6) highly localised patterns of material acquisition in the earlier MSA.

Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

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**Pleistocene archaeology and chronology of Putslaagte 8 (PL8) rockshelter, Western Cape,
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Abstract

We report on excavations of a small rock shelter – Putslaagte 8 (PL8) – located on the arid interior fringe of South Africa's Fynbos biome. The shelter preserves a long sequence of Holocene and late Pleistocene occupation dating to beyond 75 000 years before present. This paper presents data on the technological, faunal and chronological sequence.

Occupation is markedly pulsed and includes three late Pleistocene Later Stone Age (LSA) units (macrolithic, Robberg and early LSA), as well as several distinct Middle Stone Age (MSA) components from MIS 3-5. Pulsing may reflect the arid and possibly marginal environments in which the shelter is situated, and to that end some elements of the sequence contrast with occupational patterns towards the coast. Viewed in a regional setting PL8 suggests: 1) complementarity of resource movements between the coast and interior in terminal MIS 2, 2) distinctions in material selection and possibly technology between the coast and interior in earlier MIS 2, 3) an MSA lasting to at least 40 000 years before present, 4) a weak Howiesons Poort and post-Howiesons Poort in the interior, 5) possibly distinct periods of denticulate manufacture within the MIS 5 MSA, and 6) highly localised patterns of material acquisition in the earlier MSA.

Résumé

Nous proposons ici un résumé de nos activités de fouille menées à Putslaagte 8 (PL8), petit abri localisé dans la frange intérieure et aride de l'Afrique du Sud, ouvert dans un environnement de type Fynbos. L'abri contient une longue séquence Holocène et Pléistocène supérieur avec des premières occupations antérieures à 75 000 ans BP. Dans cet article, nous présentons de premières données technologiques, fauniques et chronologiques. L'occupation, marquée par plusieurs discontinuités, inclut trois phases Later Stone Age (LSA) de la fin du Pléistocène (macrolithique, Robberg et Early LSA), ainsi que plusieurs phases MSA du MIS 3-5. Les discontinuités dans l'occupation s'expliqueraient par la position marginale de l'abri et de potentielles variations hydrométriques. Dans cette perspective, certains éléments de la séquence contrastent avec les modes d'occupation observés sur les sites côtiers. D'un point de vue régional, PL8 suggère 1) une complémentarité dans les modes de gestion des ressources entre la côte et l'intérieur des terres à la fin du MIS 2, 2) des différences dans la sélection des matériaux et potentiellement dans la technologie entre la côte et l'intérieur des terres au début du MIS 2, 3) un MSA qui se prolonge au moins jusqu'à 40 000 ans BP, 4) un Howiesons Poort et un post-Howiesons Poort faiblement représenté à l'intérieur, 5) possiblement plusieurs périodes distinctes associées à la confection de denticulés au cours du MIS 5, et 6) des modes d'acquisition des ressources très localisés au cours du Early MSA.

Introduction

The Fynbos biome, occupying much of southern Africa's Winter and Year-round Rainfall Zones (cf., Chase & Meadows 2007), is an important region for studies of the origins and behavioural evolution of early modern humans (Marean 2010). Sites in the Fynbos have sequences extending beyond 100 ka¹ (Avery et al. 2008, Jacobs 2010, Marean et al. 2007) and have produced early evidence for the use of symbols, bone tools and complex stone artefact technologies (d'Errico et al. 2005, d'Errico & Henshilwood 2007, Henshilwood et al. 2001a, Henshilwood et al. 2011, Henshilwood et al. 2009, Jacobs et al. 2008a, Mackay & Welz 2008, Texier et al. 2013, Texier et al. 2010, Vanhaeren et al. 2013). To date, however, most studies in the Fynbos have focussed on sites located coastward of the Cape Fold Belt mountains (e.g., Avery et al. 2008, Henshilwood et al. 2001b, Klein et al. 2004, Marean 2010, Singer & Wymer 1982, Will et al. 2013)(Figure 1); the timing and nature of occupation of interior locations remains poorly understood (though see Deacon 1979, Högberg & Larsson 2011). The coastal/interior contrast is particularly important in the Western Cape as the region has rich marine resources but a generally arid and less productive interior (Marean 2010), in part a consequence of the rain-shadow effects of the Cape Fold Belt.

Understanding the relationship between coastal and interior sites is important to debates surrounding the behaviour of early modern humans, and particularly to the effects of demography and population fragmentation on the appearance and disappearance of cultural complexity (Compton 2011, Mackay et al. 2014); with significant demographic

1. Ka = thousand years before present.

expansion we may expect to see greater occupation of previously peripheral interior areas, while fragmentation of population interaction is likely to be first expressed in such locations.

With these points in mind, the rockshelter site of Putslaagte site 8 (PL8) was excavated in October and November 2010. The site is situated on the modern interface of the Fynbos and Succulent Karoo biomes, 82 km from the present coastline (minimum straight line distance) and in the rain-shadow east of the northern Cederberg mountains, which form the northwestern extension of the Cape Fold Belt (Figure 1 inset). PL8 is one of eight late Pleistocene sites in an area 100 km by 100 km at the northern limit of the Fynbos. As such, this area provides an unusually dense concentration of excavated late Pleistocene rock shelter sequences in southern Africa, and is an ideal location in which to explore varying patterns of land use, technology and potentially demography.

This paper details the archaeological and chronological sequence at PL8 and considers its implications for the archaeology of the region in terms of the issues outlined above. Though the focus here is on the late Pleistocene, the entire sequence at PL8 is discussed with the exception of the stone artefacts from the mid to late Holocene layers, which were the subject of a separate study (Plaskett 2012).

Late Pleistocene technology and occupational chronology in southern Africa

Occupation of the Fynbos is attested as early as MIS 6, based on dates from the south coast site of Pinnacle Point (Jacobs 2010). Occupation at this time appears to have been largely episodic and stone artefact assemblages quite small. The production of unretouched levallois points and other convergent flakes, as well as some equivocal evidence for the production of small blades, predominantly on quartzite, have been noted in the MIS 6 layers

at Pinnacle Point along with the collection and processing of ochre (Marean et al. 2007, Thompson et al. 2010).

Many Fynbos sites were likely occupied during MIS 5, though in general these suffer from a lack of dating, and potentially a lack of coherence or consistency between the composition of like-aged assemblages in different locations (Mackay et al. 2014). For example Wurz (2002) suggests that the earliest stone artefact technologies at Klasies River were focused on the production of large blades, while potentially concurrent assemblages on the west coast at Ysterfontein 1 and Hoedjiespunt have yielded flake-based assemblages rich in denticulates and notched pieces (Will et al. 2013, Wurz 2012). Material selection differs between these sites, artefacts at Klasies River being dominated by quartzite, those from Ysterfontein being dominated by silcrete and calcrete, and the Hoedjiespunt sample being dominated by quartz and calcrete.

There are similarities between Ysterfontein, Hoedjiespunt and the M3 unit at Blombos, which is also oriented towards flake production, contains an abundance of silcrete and quartz, and which includes a few denticulates and notched pieces (Henshilwood 2001a; Jacobs *et al.* 2006). M3, however, dates to around 99 ka and is likely too young for direct comparison with Ysterfontein at least. There are also similarities between the Ysterfontein denticulates and those from the undated interior site of Klipfonteinrand (Avery et al. 2008), which lies 20 km south of PL8, though Klipfonteinrand is quartzite-dominant.

Later MIS 5 technologies at Klasies River exhibit an emphasis on convergent flakes (Wurz 2002) while those at Pinnacle Point possibly reflect an alternation between blade and point production (Thompson et al. 2010), though it should be noted in the latter case that neither

form accounts for a substantial proportion of the assemblage analysed. In addition to these sites, undated potentially late MIS 5 assemblages are known from the Fynbos sites of Diepkloof², Elands Bay Cave, Herold's Bay Cave, Hollow Rock Shelter, Klipfonteinrand, Montagu Cave, Mossel Bay Cave, Nelson Bay Cave, Paardeberg, Peers Cave and Varsche Rivier 3 (Högberg & Larsson 2011, Minichillo 2005, Porraz et al. 2013a, Volman 1980). Retouch at these sites is infrequent with occasional notched and denticulate pieces, and the variable production of flakes, blades and unretouched points (Volman 1980). With the exception of Varsche Rivier 3, these sites are dominated by quartzite; Varsche Rivier 3 is quartz-dominant throughout (Steele et al. 2012).

From the end of MIS 5, technological and occupational patterns across the Fynbos become somewhat more coherent. Bifacial point-bearing 'Still Bay' assemblages dating to early MIS 4 have been recovered from isolated sites on the south coast (Blombos; Henshilwood et al. (2001b)), and in the interior 20 km south of PL8 (Hollow Rock Shelter; Högberg & Larsson (2011)). Diepkloof on the west coast also has bifacial point assemblages that may date to this time, though they may also be far older (Jacobs et al. 2008a, Tribolo et al. 2013). Early dates for bifacial point assemblages have also been presented from sites outside beyond the Fynbos such Sibudu and Border Cave (Grun & Beaumont 2001, Wadley 2012), though at Sibudu the presence of bifacial points extends into early MIS 4. In addition, undated bifacial point-bearing assemblages have been recovered from Trappieskop, Peers Cave, Varsche Rivier 3 and the open sites Soutfontein 1 and Klein Hoek 1 (Mackay et al. 2010, Mackay et al. In Press, Minichillo 2006, Steele et al. 2012). The Still Bay at Blombos is rich in silcrete, while

2. The Diepkloof chronology is contested beyond 65 ka. Rather than preferencing an age here we will treat this part of the sequence as, in effect, undated.

at Hollow Rock Shelter quartzite is the dominant material, though silcrete occurs in greater frequencies than during MIS 5 (Evans 1994, Henshilwood et al. 2001b). At Soutfontein two thirds of the points are made of quartz (Mackay et al. 2010). Jacobs et al. (2013) place the end of the Still Bay at around 71 ka at Blombos, and comparable ages have been returned from Hollow Rock Shelter (Högberg & Larsson 2011), though, again, there are earlier dates from Diepkloof (Tribolo et al. 2013).

From 65-60 ka silcrete-rich, blade-oriented, backed artefact-bearing 'Howiesons Poort' assemblages are known from several Fynbos sites, including those on the west coast (Diepkloof, Porraz et al. (2013b)), south coast (Klasies River, Singer & Wymer (1982); Klipdrift, Henshilwood et al. (2014)) and the Cederberg mountains (Klein Kliphuis, Mackay (2010)). Recent dating of Pinnacle Point suggests that the production of backed artefacts may extend back to 71 ka (Brown et al. 2012). The assemblage from Die Kelders, which has a few backed pieces but which generally lacks clearly defining characteristics of the Howiesons Poort may also have accumulated in the time between 70 ka and 60 ka (Feathers & Bush 2000, Schwarcz & Rink 2000).

Undated Howiesons Poort instances are also known from Klipfonteinrand, Nelson Bay Cave and Peers Cave and VR3. Assemblages ascribed to the Howiesons Poort are often extremely large in artefact numbers and dense relative to excavation area when compared with earlier and later assemblages at the same sites (Mackay 2010, Mackay et al. 2014). At Diepkloof the Howiesons Poort post-65 ka is associated with the engraving of ostrich eggshell, possibly flasks (Texier et al. 2013, Texier et al. 2010).

The transition from late MIS 4 Howiesons Poort to early MIS 3 post-Howiesons Poort assemblages has been shown to be a smooth and continuous one at Klasies River and Klein Kliphuis, as well as further afield at Rose Cottage Cave in the Grasslands biome (Mackay 2011a, Soriano et al. 2007, Villa et al. 2010). At Klein Kliphuis, backed artefacts, blades and high proportions of silcrete give way to larger, thicker quartzite flakes and the production of unifacial points. These initial post-Howiesons Poort layers extend through to ~50 ka at Klein Kliphuis, Klasies River and Diepkloof. Interestingly thereafter occupation of rock shelter sites seems to cease across the region (Mackay et al. 2014), with few sites show compelling evidence of occupation from 50 ka through to the start of MIS 2, ~25 ka (though note Mackay et al. In Press). This period is particularly important because it is somewhere between 40 ka and 25 ka that the Middle Stone Age (MSA) is believed to have ended (d'Errico et al. 2012, Opperman 1996). The exceptions are Boomplaas and Klein Kliphuis. Hollow Rock Shelter has OSL ages around 44 ka but it is not clear if they are associated with any archaeological finds (Högberg & Larsson 2011), while Klein Kliphuis produced a small, quartz-rich assemblage lacking distinctive retouched elements and age bracketed by radiocarbon assays of ~55 ka and >35 ka (Mackay 2010). Based on the presence of faceted platform flakes, Mackay ascribed these assemblages at Klein Kliphuis to the MSA. Boomplaas has what are described as 'youngest MSA' assemblages dating approximately 40-36 ka but details are scant and occupation appears to have been ephemeral (Deacon 1979, Faith 2013).

Occupation (in many cases re-occupation) of sites is evident throughout the Fynbos from the start of MIS 2. Boomplaas, Byneskranskop, Elands Bay Cave, Kangkara, Nelson Bay Cave, Faraoskop and Klein Kliphuis have stone artefact assemblages dating between 25 ka and 12

ka (Deacon 1978, 1982, Mackay 2010, Manhire 1993, Orton 2006, Schweitzer & Wilson 1983). In all cases these sites have very few flakes with faceted platforms and lack discoidal and Levallois core forms. MIS 2 assemblages with an abundance of small blades and platform cores have been termed 'Robberg' or alternatively 'late Pleistocene microlithic' (Deacon 1984). The discrepancy in terms may reflect a degree of spatial and/or temporal patterning (Mitchell 1988). Small blades and platform cores effectively characterise MIS 2 assemblages from the south coast sites of Byneskranskop and Nelson Bay Cave (Deacon 1978, Schweitzer & Wilson 1983), as well as at the Cape Fold Belt site Boomplaas (Deacon 1979) and in Grassland biome sites such as Sehonghong and Rose Cottage Cave (Mitchell 1995, Wadley 1995). At coeval sites on the west coast such as Elands Bay Cave, Faraoskop and Klein Kliphuis, however, quartz bipolar dominates and the 'Robberg' signal is more muted (Mackay 2010, Manhire 1993, Orton 2006). In most cases these MIS 2 assemblages include some backed pieces but are generally poor in retouched elements. There is also a temporal element to variation in the MIS 2 archaeology of the region; while ages are relatively common 12-17 ka and again 20-24 ka, there is a notable poverty of ages in the middle of MIS 2. This is most obvious at Elands Bay Cave where large numbers of ages are available, but can also be discerned at Boomplaas and Nelson Bay Cave (Deacon 1978). That the pattern is replicated at Sehonghong in Lesotho suggests that non-sequence in mid MIS 2 may be a widespread phenomenon (Mitchell 1995).

The end of the Pleistocene sees a shift away from microlithic technologies (Deacon 1984). At Elands Bay Cave the period from 13-8 ka witnesses unusually low proportions of quartz and increases in hornfels; hornfels also peaks in the Faraoskop sequence around 13 ka though quartz remains constant at around 85% of the assemblage (Manhire 1993, Orton 2006). On

the south coast at Byneskranskop and Nelson Bay Cave increases in quartzite mark the initial non-microlithic, the transition dating ~15 ka at the latter and >11 ka the former (Deacon 1978, Schweitzer & Wilson 1983). Increases in both quartzite and hornfels are observed at Boomplaas in the Cape Fold Belt (Deacon 1982). Large scrapers seem to be the most characteristic implement of these assemblages generally (Deacon 1978, 1982, 1984). In the west coast sites nearest PL8 (e.g., Elands Bay Cave and Faraoskop) these take the form of 'naturally backed knives' – a form of large scraper with a round retouched edge opposed to a flat, often cortical margin (Orton 2006). These are most commonly made from hornfels.

PL8 - site, setting and stratigraphy

PL8 is a small rock shelter located in the low canyon (or 'kloof') of the Putslaagte River, a small ephemeral tributary of the Doring River. The surrounding kloof is rich in rock paintings, with numerous overhangs preserving a large corpus of art. Few of these shelters have effective sediment traps, however, and deposits suitable for excavation are consequently rare. PL8 has very limited art, but presented an attractive proposition for excavation largely due to the configuration of boulders at the front of the site, which appeared to have protected more than one metre of accumulated deposit (Figure 2).

The shelter faces north-north-east and measures only 3 m from the boulders at front to the rear wall, and less than 2 m high at the front, tapering rapidly towards the back (Figure 2). Though the sheltered area continues for more than 20 m along the kloof wall, the width of deposit accumulated behind the boulders is approximately 11 m, restricted to the western end. The deposit surface is generally flat with a gradual slope from west to east that increases in gradient east of the excavated area. Vegetation along the front of the shelter

screens it from sight, such that it can barely be discerned when standing 20 m away in the valley (Figure 3)³.

The local geology is Table Mountain Sandstone (TMS) and vegetation is a mix of Doringrivier Quartzite Karoo and Cederberg Sandstone Fynbos (Mucina & Rutherford 2006). Limited water would be available in small ponds above the shelter immediately after rains.

Otherwise, presently-permanent waterholes occur on the Doring River, 2.2 km to the east.

The Doring River is one of the largest watercourses in the region – although seasonal, its annual outflow is roughly the same as that of the permanent Olifants River, with which it merges ~30 km northwest of PL8. Due to its large catchment, the cobble beds of the Doring contain a wealth and diversity of flakeable stone. Surveys along the river in the vicinity of PL8 revealed a consistent abundance of quartzite and hornfels with cobbles regularly exceeding 100 mm. Silcrete cobbles were less common. These were invariably grain-supported yellow silcretes with smooth red or grey cobble cortex. Chert and quartz pebbles were rarely found in the river, though small quartz pieces erode out from the TMS and are common on the land surface in the vicinity of the site.

Two contiguous square metres were excavated at PL8 in October and November of 2010.

This represents approximately 13% of the area of deposit available for excavation at the site.

The squares were placed in a flat area of deposit, oriented to extend from the front of the shelter towards the rear. Excavation units followed stratigraphy where that could be discerned and otherwise horizontal 30 mm spits were used across 500 mm quads. As a test

3. The site may have been an effective hunting blind; the normally skittish cape pheasant (*Francolinus capensis*) occasionally passed unperturbed within 10 m of the shelter during excavation.

excavation into a deposit of unknown depth and composition, artefacts were not plotted. All material was sieved on site through nested 3 mm and 1.5 mm sieves and sorted in Cape Town by experienced personnel of the UCT Archaeological Contracts Office, Mpokamo Sasa and Ntandazo Mjikeliso.

Well-defined stratigraphy was largely absent at PL8 (Figure 4). Two dung crusts – LUD (loose upper dung) and PCD (partial consolidated lower dung) – and two hearths – UHP (upper hearth pit) and MH (minor hearth) were identified in the upper 200 mm of deposit. Below this only two stratigraphic units were differentiated: unit CGBSS (compact grey brown silty sand), accounting for 26 spits between 25 mm and 1 m below surface, and FOBSS (fine orange brown silty sand), accounting for the remaining 14 spits down to a maximum depth of 1.63 m below surface. Excavation ceased at solid rock (either bedrock or massive roof-fall). Solid rock was encountered earlier in the rear-most square (square 2) than in the fore-most square (square 1), and consequently excavation there ceased at FOBSS spit 9 (FOBSS 9).

Bioturbation

Evidence of bioturbation occurred throughout the PL8 deposit. The upper strata preserve evidence of mammal burrows (most likely moles or dune-mole rats) in section, though these were difficult to isolate during excavation. Evidence of such burrowing was not apparent below CGBSS 6, however some evidence of termites and other burrowing insects was noted in almost all spits through to the base.

Concretions

Sediments became increasingly concreted towards the base of the excavation, complicating excavation and coating artefacts. Consolidation was sufficiently robust that agitation of a small sample of selected artefacts in an ultrasonic bath for up to 24 hours had no discernable effect. Artefacts were often coated in sediment to the extent that flaking features, and sometimes basic artefact classes, could not be identified. Interestingly this coating was usually present on only one surface of an artefact.

Bone

A total of 11.7 kg of bone was recovered from the excavated area, of which 9.4 kg falls within the layers considered here. The distribution of bone through these layers is strongly patterned (Figure 5, column a). Bone is most common from CGBSS 8-15 and above and tapers away dramatically below this. Bone weight peaks from CGBSS 10-14, with values between 850 g and 1770 g per spit, while weight per spit is less than 50 g in below CGBSS 18, and less than 10 g below CGBSS 20 with the exception of 29 g in FOBSS 7. That said, bone is only absent in the four deepest spits.

In the identifiable bones, most abundant are the remains of small animals (Table 1). The Holocene sample is dominated by molerat, hyrax, small bovids, and fish. The abundant molerats were likely responsible for the bioturbated nature of the deposits, particularly above CGBSS 6. The hyrax are indicative of the rocky environment, and fish reflect the nearby water sources. Occasional use of the shelter by hyenas in the Holocene is indicated by three coprolites, and one hyena phalange was preserved in CGBSS 8. Molerats are notably less abundant in the lower deposits, but otherwise the Pleistocene fauna is similar

to the Holocene fauna with abundant hyrax and small bovids. Other bovids are present as well, but they could not often be identified to species. However, Cape buffalo, Alcelaphine hartebeest/wildebeest, and zebra attest to the presence of grasslands, reedbuck to water, and klipspringer to the rocky environment. Unfortunately, sample sizes are too small to clearly identify changing environments in the region through the end of the Late Pleistocene. In addition, poor bone preservation, which included concretions, limited a detailed zooarchaeological analysis. Two cut-marked bones were present in the Holocene material, along with one from CGBSS 10, supporting human's role in collecting the fauna. No burned bones were identifiable to taxa.

Tortoise remains are prevalent in the layers that preserved bone. All angulate tortoise distal humeri breadth were measured. Angulate tortoise remains are common in most Fynbos archaeological assemblages, and changes in tortoise size may reflect the intensity of human predation on them (Klein 1983, Steele & Klein 2005). However, in PL8, significant variation in typical tortoise size is not apparent through the sequence.

Ostrich Eggshell (OES)

A total of 258 pieces of ostrich eggshell was recovered from PL8, with a combined weight of 138.5 g. Of these, 64 pieces were identified as beads or bead fragments. Almost all of the OES, however, occurs in the Holocene spits above CGBSS 8. Only 67 fragments, weighing 48 g, occur below this. The overwhelming bulk of these pieces (n=64, weight=47 g) occurs from CGBSS 8-11. These layers also contain beads (n=8). Otherwise, three isolated fragments of OES occur in CGBSS 13, 21 and 23.

Marine shell

Limited marine shell was preserved in the PL8 sequence, unsurprising given the distance from the coast. Nine fragments, mostly black mussel (*Choromytilus meridionalis*), were recovered from the spits above CGBSS 8. Two fragments were recovered from CGBSS 9.

More surprising is the presence of a *Nassarius kraussianus* shell in CGBSS 21; bone and OES are poorly preserved in this layer and it seems plausible that this piece has moved down from further in the deposit. The shell is broken but may have been a bead (Figure 6).

Nassarius sp. inhabit estuarine contexts (Richards 1987). The nearest estuary on the present coastline is at Olifants River Mouth, 95 km to the west as the crow flies, though pedestrian transport distance would be considerably greater (for example the distance if following the Doring / Olifants river would be ~150 km). Note though that distance to coast in the late Pleistocene would have been considerably greater, and the distance to the nearest estuary becomes unknowable. Transport distances for marine shell exceeding 100 km in the late Pleistocene have been reported elsewhere (Mitchell 1995, Wadley 1995).

Charcoal

Approximately 250 g of charcoal was recovered from the excavation, with ~100 g occurring below CGBSS 7. Charcoal occurs in reasonable quantities in CGBSS 8. It is practically absent in the sample from CGBSS 9-15 inclusive, where bone is at its highest abundance (Figure 5, column b). It is unclear whether the absence of charcoal at this time is a product of taphonomic or behavioural factors, or whether it reflects a change in the kind of fuel available to burn. Charcoal occurs again in small quantities from CGBSS 16 through FOBSS 6 before disappearing again in the lowest spits.

Ochre

Three hundred and ten (310) fragments of ochre weighing 589.4 g were recovered during the excavation, of which 208 pieces (429.9 g) occur below CGBSS 7. Forty six (46) of these pieces show clear signs of grinding or abrasion, with a further two showing ambiguous signs of working. Ochre occurs throughout the sequence with the exception of the basal spit.

Ochre pieces are most abundant in the upper spits from CGBSS 8-19 (Figure 5, column c), but are relatively uncommon from CGBSS 20 through FOBSS 4, exhibiting another, relatively brief peak from FOBSS 5-7 before decreasing again.

Numbers of ground pieces are more evenly distributed through the sequence than the total weight of ochre fragments, implying that total weight of ochre discarded at site does not always predict the amount of used ochre that will be discarded. That said, the earliest ochre peak in FOBSS 5-7 is well reflected in the number of pieces exhibiting use. FOBSS 6 has five ground pieces while FOBSS 7 has nine; no other spit has more than three ground pieces.

Ground ochre takes many forms, and often occurs as fragments of what were probably once larger pieces. Three of those recovered from PL 8 have convergent facets resulting in crayon-like morphologies, one in each of CGBSS 20, FOBSS 6 and FOBSS 7. There is also a single piece with a concave facet in FOBSS 7. No unambiguously scored or engraved pieces were recovered.

Stone artefacts

Approximately 15 000 stone artefacts were recovered from the 2 square meters excavated at PL8. We report here on preliminary analysis of the 11 882 artefacts recovered from spits

below CGBSS 8. All unretouched flakes >15 mm maximum dimension in the sample were analysed in detail, along with all cores and retouched/used flakes regardless of size.

Artefact numbers and densities

Artefact numbers and densities are unevenly distributed throughout the sequence (Figure 5, column d). Numbers per spit are generally low below CGBSS 19; FOBSS 7 is the only spit below this to have yielded more than 200 artefacts. Numbers per spit peak in CGBSS 16 and 17 with more than 1100 artefacts recovered from the two square metres excavated in each of these spits.

Material types and sources

In contrast to other late Pleistocene assemblages in the region, hornfels is the dominant material in the recovered sample, accounting for 54.1% of artefacts >15 mm and 49.3% of artefacts overall. Quartz (26.2% overall), silcrete (12.7% overall) and quartzite (7.9% overall) are the other common materials, with crypto-crystalline silicates (ccs) contributing a further 1.4%.

Cortex suggests that most rocks for flaking were sourced either from the river or as pebbles eroding from conglomerates. Cortex was identified as being of pebble/cobble type in 66.1% of all cases. Outcrop-derived cortex was identified in only 9.2% of cases, with the remaining 24.7% being of uncertain origin. Cortex types varied between material classes: hornfels (76.0% cobble/pebble) had the highest proportion of cobble cortex, followed by quartzite (61.3%) and ccs (46.2%). Silcretes appear to have been derived largely from primary sources (63.8% outcrop cortex), with relatively little use made of the cobbles available in the river.

The frequency of the main material types is variable through the sequence, with a number of clear peaks and troughs (Figure 5, column e). Hornfels shows peaks in CGBSS 8-12 and CGBSS 17-20, separated by a distinct peak in silcrete from CGBSS 12-15. Quartz exhibits a pulse from CGBSS 20-22 below which silcrete and quartzite proportions both increase. The peak in silcrete is sustained from CGBSS 24 through FOBSS 1, while quartzite remains common through to the base of the deposit, varying from ~20% to ~45%; above 21 quartzite never exceeds 10% of the assemblage total. The spits below FOBSS 1 are dominated by a mix of hornfels and quartzite. Silcrete, however, is almost absent in these lower spits.

While the sources of hornfels and possibly quartz seem to have remained relatively constant throughout the sequence, quartzite and silcrete show some evidence of change. Only 12.8% of cortical quartzite artefacts in the spits above CGBSS 19 exhibit signs of outcrop cortex. In the spits below CGBSS 20 this rises to 29.7% and includes some coarse quartzites possibly from the shelter itself. Among silcretes, 60.4% of cortical pieces above CGBSS 19 appear to have been outcrop-derived, while in the lower spits this value rises to 79.2% (though the older sample is small).

Retouched flakes

The excavation resulted in the recovery of a total of 160 retouched flakes. *Pièces esquillées* were the single most common type identified (n=38) followed by scrapers (n=12), denticulates (n=11), notches (n=7), backed pieces (n=3), unifacial points (n=2) and naturally backed knives (n=2) (Figure 7).

Differentiating *pièces esquillées* from bipolar cores can be difficult and indeed it may be that the artefacts themselves overlap in function and form – that is, some *pièces esquillées* may

have been bipolar cores that were also used. In the present case, however, the two types could be distinguished insofar as *pièces esquillées* were generally made on flakes, lacked scars that extended from edge to edge, and were heavier ($\bar{x}_{\text{pièce esquillée}}=9.7$ g, s.d.=8.5; $\bar{x}_{\text{bipolar}}=2.3$ g, s.d.=5.4) and far thinner relative to width ($\bar{x}_{\text{pièce esquillée}}=3.7$, s.d.=1.7; $\bar{x}_{\text{bipolar}}=2.1$, s.d.=0.8) than bipolar cores.

The distribution of key retouched flake types through the PL8 sequence is shown in Figure 5 (columns i-q). *Pièces esquillées* are prevalent from CGBSS 8-21 but infrequent earlier with the exception of the two spits FOBSS 6-7. These lower occurrences are not isolated examples, with six such implements being recovered from FOBSS 7 alone – more than any other single spit.

Naturally backed knives are a class of scraper usually made from hornfels and where a flat cortical surface is opposed to a unifacially worked, often curved, retouched edge. These may also be referred to as large scrapers, though in the western part of the Fynbos they are quite distinctive in form from other scraper types. At PL8 two such artefacts were recovered, one each in layers CGBSS 8 and CGBSS 11.

Backed pieces are another important implement class in the Western Cape sequence. Such artefacts occur in large numbers in the Howiesons Poort and again in the mid Holocene, but are generally infrequent in between. In the sample analysed here backed artefacts occurred in CGBSS 17 and again in CGBSS 23-24 (Figures 5 & 7). The younger backed piece was broken and made of hornfels. The older backed pieces are both complete and made of silcrete, with maximum dimensions of 31.5 mm and 33.3 mm. One is truncated and the other a segment. Given the prevalence of silcrete from CGBSS 24 through FOBSS 1, these backed pieces may

reflect a minor Howiesons Poort occurrence; the dimensions are similar to the means for backed pieces from Klein Kliphuis and Diepkloof (Mackay 2011b).

Unifacial points occurred in concert with backed pieces in CGBSS 23, and are typical of post-Howiesons Poort unifacial points and tips from other sites in the area (Figure 7). No clear bifacial points, generally taken to indicate a Still Bay assemblage, were recovered in the PL8 sample, though bifacial thinning flakes occur in FOBSS 1 (n=3).

Denticulates occur in the large sample of artefacts from the CGBSS 12-15 (n=2) and along with the *pièces esquillées* in FOBSS 6-8 (n=5) (Figure 5, columns l&m). Some of the five older denticulates are convergent and reminiscent of pieces from Klipfonteinrand (Mackay 2009) and Ysterfontein (Avery et al 2008), the latter dating to the warmer phases of early MIS 5.

Cores

A total of 203 complete cores and 86 core fragments were recovered from the spits below CGBSS 7 at PL8. Core types of interest here are bipolar (n=136), platform (n=55), and prepared forms including discoidal (n=7) and Levallois (n=6). The platform core category includes large, single-platform cores, and numerous small blade cores generally less than 20 g. The former class are pebble cores worked from a single unprepared cortical platform down the short axis of the pebble. The class is represented by two examples in spit CGBSS 8 and single instances in CGBSS 9, 10 and 13. Materials are hornfels and quartzite. The example shown in Figure 7 also has pitting on one of the flat surfaces, indicating complementary use as an anvil.

The small blade cores in the assemblage have one or more platforms, each with numerous removals, and tend to have little remnant cortex. Cores in the sample are made from a mix

of materials, most commonly silcrete (n=16) and hornfels (n=16), but also quartz (n=11) and ccs (n=6). These are concentrated in the spits from CGBSS 12-19 (n=40), and most particularly in the spits from CGBSS 12-15 where silcrete peaks (n=34).

Bipolar cores occur throughout the deposit but are most common in in CGBSS 22 and above. The prevalence of bipolar cores at this time has a discernible impact on minimum core weight (Figure 5, column t). All spits below CGBSS 23 include at least one core weighing less than one gram, while layers from CGBSS 10-19 inclusive contain cores weighing less than 0.5 g. The smallest cores in the sequence occur from CGBSS 11-14 (inclusive) and weigh 0.1 g (Figure 7). Such extremely small cores also occur in MIS 2 contexts at Elands Bay Cave (Mackay 2009).

Material prevalence among bipolar cores differs markedly from that among platform cores, though the two share much of their temporal range. Approximately 87% of bipolar cores are made from quartz, with hornfels (7.1%), silcrete (3%) and ccs (3%) accounting for relatively small proportions. The difference may in part reflect package size and form with quartz generally available only as small, rounded pebbles requiring bipolar working to initiate reduction. It may also reflect the suitability of different materials to bipolar (Mackay 2008). The lack of bipolar among silcrete cores, however, more likely reflects specific blank production strategies. The small silcrete platform cores at PL8 are strongly associated with the production of small blades. A sample of 1153 cores from excavated late Pleistocene contexts in the Western Cape suggests that the shift from freehand to bipolar reduction – the ‘bipolar threshold’ – occurs between 2-10 g (Figure 8). In that respect it can be noted that while the 20 silcrete cores in the PL8 sample range in weight from 27-1 g, 13 (65%) of these cores were abandoned in the range from 10-2 g, at which point a shift from the

production of small freehand blades to bipolar working would probably have been required. That these cores were not further reduced suggests that they were worked in a specific way to the exclusion of bipolar. It is clear that such a restriction did not apply equally to quartz cores.

Typical MSA core forms such as discoidal and Levallois occur in small numbers in the deposit but were only common below CGBSS 22. Necessarily this is not a consequence of sample size, and their absence from the upper spits may reflect the disappearance of these forms of core reduction by this part of the sequence. The frequency of flakes with faceted platforms (Figure 5, column s) largely mirrors this pattern, such pieces being infrequent above CGBSS 21. That said, small numbers of faceted platform flakes do persist into the upper spits. The balance of probability suggests that the MSA as defined through stone artefact technology ceases at PL8 between CGBSS 19 and CGBSS 23.

Unretouched flakes

Different flake morphologies characterise different parts of the PL8 sequence. The upper spits (CGBSS 8-11) include numerous flakes which are shorter than they are wide, generally consistent with the form of the short-axis platform cores discussed in the previous section. Approximately 70% of flakes in these spits are shorter than wide compared with ~43% in the rest of the assemblage. Similarly, ~38% of flakes in CGBSS 8-11 have cortical platforms; in the remainder of the assemblage this value is ~12%. Again, this is consistent with the dominant core form, where pebbles are worked from a flat cortical surface around one margin. These data suggest the presence of fairly distinctive flaking systems in the upper spits when compared with those below.

While laminar elements are present throughout the deposit to varying degrees they are proportionally most abundant in two clusters of spits, one from CGBSS 12-16 and the other from CGBSS 21-25. From CGBSS 12-16, laminar reduction accounts for >9.5% of flakes⁴, with a peak of 20.3% in CGBSS 14. In the second peak from CGBSS 21-25 laminar reduction accounts for >8.6% of flakes in all spits⁵. That these values are not higher probably reflects, among other things, the persistence of bipolar flaking throughout the sequence. There is a degree of correspondence between the prevalence of laminar flaking and the prevalence of silcrete, though this is more marked in the younger peak than in the older. In the older peak laminar flaking occurs from the middle of a silcrete pulse to the middle of a quartz pulse.

From CGBSS 17-19 flaking appears to feature a mix of expedient freehand and bipolar reduction, albeit with some continued production of small blades, evidenced both by the blades themselves and by the continued presence of small blade cores. Interestingly there are also small proportions of Levallois and discoidal (0.8-2.5% of flakes) in these layers. Such flake forms recur intermittently from CGBSS 20-26 but only become a concerted assemblage component from FOBSS 1. In this spit and those below, Levallois and discoidal flakes generally account for 6-8% of artefact totals. Levallois points and other convergent flake forms only become prevalent in and below FOBSS 10. Given the attendant paucity of cores in these lower spits it seems plausible that transportation of Levallois products was an important component of provisioning systems in the deeper part of the sequence.

4 All flakes, complete and broken, are included here to provide sufficient sample size in the lower spits. This undoubtedly leads to some underestimation of the proportion of laminar flaking given that on many fragments flaking system is impossible to identify. When restricted to complete flakes the proportional peak in laminar flaking rises to 29.7% with all spits between CGBSS 12-16 having >13% laminar products.

5 Laminar reduction does not account for >7.5% of flakes in any other spit.

Numerous flakes in the PL8 assemblage show ambiguous or unambiguous macroscopic signs of use. This is most apparent in the spits with small blades from CGBSS 12-16, where many examples exhibit heavy damage down one or both laterals. Approximately 5.4% (11/205) of laminar pieces in from these layers show signs of use, as opposed to 1.2% of other flaking types (15/1273). Some artefacts in these spits also exhibit possible impact fractures, including the specimen shown in Figure 7, a small convergent ccs flake which has extensive lateral damage to the ventral surface and a burin spall initiating from the tip. This artefact has a maximum dimension of 15.4 mm and a weight of 0.2 g.

Dating

We used two different dating techniques to obtain ages for the deposits at PL8 – optically stimulated luminescence (OSL) dating of sedimentary quartz grains and Accelerator Mass Spectrometer (AMS) radiocarbon (^{14}C) dating of charcoal fragments.

OSL

We used single-grain OSL both as a dating tool (e.g., Jacobs & Roberts 2007, Lian & Roberts 2006, Wintle 2008), and to explore the degree of sedimentary mixing the PL8 deposits (e.g., Jacobs 2005, Jacobs et al. 2006a, Jacobs & Roberts 2007). Eight samples were collected in a semi-continuous column from the west section from ~50 cm below the modern surface in unit CGBSS Spit 11 to ~1.2 m below surface in unit FOBSS Spit 4 (Figure 4). We were not able to collect samples from spits 5-14 in unit FOSBB, the bottom ~300 mm of the section, as it was too concreted. All samples were collected in dim red torch-light beneath an opaque tarpaulin. Quartz grains of 180-212 μm in diameter were extracted from the sediment samples in the laboratory under dim red illumination using standard procedures, including

etching by hydrofluoric acid to remove the external, alpha-dosed layer (Aitken 1998).

Equivalent dose (D_e) values were obtained from individual grains, to eliminate those with unsuitable OSL properties before calculating the age, and to address concerns about the extent of post-depositional sediment mixing (Jacobs & Roberts 2007).

A total of 8000 grains were measured using the single-aliquot-regenerative-dose (SAR) procedure, statistical models and experimental instrumentation described elsewhere (e.g., Jacobs et al., 2006). Grains were optically stimulated by an intense beam of green (532 nm) laser light (Bøtter-Jensen et al. 2003) and the ultraviolet OSL emissions were detected using an Electron Tubes Ltd 9635Q photomultiplier tube fitted with 7.5 mm of Hoya U-340 filter. Laboratory doses were given using a calibrated $^{90}\text{Sr}/^{90}\text{Y}$ beta source mounted on the OSL stimulation and detection instrument. Further details about the measurement procedures and instrumentation can be found in (Douka et al. 2014).

After measurement of the natural OSL signal, each grain was subjected to six regenerative-dose cycles and the induced OSL signals were measured. These cycles included a repeat dose and a zero dose, which form part of the SAR procedure performance tests that are routinely carried out on quartz grains (Jacobs & Roberts 2007). After measurement of the natural dose and each regenerative dose, a fixed test dose of ~9 grays (Gy) was given and then optically stimulated; the resulting OSL signal was used to monitor and correct for any sensitivity changes between successive SAR cycles. The natural and regenerative doses were preheated at 260°C for 10 s before optical stimulation for 2 s at 125°C (at 90% laser power), and the test doses at 220°C for 5 s. The OSL signal was determined from the first 0.22 s of stimulation and the count rate over the final 0.33 s was used as background. At the end of

the SAR sequence, a check was also made for the presence of infrared-sensitive grains and inclusions, using the procedure described by (Duller 2004).

As reported in previous studies, not every grain yields useful information on absorbed dose (Jacobs and Roberts, 2007). Accordingly, we rejected uninformative grains (Table 2) using criteria described and tested elsewhere (Jacobs et al., 2003, 2006). For grains that were accepted, a saturating exponential curve was fitted to the sensitivity-corrected regenerative-dose points and the D_e was obtained from interpolation of the natural signal. Under the measurement conditions specified above, this procedure gave correct estimates of dose for single grains of sample PL8-4 (mean ratio of measured/given dose of 1.01 ± 0.02 ($n = 129$)) that had been bleached in sunlight and then given a known dose.

The dose rate for each sample is dominated by the beta and gamma dose rates due to ^{238}U , ^{235}U , ^{232}Th (and their decay products) and ^{40}K , making allowance for beta dose attenuation (Mejdahl 1979) and sample water content (Aitken 1985). The bulk beta and gamma dose rates for each sample were measured by GM-25-5 beta counting (Bøtter-Jensen & Mejdahl 1988) and *in situ* gamma-ray spectrometry, respectively. The cosmic-ray dose rates were calculated following Prescott and Hutton (1994), and adjusted for the $\cos^2\phi$ zenith angle dependence (Smith et al. 1997) and for water content (Readhead 1987). We assumed an effective internal alpha dose rate of 0.03 ± 0.01 Gy/ka.

A water content of $5 \pm 2\%$ was used to determine the OSL age for the samples collected from unit CGBSS (Figure 4). This value represents the assumed long-term water content. A water content of $8 \pm 2\%$ was used for the two samples collected nearer the base of the deposit in unit FOBSS (Figure 4). The bottom-most sediments are somewhat cemented, likely due to moisture percolating down the cave wall that may occasional pond above the bedrock.

When the samples were collected, all sediment was bone dry and the field moisture contents ranged from 0.7 to 3.2% (Table 2). We assumed that a condition of secular equilibrium in the U and Th decay chains prevailed throughout the burial period of each sample, and note that the dose rate exhibits a modest increase down the profile with increase in depth: values range from 1.30 ± 0.08 to 1.80 ± 0.14 Gy/ka with the highest dose rate found at the base of the deposit.

D_e distributions and OSL ages

Of the 8000 individual sand-sized grains of quartz measured, between 16.6 and 28.8% of grains per sample proved suitable for OSL dating using the SAR procedure (Table 2). The D_e values for these grains are displayed as radial plots in Figure 6 (Galbraith et al. 1999). It is immediately apparent from Figure 9 that the D_e estimates for all 8 samples are spread more widely than can be explained statistically should they all have the same D_e values. This is also reflected in their overdispersion values (32 ± 2 to $58 \pm 3\%$; Table 3), which is significantly greater than the value of overdispersion of $7 \pm 2\%$ obtained for sample PL8-4 under controlled laboratory conditions. This spread in D_e values was expected on the basis of known bioturbation of the deposits. Can we obtain meaningful age estimates from these D_e distributions? To explore this question, we applied two statistical models to the D_e data sets. We first applied the central age model (CAM) of (Galbraith et al. 1999) to obtain a combined and weighted mean D_e value for the entire set of D_e values. These values are presented in Table 3 in the rows highlighted with a grey bar, and the weighted mean D_e value and its 2σ error is also indicated as a grey bar on each of the radial plots presented in the left-hand column of Figure 9. We then applied the finite mixture model (FMM) of Roberts et al. (2000) to statistically identify whether there are any discrete D_e components present in the

distribution and if so, the number of discrete D_e components, the proportion of grains in each D_e component, and the weighted mean D_e value and standard error of each D_e component. As the exact value of overdispersion of each D_e component is not known, we determined the optimum overdispersion value for each sample independently from a range of reasonable alternatives using maximum log-likelihood and the Bayes Information Criterion (Galbraith 2005); worked examples of this procedure have been provided in Jacobs et al. (2008b, 2011) and we have previously shown that accurate D_e values could be obtained using this method in Jacobs (2005) and Jacobs et al. (2006b, 2008a).

The D_e distributions for the 8 samples from PL8 can be divided into three groups. The first group is representative of those samples for which no discrete D_e components could be extracted using the FMM, and for which the CAM provides the most appropriate D_e value. The two uppermost samples (PL8-8 and PL8-7) is representative of this type of distribution (Figure 9). These samples may still contain grains with a mixture of ages, but where the ages are not significantly different from each other. The second group is representative of samples PL8-3, PL8-4 and PL8-5 for which 3-4 discrete dose components could be extracted, and that has one component that consists of ~50-60% of the grains and a second component that consists of ~30-40% of the grains (i.e., an almost 50:50 mixture of two discrete age components). It is to be expected that the archaeological signature would also indicate a similar mixture. In this case the CAM would not be appropriate and not a single age from one component will accurately date the entire archaeological assemblage extracted from these spits. Instead, it is more appropriate to suggest two ages (FMM-1 and FMM-2). The third and fourth components (FMM-3 and FMM-4) represent only a very small proportion of the grains and not representative of the vast majority of the archaeology. The

third group of samples are best represented by samples PL8-1, PL8-2 and PL8-6. These three samples have major dose components (FMM-1) that dominate their respective D_e distributions (Fig. 6); between 73 and 92% of the grains belong to FMM-1. We believe that this major component provides the best age estimate for the archaeology in each of these units, but that there is still some sediment mixing present that may skew the age when a mean or weighted mean age is determined (see Table 3); this is most significant in the oldest samples (PL8-1 and PL8-2) where the minor components represent grains with significantly smaller D_e values.

Ages

The OSL age for each sample was calculated by dividing the best-estimate D_e value by the total environmental dose rate. The OSL ages are listed in Table 3, together with the supporting D_e and dose rate information. The majority of Unit FOBSS remains undated because no OSL samples were collected from these deeper spits. The only OSL sample from Unit FOBSS was collected from spits 4/5 towards the top of this unit (Figure 9) and gave an age of 75.5 ± 6.0 ka. Seven OSL samples provide a sequence of ages for the entire Unit CGBSS. From the base in spit 26, on the border with unit FOBSS, an age of 66.0 ± 4.9 ka was obtained. The uppermost samples in CGBSS 10-13 gave ages of 17.0 ± 1.2 and 17.8 ± 1.2 ka. Overall, the OSL ages for unit CGBSS exhibit good stratigraphic consistency, and suggest that the deposits accumulated in a series of occupation pulses centred in ages of ~17-18 ka, ~20-25 ka, ~36-41 ka and ~56-66 ka over an interval of ~50 ka from ~17 ka to 66 ka that were then post-depositionally mixed. The sediments are clearly not all in tack and there is evidence for significant mixing, especially within the middle portion of the deposit, but it still

retains some age information that is useful in terms of placing the archaeology within a broader chronological framework.

¹⁴C dating

AMS ¹⁴C dating of the PL8 sequence was complicated by the poverty of charcoal, the small size of the fragments present, and the effects of bioturbation. Very few charcoal fragments were plotted below CGBSS 7. Initial attempts to date bone from the site failed for lack of collagen, necessitating use of the available small fragments of sieve-derived charcoal, with all their attendant problems. Consequently, ¹⁴C dating is largely used here to refine the results of the OSL determinations. All ages were calibrated following Hogg et al. (2013).

A total of 16 samples were sent for dating at University of Arizona AMS lab. To the extent that it was possible, all samples were taken from a single column – quad 'a' in square 2. In many cases, however, this quad produced no charcoal and it was necessary to use fragments from adjacent quads or from square 1. The results are presented in Table 4.

Three of the AMS samples failed, and seven produced late Holocene ages within a restricted range between roughly 700-150 cal yr bp. These are distributed throughout the sequence, reflecting contamination. Five of the late Holocene dates have central ages between 500-400 cal yr bp, suggesting that the source of contamination was time restricted. This source may be the charcoal-rich upper hearth pit, which produced an age of 325-509 cal yr bp (AA98837) from a confidently plotted *in situ* fragment. Six of the 16 samples produced non-late Holocene ages. One of these dates CGBSS 17 to 6433-6220 cal yr bp (AA98831) and thus the mid Holocene, though this is at odds with the OSL data and seems improbable based on the artefacts. Note, however, that one of the dose components (FMM-3) obtained for the

OSL data sets reflects a small portion of the intrusive grains to 6 ± 1 ka, consistent with the ^{14}C age. The presence of mid Holocene aged charcoal in the deposit is interesting, consistent with the sediment mixture based on OSL dating, but as it stands is not obviously informative with respect to the archaeological sequence.

The remaining five samples produced Pleistocene ages which match the stratigraphically equivalent OSL determinations. Two samples from different squares in CGBSS 16 produced ages of 20.0-22.8 cal kyr bp (AA98830) and 21.7-23.0 cal kyr bp (AA99784); the OSL age for CGBSS 16 was 22.9 ± 1.6 ka. All of these ages overlap at one σ . Three AMS samples from CGBSS 19/20 produced ages of 36.1-38.7 (AA98833), 38.7-41.6 cal kyr bp (AA98834) and >37.2 uncal kyr bp (AA99786). The OSL sample for CGBSS 19/20 shows a mixture of ages with two age components dating to 25.2 ± 1.8 (63% of grains) and 39.1 ± 3.3 ka (30.5% of grains). The ^{14}C ages are consistent with one of these dose components and also with the age for one of the components of the underlying sample (CGBSS 21/22) that gave ages of 41.2 ± 3.3 (54.3% of grains) and 65.1 ± 5.5 ka (33% of grains).

Dating synthesis

In synthesising the chronometric data, it needs to be borne in mind that there were no culturally sterile layers at PL8. This is not because occupation was continuous, as the pulsed nature of the ages demonstrates. As with other sites in the area the accumulation of sediment at PL8 appears to have been tied to periods of occupation, necessitating that there was no significant sedimentation at PL8 during hiatuses. This in turn has important implications.

First, all periods of significant sediment accumulation reflect periods of human occupation, and all OSL ages at PL8 thus necessarily date periods of human occupation. Second, sediment surfaces would have been exposed during long periods of non-occupation. In that respect it should be noted that the average rate of accumulation of sediment at PL8 was overall extremely slow; approximately 1 m of deposit accumulated in the last ~75 kyr⁶, at an average rate of ~14 mm per thousand years, or 1.4 mm per century. Given the impacts even of minor trampling and other bioturbation on the sediment surface we would expect mixing of younger and older sediments during periods of re-occupation.

With these points made, we can infer from the combination of OSL and AMS ages that Pleistocene occupation of PL8 occurred in a number of pulses as follows:

- Late / terminal Pleistocene from CGBSS 8-11, with a lower age limit of ~17 ka (including 1 σ probability).
- MIS 2 pulse(s), represented by a suite of determinations from ~16 ka to ~27 ka and covering spits CGBSS 12-19. These dates include four OSL ages and two AMS ages. This incorporates both the silcrete-rich and hornfels-rich artefact layers with small laminar pieces. These ages likely relate to more than one pulse, with a younger pulse around 18-21 ka and an older pulse around 22-25 ka.
- Mid MIS 3 pulse(s), represented by three OSL ages (one primary and two secondary components) and two AMS ages between CGBSS 20-22, with an age range from 33.2 ka – 44.5 ka (central age of 38.9 ka). Again, there may be two pulses here, an older pulse around 41 ka and a younger around 38 ka.

6 Depth between surface and lowest OSL age.

- An MIS 4 component, represented by primary OSL ages 62.1 ± 4.4 , 66.0 ± 4.9 and a secondary age of 65.1 ± 5.5 . These cover the spits from CGBSS 23 through FOBSS 1 which include unifacial points, backed artefacts and thinning flakes.
- An MIS 4/5 component represent by a primary OSL age of 75.5 ± 6.0 from FOBSS 4/5.
- Pre-MIS 4 sediments, as yet undated. These contain more than one archaeological component, and, given the low rates of sedimentation and the very pulsed nature of the overlying units, could conceivably extend into MIS 6.

Summary of results

The PL8 sequence exhibits discontinuous coverage of the last >75 ka, with variable preservation. This section summarises the sequence in terms of a number of units, with ages given where appropriate (Table 5).

The uppermost spits presented here, from CGBSS 8-11, include large amounts of bone, OES and OES beads, and moderate densities of flaked stone artefacts ($n=1036$). The bones are dominated by small bovids and rock hyrax, with considerable quantities of angulate tortoise. Also present are larger, locally extinct animals such as buffalo, reedbuck, rhinoceros and zebra. The presence of hyrax, hare, tortoise and fish attest to the possibility of small-game procurement, while the black mussel fragments imply contact with coastal populations if not movement between the coastal and interior regions (Parkington 1977). The stone artefact assemblages are dominated by hornfels (63.5%) with significant contributions from quartz (18.5%) and quartzite (11.5%). Bipolar cores are the dominant core form ($n=25$), with the smallest examples weighing 0.1 g, and the mean being 3.3 g (s.d.=9.2). Much of the flaking debris from these pieces fell below the minimum analysed size of 15 mm. The secondary

flaking component in these spits related to the reduction of hornfels and quartzite pebbles from a single platform along a short axis. The resulting flakes are short, wide and have cortical platforms. It is conceivable that the cores themselves functioned as implements, including roles as anvils and possibly scrapers, though the latter claim requires testing. Otherwise the characteristic implements of these assemblages are *pièces esquillées* and naturally backed knives. These latter types have been dated to >8 ka at Elands Bay Cave (Orton 2006), and 8-17 ka may provide an approximate age for this suite of spits.

Technologically the spits from CGBSS 12-15 are among the easiest to characterise given the large samples (n=1542) and the distinctive flaking systems employed. While small bipolar cores are common in these spits (n=33) they are slightly less common than platform cores (n=34) most of which appear to have been used to produce small blades. The bipolar cores that are present are generally exceedingly small ($\bar{x}_{weight}=0.9$ g, s.d.=1.2). While hornfels (50.9%) continues to dominate, silcrete exhibits a conspicuous spike (24.1%) that is unmatched elsewhere. The fact that ccs (6.1%) also occurs at its highest rate in these spits implies a more general pattern of selection for fine grained silicious rocks. Quartz (11.9%) is the third most common material from CGBSS 12-15. As noted previously, the spits in this grouping include large numbers of small blades, with laminar reduction accounting for more 18.9% of all complete flakes. Though many of these pieces are used, few are retouched. *Pièces esquillées* continue to be relatively common. In general the artefacts in this grouping exhibit the typical characteristics of Robberg assemblages elsewhere.

Though bone preservation remains relatively good in these layers, OES is effectively absent, with one solitary fragment in CGBSS 13. Numerically tortoise, hyrax and small game bones continue to dominate, though fish bones are conspicuously less abundant. Locally extinct

species include blue antelope, alcelaphine antelope (hartebeest or wildebeest) and rhinoceros. Blue antelope were likely known in the area historically, based on crayon depictions in rock art near PL8. While grazers are present, habitual browsers are absent, though the sample is small. The most probable age range for these spits is ~18-21 ka.

In the spits from CGBSS 16-19 artefact densities remain generally high and the sample of artefacts is consequently large (n=1594). Hornfels (67.6%) reaches its highest proportion in the assemblage, with quartz (12.4%) and silcrete (8.4%) the next most common rock types. CCS proportions (2.9%) are about half those in the overlying layers. Though these spits contain small laminar elements, bipolar cores (n=31) far outnumber platform cores (n=6) suggesting a difference in the dominant mode of reduction. The presence of some small blade cores coupled with the paucity of laminar elements implies less on-site reduction of such cores in this period in contrast with that which followed. While retouched pieces remain uncommon, a single backed artefact was recovered. *Pièces esquillées* continue to be present. While these spits have some Robberg-like characteristics, they are sufficiently distinct from the overlying spits that it seems inappropriate to assign them to the same culture-historic grouping. The sample of bone from this grouping is very small, and diversity is consequently low. Most remains are bovids, although only those of grysbok/steenbok could be identified further. The most probable age range for the spits in this grouping is ~22-25 ka.

Below CGBSS 18 artefact numbers shrink dramatically. From CGBSS 20-22 platform cores are absent, and while bipolar cores remain the most common form (n=7), possible MSA indicators in the forms of flakes with faceted platforms were recorded. Figure 5 (column t)

shows the appearance of small (sub gram) core technology in this grouping and its persistence through the overlying layers.

Quartz (35.9%) exhibits its highest proportion in the sequence from CGBSS 20-22, though hornfels (43.5%) continues to be the largest single contributor. No other material types exceed 10% in these spits. Laminar flaking is prominent in CGBSS 21 and 22 in spite of the absence of platform cores. *Pièces esquillées* are the only typical retouched flake type observed. With respect to the small assemblage size, presence of faceted platforms, lack of retouched flakes and relative abundance of bipolar cores, the spits in this grouping broadly match those in the late MSA grouping at Klein Kliphuis, dated >35 ka, <55 ka. Interestingly they do not obviously match the characteristics of the MIS 3 assemblages recovered 2 km east at Putslaagte 1, which is dominated by centripetal reduction of hornfels cobbles (Mackay et al. In Press). At PL8 the MIS 3 spits may represent one or two pulses of occupation in the range of 33.2-44.5 ka.

Spits from CGBSS 24 to FOBSS 1 express a second silcrete spike, albeit one more muted than from CGBSS 12-15. Silcrete accounts for 17.8% in the grouping, though as such it is only the fourth most common material type. What is perhaps most notable about material selection in these spits is the evenness of distribution; this is the only part of the sequence in which no single material type exceeds 30% of the total. The other distinctive aspect of these spits is the presence of typical Howiesons Poort and post-Howiesons Poort markers in the forms of backed artefacts (truncated and segment forms) and unfaial points. These implement types occur together towards the top of this silcrete-rich band. The relatively high proportion of laminar elements in the upper spits of this grouping is consistent with systems observed at other Howiesons Poort sites, while in the lowermost spits there are possible bifacial thinning

flakes, weakly implying a Still Bay. The relative abundance of silcrete here is consistent with material selection patterns in the Howiesons Poort and Still Bay at other sites in the region, while the OSL ages range from 58-71 ka is consistent with temporal range of early post-Howiesons Poort, Howiesons Poort and Still Bay ages elsewhere.

From FOBSS 1-5 the proportion of silcrete (4.2%) declines again and hornfels (47.4%) values are elevated. Quartzite (23.5%) and quartz (18.0%) remain fairly consistent. With respect to retouch this grouping includes two notched flakes and two possible scrapers but nothing either definitive or distinctive. Cores are poorly represented (n=13) with bipolar (n=5), platform (n=3) and discoidal (n=2) as the most common types. Flakes have a generally MSA character and include laminar and Levallois elements. OSL ages place these spits in the range from ~68-79 ka.

The spits from FOBSS 6-8 are distinct from those around them in several respects. Hornfels (30.7%) occurs in relatively low proportions compared with other units, and indeed this is the only grouping in which hornfels is not the most common rock type. Quartzite accounts for 37.0% of this assemblage, with quartz (22.8%) the third most common lithology. Bipolar (n=4) and Levallois (n=2) cores are the most common identifiable types, but most cores occur as fragments (n=13, 52%). Retouched flakes are unusually common in this grouping with denticulates and *pièces esquillées* both prevalent. In addition there is a brief but striking increase in the abundance of ochre in these spits. This grouping likely antedates 75 ka but is otherwise undated.

Artefacts in the lowest grouping (FOBSS 9-14) are in many respects typically MSA with an abundance of quartzite (34.1%) and a poverty of quartz (13.3%) and silcrete (1.1%). Hornfels

(47.4%) remains the dominant material type. Bipolar cores are absent in this group, distinguishing it from all others, though again this observation must be weighed against sample size. Retouched flakes are similarly poorly represented, probably for similar reasons.

PL8 in regional context

Though a small and unimposing shelter, PL8 contains a long sequence in a poorly documented region of southern Africa. Occupation of the shelter spans more than 75 000 years, and appears to have been markedly pulsed. Pulsing of occupation combined with the slow sedimentation rate unquestionably led to mixing of sequence components, as reflected in the OSL ages. Excavation in horizontal spits, necessitated by the absence of visible stratigraphy, is likely to have led to further conflation of information from different pulses. Bioturbation, mainly from termites, produced some downward redistribution of small finds including charcoal and possibly shell. Yet in spite of these confounding factors, the 2010 excavation produced a fairly clear sequence of changes from the later MSA to the Holocene.

The strongest pulse in the sequence occurs in MIS 2 where artefact discard rates are at their highest. MIS 2 occupation of the site probably occurred in three distinct phases, including a post-microlithic initiating some time after ~17 ka, a silcrete-rich, strongly microlithic dating probably ~18-21 ka and a silcrete-poor, weakly microlithic component dating ~22-25 ka. The post-microlithic MIS 2 pulse is hornfels dominant and includes naturally backed knives and a distinctive flaking strategy. While the recurrence of this particular strategy at sites nearby to the west is unclear the presence of marine shell in this part of the PL8 sequence and the complementary occurrence of increased hornfels prevalence on the coast may imply inter-connection of the two areas at this time.

The mode probably dating 18-21 ka is classically 'Robberg' insofar as the production of small blades from fine-grained silicious rocks comprise one of the dominant technological components, the other being bipolar reduction of quartz. In this respect PL8 is different from the nearest coeval microlithic occurrences at Elands Bay Cave and Farasokop where quartz accounts for >85% of artefacts and bipolar reduction is consequently dominant (Manhire 1993, Orton 2006). The spatial patterning in material selection and reduction mode identified by (Mitchell 1988) may be more complicated than first thought.

The older quasi-microlithic mode around 22-25 ka is quite distinct, being less laminar, more bipolar and featuring less silcrete. To an extent this technological pattern matches that at some nearby sites. At Boomplaas, for example, the CL member has large numbers of small blades and blade cores, while these components are described as being “virtually absent” in the underlying LPC member dating >22 ka (Deacon 1982: 109). The CL member may be too young for comparison with the Robberg at PL8 given bracketing ages of 18-21 ka, though interestingly only in the unit GWA and the immediately overlying spit CL 4 – which fall between the dates of 16846-17881(UW-301) and 20507-21751 cal yr bp (Pta-3283) is silcrete a significant assemblage component (Deacon 1982). Similarly at Nelson Bay Cave layer YSL with an age of 19527-20695 cal yr bp (I-6516) is richest in small blades, blade cores and silcrete (Deacon 1978). In contrast, at Faraoskop and Sehonghong layers dating ~13 ka have proportionally more blades than those dating ~20 ka, though there is little material change in these cases (Manhire 1993, Mitchell 1995). Layer 19 at Byneskranskop dates 14236-15669 cal yr bp (I-7948) and contains an abundance of small blades and blade cores, and relatively high proportions of silcrete (Schweitzer & Wilson 1983), while layer BBD/BHL

with an age of 13831-14924 cal yr bp (Pta-782) at Kangkara is similarly silcrete-rich (Deacon 1982). The pattern is thus a complex one.

Discussion of MIS 2 bipolar core technology in these sites is generally lacking and it is consequently difficult to assess if or when cores comparable to the very small bipolar cores at PL8 were made elsewhere. Data collected from Elands Bay Cave suggests the presence of similar cores in both MIS 2 modes (Mackay 2009). At other sites however, such artefacts are probably subsumed in most cases into the classes 'scaled pieces', 'core reduced pieces' or '*pièces esquillées*'. More work needs to be done on the distinction between these artefact types (cf., White 1968).

The PL8 sequence conforms to the Fynbos / Winter Rainfall Zone pattern of limited occupation in the temporal band from 50-25 ka. One or two weak pulses and a few hundred stone artefacts from 36-42 ka is all that attests to use of the shelter in this time range. As noted earlier, sedimentation at the site is extremely slow, and periods of occupation in the order of several centuries – e.g., something akin to the duration of European presence in the region – could conceivably have no discernible archaeological signal. That aside, the case for weak MIS 3 shelter occupation in the Fynbos is strengthened by the results from PL8.

Interestingly the available MIS 3 ages from other Fynbos sites seem to coalesce in the range from ~33-~45 ka. Boomplaas, Hollow Rock Shelter and Klein Kliphuis and PL8 all have ages in this range, though notably the assemblages in all cases are small. Ages from ~50-45 ka and from ~33-25 ka are far more difficult to identify in shelter sequences in this area. The cause of weak MIS 3 shelter occupancy in the Fynbos as yet has no clear explanation (Mackay 2010), though significant reorganisation of land use has been proposed (Mackay et al. In Press).

A strong MIS 4 'Howiesons Poort' pulse, reflected by extremely high rates of artefact discard, is registered at many sites around the Fynbos and beyond (e.g., Apollo 11, Sibudu, Rose Cottage Cave), including at sites within 30 km of PL8. PL8 however, registers only a weak pulse in this time range. There are post-Howiesons Poort, Howiesons Poort and possible Still Bay components; however these are compressed, accounting for less than 100 mm of sediment accumulation, and fewer than 300 artefacts in the 2 m² sample. This is more than an order of magnitude less than samples from 1 m² at Diepkloof (n=3120) and Klein Kliphuis (n=7386). While PL8 is only one small site which may have had particular conditions of use, these data suggest that large accumulations of artefacts in the Howiesons Poort are not a universal. Whether this pattern holds more broadly in these arid interior parts of the Cape Fold Belt awaits further data from similar sites.

As with many other sites, PL8 was occupied during MIS 5 and possibly earlier. Lamentably, however, we have left this component of the site undated at the present time. In spite of this, the data recovered provide some interesting results. Specifically, the pre-MIS 4 technology at the site is not unvarying, with changes in material selection and in implement production. This is most notable in the hornfels-poor, denticulate-rich levels, which also correspond to a spike in ochre prevalence. These levels suggest that while denticulates may be a recurrent feature of earlier MSA assemblages, there may also have been periods during which they were made/discarded more frequently. Moreover these levels include convergent denticulate forms that are potentially more time-sensitive.

In more general terms, the PL8 sequence can be used to make several points. Principally, occupation of the Fynbos interior of the Cape Fold Belt unquestionably antedates MIS 4. Rather than being continuously occupied through the last >75 ka, however, the PL8 data

imply occupation of the region in a series of time-restricted pulses. Conceivably these reflect episodes of unsustained range expansion from the better-watered, better-resourced areas of the Cape Fold Belt and the coastal plains, or alternatively they may reflect use of a complementary resource zone by highly mobile foragers moving between the coast and the interior (Parkington 1977). Be that as it may, where age-bracketing allows, these pulses seem generally to have been brief, possibly in the order of several millennia. What is pertinent to more general debates here is that any possible demography-driven range expansion into the interior during MIS 4 was not unprecedented, at least with respect to the eastern Cederberg region of the Cape Fold Belt.

With respect to territoriality and the articulation of the interior, mountains and coast, PL8 offers limited but interesting information. Parkington (1977) has earlier argued that the prevalence of hornfels in coastal sites in the Holocene reflects interactions between the coast and the interior. The presence of marine shell in the probable late/terminal Pleistocene at PL8 documents some complementarity in movement of goods between these zones which appears to be absent during the Robberg.

A final point that can be taken from the PL8 data relates to the diversity of material selection patterns in the earlier MSA. Early work on the MSA technology of the Cape suggested a tendency for strong preferential selection of quartzite during this period (Volman 1980). PL8, along with Varsche Rivier 3 (Steele et al. 2012), suggests instead that selection at this time, rather than being preferentially geared towards quartzite, was probably in fact quite neutral (Brantingham 2003). In the earlier MSA of Cape Fold Belt sites such as Blombos, Diepkloof, Elands Bay Cave, Hollow Rock Shelter, Klipfonteinrand, Klasies River, Nelson Bay Cave, Peers Cave and Pinnacle Point where quartzite is probably the most easily obtainable rock type,

quartzite dominates. Immediately north of the Cape Fold Belt at Varsche Rivier 3, situated on the quartz-plains of the Knersvlatke, quartz dominates. At PL8, situated in a Table Mountain Sandstone shelter adjacent the hornfels-rich Doring River and only 20 km north of Klipfonteinrand and Hollow Rock Shelter, a mix of hornfels and quartzite dominate the earlier periods. Thus, rather than actively seeking quartzite it seems that people in these earlier periods were inclined to make use of whatever materials were most readily available (note also Thompson & Marean 2008).

An important caveat here concerns the use of quartz. Quartz erodes from conglomerate beds in the Table Mountain Sandstone and as such is probably available in close proximity to all of the Cape Fold Belt sites mentioned above. However, with the exception of Varsche Rivier 3 where quartz-rich boulders have been observed, quartz is usually available only as small pebbles. The small size of these packages often necessitates bipolar reduction with the attendant necessity for knappers to be prepared to use the small flakes which result. Figure 5 (column t) suggests that small and very small core-reduction systems did not appear in the Fynbos until ~40 ka. The shift to increased quartz selection and small core reduction may thus be bound up in some ways with the end of the Middle Stone Age.

Concluding remarks

The late Pleistocene archaeology of southern Africa is currently the focus of considerable research. Numerous patterns have been highlighted and various hypotheses proposed to explain them. Our capacity to assess these hypotheses critically is hampered by the small and spatially uneven dataset with which we presently work. PL8 is one of several excavations aimed at expanding the number and spatial coverage of archaeological data in the pre-

Holocene. In spite of its limitations, the sequence has a bearing on several issues of interest, providing the only hornfels-dominant assemblage in the region and demonstrating pulsed occupation of the interior fringes of the Succulent Karoo / Fynbos prior to 17 ka. Further work is now required to examine the extent to which the data from PL8 – a small site in a poorly understood region – can be considered representative of the area.

Acknowledgements

Richard Klein provided assistance with faunal identifications, and Iziko South African Museum provided access to their facilities for the faunal analysis. Excavations were conducted with Will Archer, Wesley Flear and Aara Welz. Guillaume Porraz was kind enough to provide a French translation of the English abstract. Funding for this research was provided by Australian Research Council grants #DP1092445 and #DE130100068.

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Figure Captions

Figure 1. Location of PL8 and other late Pleistocene sites in southern Africa relative to modern biomes, following Mucina & Rutherford (2006). Numbered sites in the inset as follows: 1 Klipfonteinrand, 2 Hollow Rock Shelter, 3 Klein Kliphuis, 4 Faraoskop, 5 Diepkloof, 6 Elands Bay Cave, 7 Hoedjiespunt, 8 Varsche Rivier 3

Figure 2. Putslaagte 8 site plan (a) and long section (b) showing location of the excavation relative to shelter, sediment trap and talus.

Figure 3. View to PL8 from the north (looking south).

Figure 4. PL8 excavation west section showing OSL sample locations and ages, and major stratigraphic units.

Figure 5. Archaeological sequence at PL8. Open circles in column (a) reflect spits containing ostrich eggshell beads. Filled circles in column (c) indicate numbers of ground ochre pieces per spit. Intrusive AMS ages are shown in grey in column (w).

Figure 6. *Nassarius kraussianus* shell from CGBSS 21.

Figure 7. Artefact images from PL8. Scale bars are 10 mm; note the scale change for the inset images. 1a&b, naturally backed knives; 2a-l, small blades; 3a-f, small blade cores; 4a, unifacial point from post-Howiesons Poort layers; 4b, backed artefact (segment) from 'Howiesons Poort' layers; 4c-f, blades from 'Howiesons Poort' layers; 5a, Levallois core from earlier MSA layers; 5b-d, denticulates from earlier MSA layers; 6, short axis platform core from late Pleistocene post-microlithic; 7, example of flake with concretions predominantly

on one face; [inset] 8a-b, small flakes with potential impact fractures; 8c-d, complete bipolar cores weighing ~ 0.1 g; unifacially-retouched pointed flake from early LSA layers.

Figure 8. Comparison of weight for freehand and bipolar cores in the available sample from late Pleistocene sites in southern Africa. Note that the weight axis is log scaled.

Table Captions

Table 1. The faunal remains from PL8, by grouped spit. The Number of Identifiable Specimens (NISP) is presented first, followed by the Minimum Number of Individuals (MNI) that the identified specimens could represent.

Table 2. Number of single-grains measured, rejected and accepted, together with the reasons for their rejection.

Table 3. Dose rate data, D_e values and OSL ages for 8 sediment samples from Putslaagte 8 in depth order. The total dose rate includes an allowance of 0.032 ± 0.011 Gy/ka for the internal dose rate. The grey bands indicate the D_e values and ages for each sample when all grains are included in the estimate of age. The ages in bold and italics are the ages thought to be best representative of the archaeological signatures present in the excavated spits. For those samples where there is no dominant D_e or age component, two ages are presented.

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Linnaean Names	Vernacular Names	Holocene	C8- 11	C12- 15	C16- 19	C20- 22
<i>Procavia capensis</i>	rock hyrax	26/3	24/3	15/2	2/1	
Leporidae gen. et sp. indet.	hare(s)	10/1	8/2	7/1		
<i>Bathyergus suillus</i>	Cape dune mole rat	46/2	7/1		1/1	
<i>Hystrix africaeaustralis</i>	porcupine	1/1	1/1	2/1		
Hyaenidae gen. et sp. indet.	hyena (coprolites)	3/1	1/1			
<i>Caracal caracal</i>	caracal			1/1		
<i>Herpestes pulverulentus</i>	gray mongoose	11/1				
Rhinocerotidae gen. et sp. indet.	rhinoceros		1/1	1/1		
<i>Equus</i> sp.	indet. equid		1/1			
<i>Syncerus caffer</i>	Cape buffalo		2/1			
Alcelaphini gen. et sp. indet.	hartebeest/wildebeest			1/1		
<i>Hippotragus leucophaeus</i>	blue antelope			1/1		
<i>Sylvicapra grimmia</i>	gray duiker	1/1	1/1			
<i>Redunca</i> sp.	reedbuck		2/1			
<i>Pelea capreolus</i>	vaalribbok	1/1				
<i>Raphicerus</i> sp(p.)	grysbok/steenbok	5/1	4/1		2/2	
<i>Oreotragus oreotragus</i>	klipspringer			1/1		
	small bovid(s)	38/2	65/3	23/1	8/1	
	small-medium bovid(s)	9/1	1/1	7/1	4/1	
	large-medium bovid(s)		8/1	3/1	1/1	
	large bovid(s)		2/1	1/1	2/1	
	bird cf. francolin		1/1			
	fish	81/--	22/--	3/--		
	snakes	5/--	5/--			
<i>Chersina angulata</i>	angulate tortoise	10/--	13/--	31/--	3/--	1/--
	humeri					
<i>Pelomedusa</i>	helmeted turtle			2/--		
	other turtles		2/--	1/--	1/--	

Table 2. Number of single-grains measured, rejected and accepted, together with the reasons for their rejection.

Sample name	No. of grains measured	T _N signal <3xBG	0 Gy dose >5% of L _N	Poor recycling ratio	No L _N /T _N intersection	Depletion by IR	Sum of rejected grains	Acceptable individual D _e values
PL8-8	1000	532	59	86	5	35	717	283
PL8-7	1000	544	43	89	3	33	712	288
PL8-6	1000	623	32	83	4	28	770	230
PL8-5	1000	607	28	70	11	24	740	260
PL8-4	1000	679	18	57	28	33	815	185
PL8-3	1000	654	16	59	33	32	794	206
PL8-2	1000	645	21	57	60	31	814	186
PL8-1	1000	639	23	75	72	25	834	166

T_N is the OSL signal measured in response to the test dose given after measurement of the natural OSL signal.

L_N is the natural OSL signal.

Recycling ratio is the ratio of the sensitivity-corrected OSL signals measured from duplicate doses to test the efficacy of the test dose correction used in the SAR procedure.

IR is the infrared stimulation used to erase any part of the signal that may be derived from IR-sensitive (e.g., feldspar) grains.

Table 3. Dose rate data, D_e values and OSL ages for 8 sediment samples from Putslaagte 8 in depth order. The total dose rate includes an allowance of 0.032 ± 0.011 Gy/ka for the internal dose rate. The grey bands indicate the D_e values and ages for each sample when all grains are included in the estimate of age. The ages in bold and italics are the ages thought to be best representative of the archaeological signatures present in the excavated spits. For those samples where there is no dominant D_e or age component, two ages are presented.

Sample name	Moisture content (%)	Dose rates (Gy/ka)			Total dose rate (Gy/ka)	D_e (Gy)	No. of grains	D_e Model	OD (%)	OSL age (ka)	Proportion of grains in age comp. (%)
		Beta	Gamma	Cosmic							
PL8-8	1.8	0.65 ± 0.04	0.53 ± 0.04	0.09 ± 0.01	1.30 ± 0.08	22.2 ± 0.6	283	CAM	41 ± 2	<i>17.0 ± 1.2</i>	100
PL8-7	1.9	0.72 ± 0.04	0.57 ± 0.03	0.09 ± 0.01	1.41 ± 0.08	25.1 ± 0.7	288	CAM	43 ± 2	<i>17.8 ± 1.2</i>	100
PL8-6	2.8	0.80 ± 0.05	0.65 ± 0.05	0.09 ± 0.01	1.57 ± 0.10	36.1 ± 1.0	230	CAM	35 ± 2	22.9 ± 1.6	100
						35.2 ± 1.0		FMM-1		<i>22.5 ± 1.6</i>	92.0
						88.5 ± 12.7		FMM-2		56.2 ± 8.9	4.4
						9.3 ± 1.3		FMM-3		5.9 ± 0.9	3.6
PL8-5	2.5	0.77 ± 0.05	0.63 ± 0.04	0.09 ± 0.01	1.52 ± 0.09	41.8 ± 1.0	260	CAM	32 ± 2	27.6 ± 1.9	100
						38.2 ± 1.3		FMM-1		<i>25.2 ± 1.8</i>	63.0
						59.2 ± 3.2		FMM-2		<i>39.1 ± 3.3</i>	30.5
						18.3 ± 1.4		FMM-3		12.1 ± 1.2	6.5
PL8-4	0.7	0.77 ± 0.05	0.64 ± 0.04	0.08 ± 0.01	1.52 ± 0.09	67.4 ± 2.1	185	CAM	36 ± 3	44.2 ± 3.1	100
						62.7 ± 3.0		FMM-1		<i>41.2 ± 3.3</i>	54.3
						99.2 ± 5.6		FMM-2		<i>65.1 ± 5.5</i>	33.0
						33.7 ± 2.5		FMM-3		22.1 ± 2.2	12.7
PL8-3	1.0	0.74 ± 0.05	0.65 ± 0.04	0.08 ± 0.01	1.50 ± 0.09	67.7 ± 2.3	206	CAM	43 ± 3	45.2 ± 3.2	100
						93.1 ± 3.2		FMM-1		<i>62.1 ± 4.4</i>	52.6
						54.4 ± 3.2		FMM-2		<i>36.3 ± 3.1</i>	39.1
						29.6 ± 3.4		FMM-3		19.7 ± 2.6	6.9
						14.4 ± 2.2		FMM-4		9.6 ± 1.6	1.5
PL8-2	3.2	0.90 ± 0.06	0.69 ± 0.05	0.08 ± 0.01	1.71 ± 0.11	86.6 ± 4.0	186	CAM	57 ± 3	50.6 ± 4.2	100

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						112.9 ± 3.1		FMM-1		66.0 ± 4.9	79.3
						44.7 ± 4.9		FMM-2		26.1 ± 3.4	14.0
						22.7 ± 3.3		FMM-3		13.3 ± 2.1	4.9
						9.9 ± 1.6		FMM-4		5.8 ± 1.0	1.8
PL8-1	1.8	0.91 ± 0.06	0.78 ± 0.05	0.08 ± 0.01	1.80 ± 0.14	108.2 ± 4.4	166	CAM	44 ± 3	60.1 ± 4.8	100
						135.8 ± 5.7		FMM-1		75.5 ± 6.0	73.0
						74.4 ± 9.8		FMM-2		41.3 ± 6.1	19.3
						38.6 ± 3.9		FMM-3		21.5 ± 5.6	7.7

Table 4. List of all AMS ages for PL8, including calibrated and uncalibrated values at 2 σ .

Square(quad)	Stratum	Spit	AMS age		Lab code
			Uncal.	Cal.	
1	UHP	-	427 $\pm$ 35	325-509	AA98837
2 (a)	CGBSS	4	415 $\pm$ 43	315-487	AA99788
2 (a)	CGBSS	5	196 $\pm$ 43	recent-296	AA99787
2 (d)	CGBSS	8	399 $\pm$ 44	321-498	AA99785
2 (a)	CGBSS	10	729 $\pm$ 35	560-681	AA98829
1 (a)	CGBSS	16	18500 $\pm$ 280	21664-22977	AA99784
2 (a)	CGBSS	16	17700 $\pm$ 590	19985-22820	AA98830
2 (a)	CGBSS	17	5582 $\pm$ 42	6220-6433	AA98831
2 (a)	CGBSS	18	<i>failed</i>		AA98832
2 (d)	CGBSS	18	372 $\pm$ 38	315-487	AA99782
2 (a)	CGBSS	19	33170 $\pm$ 560	36051-38724	AA98833
1 (c)	CGBSS	20	>37200		AA99786
2 (d)	CGBSS	20	35610 $\pm$ 740	38725-41649	AA98834
1 (d)	CGBSS	21	334 $\pm$ 37	294-462	AA99783
2 (a)	CGBSS	21	<i>failed</i>		AA98835
2 (a)	CGBSS	22	<i>failed</i>		AA98836

Table 5. Breakdown of excavation layers at PL8 into culture historic groupings.

Spits	Ages (ka)	N artefacts	Materials	Cores	Flakes	Retouch	Other	Industry
C8-11	<17	1036	Hornfels, quartz	Bipolar, short-axis platform	Bipolar, short wide cortical	Naturally backed knives	OES beads, marine shell	Early Holocene
C12-15	18-21?	1542	Hornfels, silcrete	Platform, bipolar	Laminar	Pieces esquillees		Robberg
C16-19	22-25?	1594	Hornfels, quartz	Bipolar, platform	Informal, bipolar, laminar	Pieces esquillees		Early LSA
C20-22	33-45	262	Hornfels, quartz	Bipolar	Laminar, bipolar	Pieces esquillees		Late MSA
C23-F1	58-71	326	Hornfels, quartzite	Levallois, platform, bipolar	Laminar, bipolar, thinning	Backed, unifacial point	High proportion of silcrete	HP / post-HP / SB?
F2-5	69-81	289	Hornfels, quartzite	Bipolar, platform, discoidal	Levallois	None		pre-SB?
F6-8	>76	443	Quartzite, hornfels	Bipolar, Levallois	Levallois, convergent	Denticulates, pieces esquillees		Denticulate MSA?
F9-14	>76	346	Hornfels, quartzite	Discoidal	Levallois, convergent			Older MSA