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TRUE COLOURS: ANALYSING APPARENT SEDIMENTARY DIVISIONS IN THE STRATIGRAPHIC SEQUENCE OF UMHLATUZANA ROCKSHELTER (SOUTH AFRICA) USING MUNSELL-BASED COLOUR DETERMINATIONS

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1. Introduction and background

Sediment colour is one of the main characteristics used to differentiate stratigraphic sequences together with texture, consistency, and plasticity (Kyrillidou 2006; Ward et al. 2016). In archaeology, layers and contexts are often described based on their colour difference (e.g., Mitchell 1995 – Sehonghong Cave; Wadley & Jacobs 2006 – Sibhudu Cave; Morrissey et al. 2022 – Klasies River Main Site; Rhodes et al. 2022 – Wonderwerk Cave). This is also the case at Umhlatuzana rockshelter (hereafter Umhlatuzana), a site that contains a rich Middle and Later Stone Age archaeological sequence spanning the last 70 000 years (Kaplan 1990; Lombard et al. 2010; Sifogeorgaki et al. 2020).

The original excavator, Jonathan Kaplan (1990), observed a very homogeneous sequence of Pleistocene deposits, which he divided into two main stratigraphic entities: Purple Brown Sands and Red Brown Sands. The contact between these two entities is not a horizontal break, but instead a diagonal/lateral change in sediment colour. He interpreted the contact of these two layers to represent the surface over which a slumping event occurred: the upper part of the sequence (Red Brown Sands) slid towards the rockshelter's dripline (Kaplan 1990). This suggests that part of the archaeological assemblage is not *in situ* which led to doubts about incorporating the site's archaeological material into the discourse on the Middle and Pleistocene Later Stone Age (Deacon & Deacon 1999; Mitchell 2002). During renewed excavations at the site the same colour offset was observed, but various analyses demonstrate that no large-scale sediment translocation has occurred in the sequence (Sifogeorgaki et al. 2020; Reidsma et al. 2021; Sifogeorgaki et al. submitted).

At the original excavations, it was interpreted that the lateral colour difference was caused by different oxidation states of iron minerals in the deposits (Kaplan 1990: 5). A difference in moisture content between the Purple Brown Sands and the Red Brown Sands was also noted. The lateral colour difference in the Pleistocene sediments was used by Kaplan (1990) to argue for the slumping of the deposits.

We observed moisture and colour differences between the deposits during excavations in 2018 and 2019 (Figs 1 & 2). The boundary between the dark deposits (Purple Brown Sands) and light deposits (Red Brown Sands) was diffuse. Kaplan (1990: 5) suggests this may be caused by mixing of the different sediments at the boundary. Several lines of evidence refute this, such as the analysis of piece-plotted archaeological materials that demonstrate discrete zones of high- and low-find density (Sifogeorgaki et al. 2020), in addition to no visible differences between the deposits in their micromorphology samples (Sifogeorgaki et al. submitted).

To explore the difference between the deposits further, we analyse the sediment colour from samples across the Umhlatuzana sequence in laboratory conditions. We sampled the sediments across a tight grid over the western profile and analysed them using the Munsell colour system that is based on the hue (basic colour), chroma (colour intensity), and value (lightness) properties (Cleland 1921; Kuehni 2001). Additionally, we compare those results with Munsell readings from the field that were published by Sifogeorgaki and colleagues (2020). Here we explore whether there is an actual colour difference between the Purple Brown Sands and Red Brown Sands, the existence of which was one of the arguments for the sediment sliding (Kaplan 1990: 5-7).

2. Materials and methods

The stratigraphic sequence of Umhlatuzana comprises 10 stratigraphic units corresponding to Holocene deposits (Group H – Units H1 to H10) and 17 units corresponding to Pleistocene deposits (Group P – Units P1 to P17) (new excavations, for details see Sifogeorgaki et al. 2020). The lower and southern parts of the Group P units have a noticeably higher moisture content (Fig. 1). We attribute this to water flowing through the rockshelter walls towards the dripline. The higher-moisture units appear darker in colour than the rest of the deposits and correspond to the Purple Brown Sands that were discussed by Kaplan (1990).

To assess sediment colour, we use the Munsell Soil Colour chart which is frequently used by archaeologists and has proven to be reliable and reproducible (Gerharz et al. 1988; Bloch et al. 2021). We assess the colour sequence using 123 samples deriving from the western profile of the new excavations (for sample location see Reidsma et al. 2021: figs 2 & 4). We do so in a controlled laboratory environment on homogenised and dried sediments to minimise measurement bias. The colour was determined on air-dried sediments under natural light.

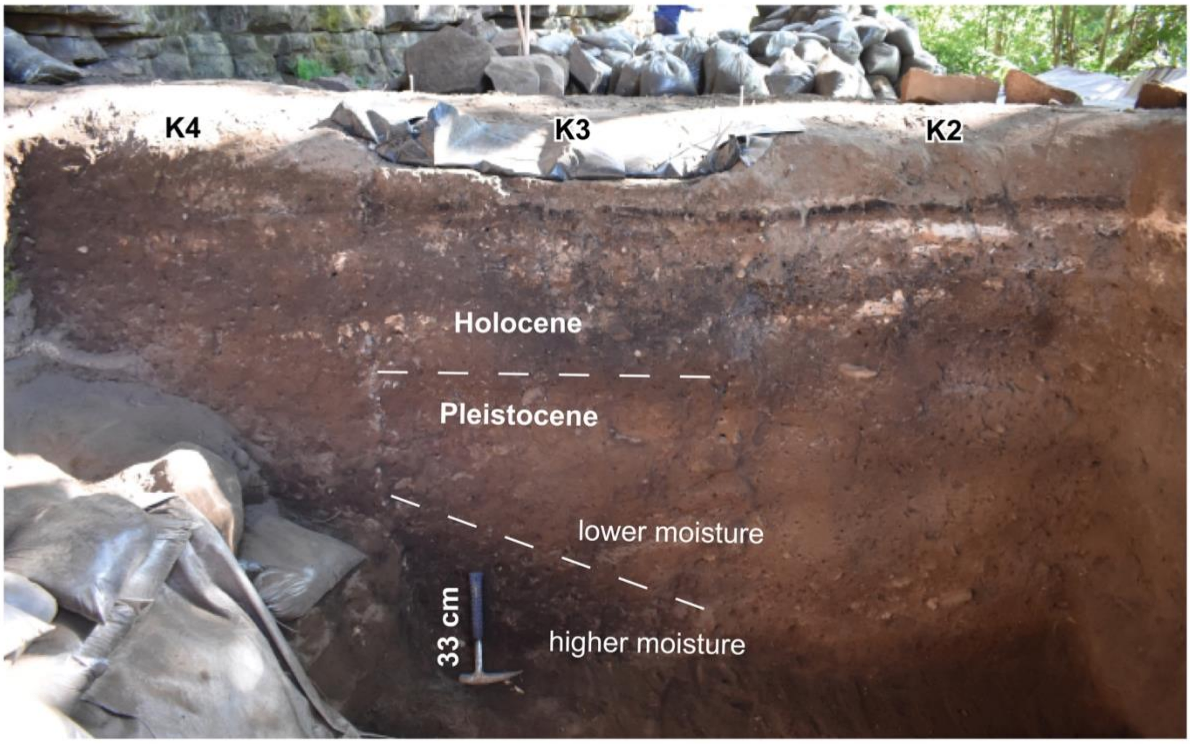

Figure 1. Overview of the western profile of the K squares excavated by Kaplan (1990), highlighting the differences between the higher- (Dark Brown Sands) and lower- (Red Brown Sands) moisture sediments and across the approximate Pleistocene (Group P)/Holocene (Group H) boundary. This picture was taken prior to the 2018-2019 excavation. Image after Sifogeorgaki et al. (2020).

3. Results

The results are presented in Table 1 and indicate that the sequence predominantly has a dull yellowish brown colour (10YR4/3, 70% of the samples) followed by brown (10YR4/4, 18%), dark brown (10YR3/3, 7%), and greyish yellow brown (10YR4/2, 4%). The dark brown and brown sediments tend to correspond to the lower part of the Group P units (Fig. 2). When analysing the air-dried sediments, the southern part does not demonstrate darker sediment colours than the northern part. No further patterning was detected based on the colour identification.

Table 1. Colour determination results and stratigraphic context of the samples (Sq.=square). Munsell colour codes and descriptions are as follows: 10YR5/2 grey yellow brown; 10YR5/3 dull yellowish brown; 10YR5/4 dull yellowish brown; 10YR4/2 grey yellow brown; 10YR4/3 dull yellowish brown; 10YR4/4 brown; 10YR3/2 brown black; 10 YR3/3 dark brown; 10YR3/4 dark brown.

Grid ID	Sq.	Unit	Code	Grid ID	Sq.	Unit	Code	Grid ID	Sq.	Unit	Code
A2		H4	10YR4/3	C13		P12	10YR3/3	F6		P3	10YR5/3
A3		H5	10YR4/3	C15		P1	10YR4/3	F7		P4	10YR5/3
A4		H9a	10YR4/3	C16		P3	10YR4/3	F8		P5	10YR5/3
A5		P1	10YR4/3	C17		P4	10YR5/3	F9		P8	10YR5/3
A6		P2	10YR4/3	D1		H1b	10YR4/3	F10		P8	10YR5/4
A7		P4	10YR4/3	D2		H5	10YR4/3	F11		P11	10YR5/3
A8		P5	10YR4/3	D3		H7	10YR3/3	F12		P13	10YR5/4
A9		P6	10YR4/3	D4		H10	10YR4/2	F13		P13	10YR5/4
A10		P7	10YR4/3	D5		P1	10YR4/3	F14		H10	10YR4/3
A11		P9	10YR3/3	D6		P3	10YR4/4	F15		P1	10YR4/3
A12		P12	10YR3/4	D7		P4	10YR4/4	F16		P3	10YR4/3
A13		P14	10YR3/4	D8		P5	10YR5/3	F17		P4	10YR4/3
A14		H10	10YR4/3	D9		P8	10YR5/3	G1		H1b	10YR4/3
A15	L3a	P1	10YR5/3	D10		P8	10YR4/4	G2		H	10YR3/3
A16		P3	10YR5/3	D11		P10	10YR4/4	G3		H8b	10YR4/3
A17		P4	10YR5/3	D12		P13	10YR4/4	G4		H10	10YR4/3
B2		H4	10YR4/3	D13		P13	10YR4/4	G5		P1	10YR4/3
B3		H	10YR4/3	D14	L2b	H10	10YR3/3	G6		P2	10YR4/3
B4		H	10YR4/3	D16		P3	10YR4/4	G7		P3	10YR4/3
B5		P1	10YR4/3	D17		P4	10YR4/4	G8		P5	10YR4/3
B6		P3	10YR5/3	E1		H1b	10YR4/4	G9	L2a	P5	10YR4/3
B7		P4	10YR5/3	E2		H	10YR4/3	G10		P8	10YR4/4
B8		P5	10YR4/3	E3		H8b	10YR3/2	G11		P11	10YR4/4
B9		P8	10YR4/3	E4		H10	10YR4/3	G12		P13	10YR5/4
B10		P7	10YR4/3	E5		P1	10YR4/4	G13		P13	10YR5/3
B11		P9	10YR4/3	E6		P3	10YR5/3	G15		P1	10YR4/3
B12		P12	10YR4/2	E7		P4	10YR5/3	G16		P3	10YR4/3
B14		H10	10YR4/3	E8		P5	10YR5/3	G17		P4	10YR5/3
B15		P1	10YR4/3	E9		P8	10YR4/4	H1		H1b	10YR4/3
B16		P3	10YR5/3	E10		P8	10YR4/4	H2		H5	10YR3/3
C2		H4	10YR4/2	E12		P13	10YR4/4	H3		H	10YR4/3
C3		H5	10YR4/2	E13		P13	10YR4/4	H4		H10	10YR4/3
C4		H10	10YR5/2	E14		H10	10YR4/4	H5		P1	10YR4/3
C5	L2b	P1	10YR4/3	E15		P1	10YR5/3	H6		P2	10YR4/3
C6		P2	10YR4/3	E16		P3	10YR5/4	H7		P3	10YR4/3
C7		P4	10YR5/3	E17		P4	10YR5/3	H8		P5	10YR5/3
C8		P5	10YR5/3	F1		H1b	10YR4/4	H9		P5	10YR4/3
C9		P8	10YR4/4	F2		H	10YR4/3	H10		P8	10YR4/3
C10		P8	10YR4/3	F3	L2a	H8b	10YR4/3	H11		P11	10YR4/4
C11		P10	10YR4/4	F4		H10	10YR4/3	H12		P13	10YR4/4
C12		P9	10YR3/3	F5		P1	10YR4/3	H13		P13	10YR5/4

4. Discussion

Inconsistent colour determinations can be the result of light source, moisture, and texture of the sediments (see Bloch et al. 2021 and references therein). We show that the colour difference observed in the Pleistocene sequence at Umhlatuzana does not reflect post-depositional events such as the sediment movement proposed by Kaplan (1990). Laboratory sediment descriptions of the western profile show limited colour variation that does not appear clearly patterned. The consistent colour of the sediments within the Pleistocene is supported by micromorphology that show similar fabrics throughout the sequence (Reidsma et al. 2021; Sifogeorgaki et al. submitted). Moreover, grain-size data point to a single source for the sediments present across the 2.5 m deep sequence (Sifogeorgaki et al. 2020). Finally, geochemical differences in the deposits do not correspond to changes in sediment colour. For instance, iron content is higher in the lowermost part of the sequence (Reidsma et al. 2021: fig 6), but such patterning is not reflected in the hue and chroma of the sediments. The fact that the iron content does not mirror the colour change between the wet and dry sediments is also an argument against seeing them as different sedimentary packages characterised by differing oxidation.

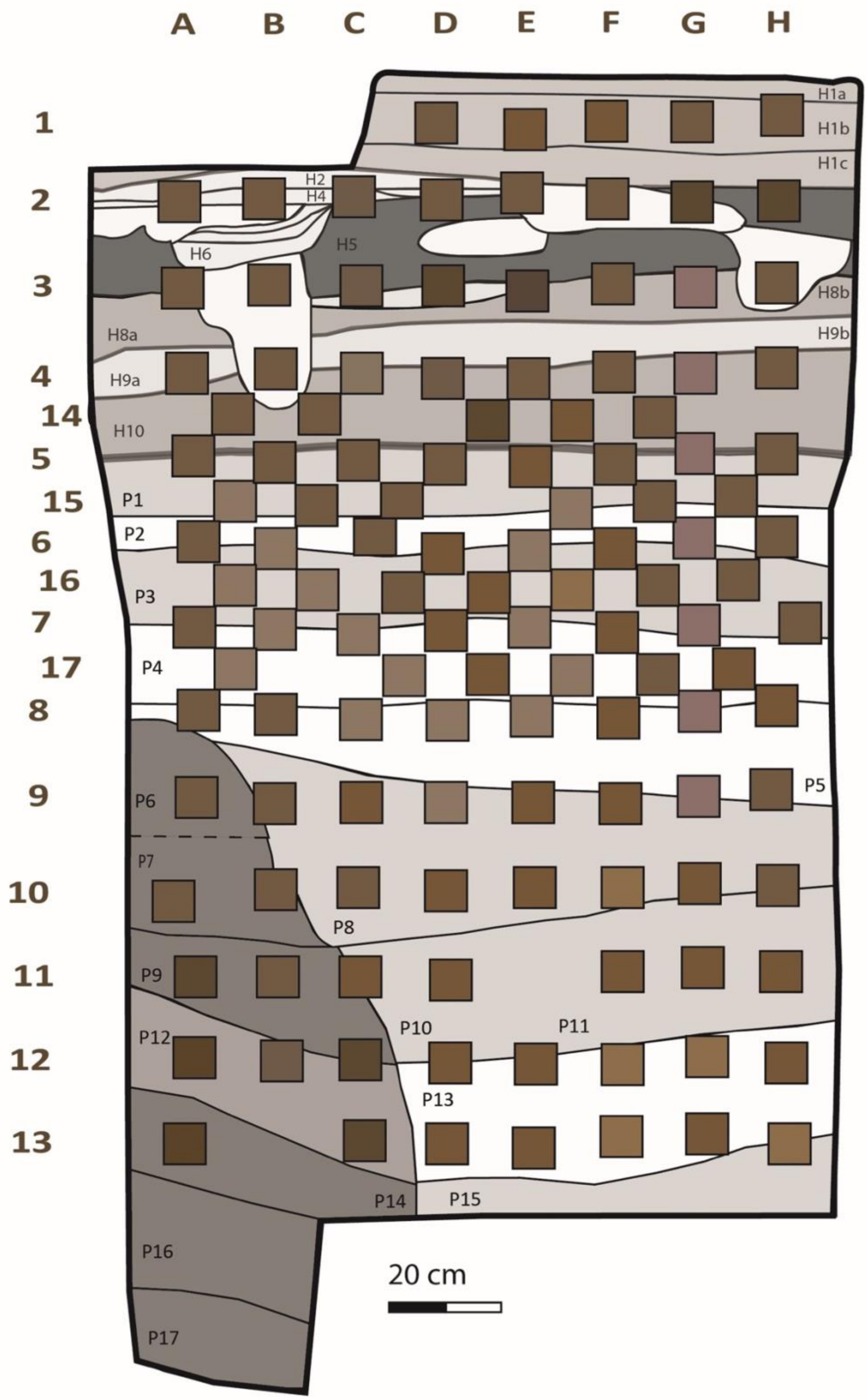

Figure 2. Stratigraphic drawing of west profile with sample locations (square frames) and sample naming system (numbers indicated on the left, letters indicated at the top). The hues selected for the frames resemble actual colours based on the colour code results.

It is important to note that for this study we used dry sediments for the colour determination (as suggested in guidelines by Gerharz et al. 1988). When the sediment determination is performed in the field, it is often conducted on freshly excavated samples that retain their original moisture level (e.g., Goldberg & Macphail 2006) or on wet samples (e.g., Ayala et al. 2015). Most guidelines agree that colour determination is an important aspect of stratigraphic descriptions and that the conditions in which the colour was determined should be clearly stated (e.g., Goldberg & Macphail 2006; Kinne 2016; SIKB 2018). Depending on the colour determination conditions used (moist vs. wet/shade vs. light) the results will be different. Indeed, this was the case in the colour determinations published by Sifogeorgaki and colleagues (2020) where the colour was determined on freshly excavated sediments that maintained their original moisture content. There, the colour of the high-moisture deposits was determined dark brown (Units P6, P17 – 10YR3/3), dark reddish brown (Units P9, P12, P14, P16 – 5YR3/3 and 5YR3/2), and black (Unit P7 – 10YR1.7/1) (Sifogeorgaki et al. 2020: table 2).

Sediment colour remains an important characteristic for stratigraphic description and analysis, but it is crucial to separate out the influence of differing sedimentary input (e.g., anthropogenic input, such as ash; charcoal at Umhlatuzana does create colour differences in the Holocene) from diagenetic processes (e.g., weathering, soil formation, hydrological features) in describing the sedimentary units and their characteristics. Moreover, the use of a non-arbitrary technique, such as the Munsell colour system, to support colour determination is important to limit inter-observer errors relating to colour perception and to promote comparability of the results. Finally, determining soil colour in the controlled environment of laboratory facilities proved essential for avoiding inconsistencies.

5. Conclusion

The results of this study reinforce previous results on the geoarchaeology of Umhlatuzana rockshelter, which suggest that the Purple Brown Sands and the Dark Brown Sands do not represent different depositional sedimentary packages. Rather, they appear to represent a single horizontally deposited sedimentary package in which lateral colour differentiation was caused by post-depositional subsurface water flow through the sediments nearest to the rockshelter wall, and not by sedimentary differences (e.g., in organic matter content and/or iron oxidation state; also see Bloch et al. 2021). Characterised by higher moisture content, they appear darker in the field (Purple Brown Sands) than the drier sediments near the valley edge (Red Brown Sands). When dried and analysed under artificial light, the sediments at Umhlatuzana have a similar colour throughout the analysed stratigraphic profile. This study serves as a reminder that aspects like moisture content and light circumstances should be considered and be clearly communicated before publishing sediment colour data. More so if the sediment colour is used as an argument for the occurrence of depositional and/or post-depositional processes.

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