Southern African Humanities **23**: 55–76 September 2011 KwaZulu-Natal Museum

Digital imaging and the revelation of 'hidden' rock art: Vaalekop Shelter, KwaZulu-Natal

[1]**Jeremy C. Hollmann** and [2]**Kevin Crause**

[1]KwaZulu-Natal Museum, P. Bag 9070, 3200 Pietermaritzburg; University of KwaZulu-Natal, School of Anthropology, Gender & Historical Studies, P. Bag X01, Scottsville, 3209 South Africa; jhollmann@nmsa.org.za

[2]603a Disa Park, Clifford Ave, 8001 Cape Town; kevin@fingerprintsintime.com

ABSTRACT

Vaalekop Shelter, a small and seemingly sparsely painted rock art site on the upper reaches of the iMpofana (Mooi) River, KwaZulu-Natal, will be flooded by the construction of the Spring Grove Dam downstream. In mitigation, the site was photographed using a proprietary digital imaging process with the acronym CPED (Capture, Process, Enhance and Display). CPED provides different views of the rock art: a 360° view of the painted rock surfaces and their surrounds, a very high-resolution mosaic of the painted rock surface, and enhancements of the painted rock surface that reveal details of the art invisible to the naked eye. These innovations literally change the way that we look at rock art. Instead of the traditional approach to rock art photography in which many separate images are recorded of the paintings, CPED takes the painted rock surface as the basic unit of analysis and users may zoom in and out of the the high-resolution mosaic image depending on the level of detail required. Rock art that was formerly considered 'indecipherable' due to the deterioration of the painted surfaces, becomes more clearly visible after applying image-enhancement algorithms that produce 'false-colour' and greyscale images. Direct tracing of rock art images could be obviated because better copies can be obtained from the digital images. The benefits of CPED imaging should be shared as widely as possible. Strategies suggested are the creation of a national centre for CPED imaging, the improvement of skills and equipment in heritage and research institutions, and the release of CPED as a proprietary system.

KEY WORDS: San, rock art, Vaalekop Shelter, Mooi-Mngeni Transfer Scheme, iMpofana River, heritage imaging, CPED, digital photography, image enhancement, animal behaviour, eland, grey rhebok.

The construction of the Spring Grove Dam on the upper reaches of the iMpofana (Mooi) River (part of the Mooi-Mngeni Transfer Scheme (MMTS) due to be completed early in 2013) will result in the eventual destruction of a small, but archaeologically significant overhang (national site number 2929BD 025) on the bank of the river (Fig. 1). The back 'wall' of the overhang has been painted with motifs that are typical of the 'Bushman paintings' that occur in this part of KwaZulu-Natal (e.g. Pager 1971; Mazel 1981). One of us (JCH) was employed to report on the rock art. In the report three painted areas were identified and briefly described (Hollmann 2010), and further documentation of the rock paintings, before their subsequent outright removal was recommended. In view of the impending flooding of the place, the rock art needed to be recorded by a skilled photographer with high-quality equipment; typically, archaeologists are not expert photographers, nor do they possess the requisite cameras and accessories, which are expensive and require skill and experience to operate properly. Indeed, with digital imaging replacing traditional photographic techniques, the generation of high-resolution images of objects has become increasingly complex, specialized and, therefore, beyond the capabilities of many archaeologists. For these reasons author KC, a software engineer and photographer, was contracted to record the rock paintings. This paper reports on the imaging techniques used to record the rock art at Vaalekop and the promise these techniques hold for future research and documentation projects.

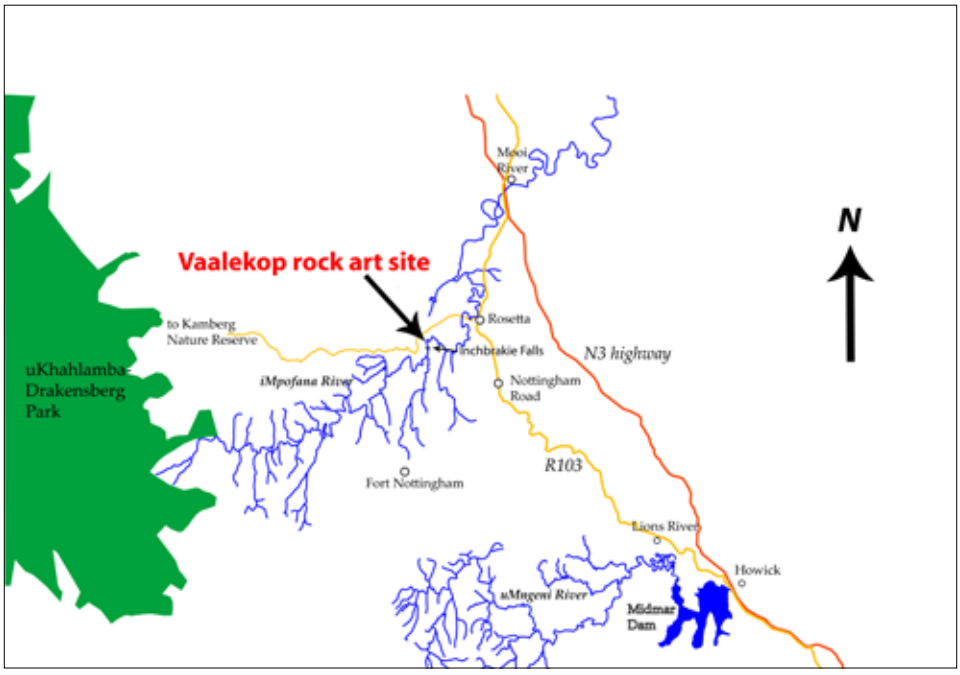

Fig. 1a. The Vaalekop rock art site in relation to Pietermaritzburg, the local towns and villages, the main tributaries of the uMngeni and iMpofana rivers (blue), the N3 highway (red) and the R103 (yellow) road.

Fig. 1b. View of the Vaalekop rock art site from the eastern bank of the Mpofana (upper Mooi) River looking upstream. The overhang is in shadow in the top right of the picture.

THE CPED TECHNIQUE

The acronym CPED summarizes the four stages of the digital imaging process: capture, process, enhance and display. We briefly describe each phase.

Capture

The capture phase takes place in the field. The rock art and its context are digitally photographed using high-resolution, tripod-mounted, digital SLR and medium-format cameras in RAW mode capture. Colour depth for the digital SLR (Nikon) is lossless 14-bit and for the medium-format camera (Hasselblad) it is lossless 16-bit. The digital camera bodies and lenses used are professional-standard Nikon and Hasselblad models. Off-camera lighting is combined with available light when necessary. The 'context' of the rock art refers to the surrounding rock face, the floor and ceiling of the overhang, and the landscape around the site. A 360º panoramic sequence enables one to see exactly where the images are located and how the site relates to the surrounds. Then an ultra-high-resolution (UHR) mosaic of the entire painted surface is created. The UHR mosaic enables the recorded rock art to be viewed at very high magnifications without any loss of resolution and with very accurate colour reproduction. The mosaic is compiled using a tripod-mounted camera and spherical panoramic attachment that rotates in increments around the optical centre of the lens (nodal point), thereby obviating optical distortion (Fig. 2). This procedure ensures that the target area is comprehensively recorded. To cater for the uneven topography of the rock surface, image sets are focus-bracketed to extend depth of field. These bracketed images are blended algorithmically during the processing phase to create a composite image that is uniformly sharp, colour-accurate and distortion free. In sites with highly variable ambient light or with surfaces of mixed reflectivity, exposure bracketing or High Dynamic Range (HDR) imaging methods are used.

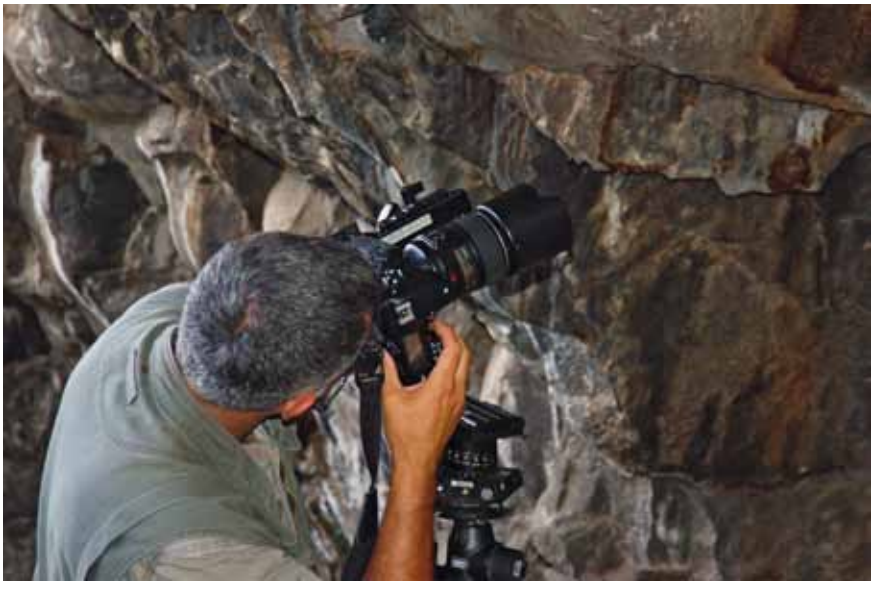

Fig. 2. Kevin Crause operates a tripod-mounted camera on a spherical panoramic head.

Processing

The processing, enhancement and display components are labour-intensive: for every hour spent in the field acquiring images, between eight and ten hours is needed to process, enhance and display them. Processing is done on a workstation-class computer (quad processor, 64-bit workstation with 12GB RAM and dual high-end graphics boards). The RAW images are loaded into Adobe Lightroom for selection and colour balancing before being imported into Adobe Photoshop as 16-bit images (in the case of images captured with the Nikon DSLR, these are interpolated to 16-bit from the native 14-bit NEF captures). These master files are saved as 16-bit Photoshop documents (PSDs) with 16-bit TIF file copies being exported for enhancement using the proprietary image-enhancement routines. A colour calibration device is placed at the site and included in key frames (Fig. 3). This device enables faithful colour reproduction and accuracy. Once all the images are processed they are divided into directories for stitching or enhancement. Stitching is the process by which individual images are seamlessly blended together to produce composite images for incorporation into the 360º Art in Context Viewer or the UHR Viewer(s). These modules are described below in greater detail (see 'Display').

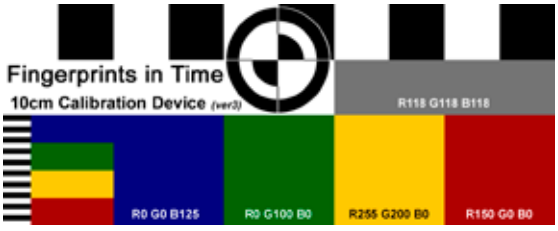

Fig. 3. Printed on non-reflective, archival grade, heavyweight matt paper using pigment inks, the calibration device serves as an accurate colour reference, grey card, and scale bar. The print is mounted onto acid-free matt board. Printing colour accuracy is measured with a colorimetric device and custom ICC profiles. The neutral grey area is hand painted with an imported 18 % grey acrylic paint. Subject to usage the calibration device also assists in correcting optical distortion.

Enhancement

The enhancement algorithms were designed to resolve details in the imagery that cannot be seen under normal light conditions by the human eye. Two software-based methods are used to amplify 'hidden' detail: the first method produces a false-colour image, and the second produces a greyscale image that isolates and amplifies a specific pigment colour value. Despite being 'false-colour', the amplified colour images match as closely as possible the hue and tonality of the original image. For example, faded (from slightly faded to invisible to the unaided eye) red pigments will be red, yellow pigments yellow, etc. The chromaticity values, however, will be hue-shifted and variably saturated, and thus defined as false colour. The enhancement method is algorithmic and does not make use of selective masking nor 'painting' in any form. The enhancement work flow combines various custom algorithms and image-processing methods that deconstruct the RGB source images and remap these components to custom colour spaces, which are further stacked, processed, amplified and blended back with the original image. The resulting enhancements are always presented alongside the unaltered or 'true colour' image for comparison.

Display

Three modes of viewing the data were generated for the Vaalekop rock art site: the Art in Context module (a 360° spherical panorama of the site and surrounds), the UHR Viewer and a number of analysis sheets. It is well-nigh impossible to reproduce the Art in Context module and the UHR Viewer in journal format, however, because these modes are interactive and dynamic. We must therefore be satisfied here with a verbal description.

The panoramic images were coded into a dedicated Art in Context Viewer which facilitates panning, scanning and zooming of the site through 360°. The UHR Viewer provides an interactive viewing module whereby the viewer may zoom into and pan around a rectified, colour-balanced, composite image of the site (or selected sections of the site) at resolutions from 50 % life-size to 500 % scale. Analysis sheets are produced for selected motifs and sections of the painted surfaces, each comprised of three images: a true-colour image (colour-balanced), an enhanced false-colour image and a greyscale image that shows enhancement of selected pigment colour ranges. These enhancements are often the most dramatic results of the documentation process because they reveal visual information no longer visible to the naked eye. Fourteen analysis sheets were produced.

RESULTS

In his report, Hollmann identified three discrete areas on the rock face that had been painted (Fig. 4; Hollmann 2010: 4). These observations were made with the naked eye, unassisted by magnification and lighting. During the initial site visit Hollmann took

Fig. 4. The overhang with the three more-or-less discrete painted areas in the initial report (Hollmann 2010).

single RAW digital images of the rock art, but without correcting for distortions, such as parallax errors or differences in depth of field caused by the uneven rock surface. Area A comprised at least three smudges of paint and, to their right, three images of small antelope painted in white. A few centimetres to the left of, and above, Area A is a painting in red and white of an eland viewed from the rear (Area B).

The third area (Area C) is in a separate 'alcove'. Four left-facing small antelope motifs are painted in an area measuring about 350 by 250 mm. Two of the images were bichrome, painted in red and white. The other two may originally have been bichrome, but it was only possible to see red pigment. The antelope motifs have red lines painted close by; the animal motifs are juxtaposed with approximately four anthropomorphic figures. Three of the anthropomorphs are very faded. The fourth figure looks larger than the other three and looks dark brown or black in colour. It appears to be lying on its side. Overall, then, the initial visit suggested that while there were detailed motifs depicted on the rock in three areas, it was no longer possible to decipher many details.

Viewing high-resolution digital images of Vaalekop Shelter changes one's perception of the place, however; instead of three, isolated areas of painting, it seems that the imagery is in fact interlinked and may be interpreted as a single 'composition'. With the benefit of the enhanced images of the rock face it is possible to recognize how the painted elements may be conceptually linked. We begin by pointing out some of the most significant details of the Vaalekop rock art site that the CPED process revealed.

Area A

Enhancement of the rock surface to the left of Area A shows that what appear to be traces of red pigment barely discernible with the naked eye are in fact interesting images. On the left is a right-facing figure that may combine human and other animal characteristics (i.e. it is therianthropic): it appears to have a tail, two anthropomorphic back legs and a penis (Fig. 5a). The two front limbs are held downwards; they may depict a zoomorph's front legs rather than human arms because of the way in which they are held out straight. If these limbs were intended to depict an anthropomorph's arms, one might expect to see a slight bend at the elbow. The enhanced images show that there is a thin line of pigment that runs across the rock face between the vicinity of one of the therianthrope's front limbs and the ear of a small antelope some 45 mm to the right. It seems likely that originally the therianthropic image was depicted as holding or touching the line of red pigment; close inspection of the enhanced images shows that the rock surface in this crucial area has been damaged and that the flakes of rock, together with the pigment, have fallen off.

The small red antelope with the line of pigment touching its ear is one of a group of three zoomorphs, all of which have been rendered immediately below a joint between two strata of rock (Fig. 5b). The zoomorph immediately adjoining the small antelope with the line of pigment is also an antelope; it has the tail, ears and build of an antelope. The third zoomorph could also be an antelope but it seems to have been depicted as seen from directly above; the head is in the middle, and on either side of the head are the two extended front limbs. Just to the right of this third possible antelope are the remains of red pigment that may have been a fourth, possibly uncompleted zoomorphic motif.

Fig. 5a. A therianthropic figure in Area A is invisible in the colour-balanced image at left, but can be seen in the false-colour enhancement at right.

Fig. 5b. Zoomorphs in Area A: colour-balanced image at top, false-colour enhancement at bottom.

Area B

Area B, above the joint between the two strata of rock, also turned out to have more imagery than was apparent to the naked eye. The rear-facing antelope (Fig. 6) is probably an eland to judge from its large size relative to the other antelope paintings at the site. The depiction has a neck (painted in white) and a mane (in red paint). The rock on which the head was probably painted has flaked off, but a single ear (the animal's left ear), painted in white, remains. The eland's rump is prominent and one can see a tail, which hangs straight down. Interestingly, the back legs seem to be drawn together so that the hock joints are situated close to each other. The front legs are somewhat splayed.

These details about the eland image suggest that it may depict female-eland mating behaviour (see discussion of the possible significance of eland mating postures in Lewis-Williams 1981: 47). Pager recorded similar motifs in painting sites in Didima Gorge and surrounding areas (1971: fig. 371). All of these details are visible under ambient light conditions. What cannot be seen without enhancement, however, is the anthropomorphic figure in red paint to the right (Fig. 6b). The anthropomorph bends forward slightly from the waist and a single arm, bent slightly at the elbow, hangs down. This is a characteristic posture seen at painting sites across the subcontinent that Lewis-Williams (1981: fig. 23, 78, 88–89) links to the boiling of what the Kalahari Bushmen call *n/om*, which Marshall interprets as 'supernatural potency' (1969: 350). If one zooms in on the enhanced images one can discern that the figure was depicted holding a stick-like object (perhaps a bow), although now only remnants can be seen. The presence of this anthropomorph and its juxtaposition with the eland add important visual information to what can be seen with the naked eye; it is a meaningful juxtaposition that could be developed with the use of Bushman ethnography.

'Unpainted' rock surfaces between A and C

Seemingly unpainted rock surfaces between Areas A and C were found to have rock art images painted on them (Fig. 7). The CPED process confirmed that traces of red pigment are indeed remnants of a figure in red paint holding a bow-shaped object. What was not visible, however, were details of this figure and the fact that it is but one of a row, or 'procession', of anthropomorphs (Fig. 8). The bow-holding figure appears to be headless; there does not appear to be any trace of pigment where the head would have been painted (Fig. 8b). Another interesting detail (one that would probably have been missed were it not for the high-resolution images and their enhancement) is that the figure with the bow seems to have its feet pointing to the right; the bow, therefore, seems to be held behind the figure. This posture is reminiscent of another common motif in southern African rock art—the 'arms-back' posture—although it is not common for a figure in the arms-back posture to hold an object. Again, it was Lewis-Williams who recorded Kalahari Bushman informants' explanation that healers hold their arms back in this way when they are getting *n/om* from god (Lewis-Williams 1981: 88). The row of figures was almost completely invisible to the naked eye (Fig. 8a). In retrospect it is possible to discern a few small painted areas but nothing more. Enhancement reveals a row of four anthropomorphs (Fig. 8b). These figures may be juxtaposed with a fault in the rock, although one cannot be certain because a piece of the rock seems to have fallen off after the images were painted.

Fig. 6a. Rear-view eland motif, colour-balanced.

Fig. 6b. False-colour enhancement reveals an anthropomorph in a bending-forward posture and holding a stick-like object that may be a bow.

Fig. 7a. Colour-balanced image of the seemingly unpainted area of rock between painted areas A and C.

Fig. 7b. False-colour enhancement of the area between painted areas A and C.

Fig. 8a. Very faint areas of red can be discerned in this colour-balanced close-up.

Fig. 8b. False-colour enhancement reveals a row of several anthropomorphic figures, possibly in dance postures.

As is common in the rock art of the country, the figures are naked and their penises have a bar painted across them, a feature referred to loosely as 'infibulation' (Vinnicombe 1976: 249–51; Willcox 1978). All four figures are oriented in the same direction but they are pictured in different attitudes. The two middle figures hold stick-like objects in their raised right arms; and, together with the figure at the far right, are depicted with their heads tilted, looking to the right, over their shoulders, towards the isolated bow-holding figure mentioned in the previous paragraph. It as if they are in the midst of a co-ordinated activity, perhaps a dance. The fourth figure, furthest to the left, faces to the left and holds a bow-like object (not well preserved, even when enhanced) in front of him with an outstretched right arm.

Area C

Area C is the largest painted area in the overhang (Fig. 9). We first point out details that are visible without any enhancement. The surface comprises sections of painted red line, three anthropomorphs and a few antelope. Two of the anthropomorphs—one at the top and one at the bottom—appear to be depicted in prone positions but they have become obscured by an overlying layer of mineral or biological growth. The lower figure appears to have a painted line associated with its lower body. The third anthropomorph, towards the left-hand side of the surface, is juxtaposed with a motif of a small antelope.

Fig. 9a. Colour-balanced overview of Area C.

Two of the small antelope are rendered in red and white pigment, as was the convention for painting zoomorphic motifs in this part of KwaZulu-Natal. Both antelope images exhibit similar behavioural features. The necks are extended and the heads hang downward. The right-hand back leg of the topmost antelope may have been depicted as being held off the ground; one cannot be certain about this point, however, because part of the leg was on a portion of rock that has flaked off. Nonetheless, comparison of the angle of this back leg with the back legs of the other

Fig. 9b. False-colour enhancement of Area C.

nearby antelope suggests this is the case. The antelopes' postures could indicate a communicative 'display' of behaviour, perhaps a defensive 'head-low' posture (e.g. Estes 1999: 29).

The third small antelope (to the left of the middle small antelope) also has its neck extended but its head is held more or less straight. There is also a red painted line associated with the rump of the antelope, and an anthropomorph with one arm extended, as if 'driving' the antelope, has been placed immediately to the right of the antelope motif (Fig. 10). In addition to these details, all discernible with the naked eye, there are portions of painted red lines as well as patches of red paint, but they cannot be resolved because of the layer(s) of mineral or biological growth over the images.

Digital imaging yielded additional visual data that could not be seen under ambient light conditions. The enhancements supply missing detail that contributes to an appreciation of the composition of the images. The small antelope's head on the far right has two short, straight horns, painted in red (Fig. 11). This detail suggests that the antelope motif depicts a *male* grey rhebok (*Pelea capreolus*) rather than the similar-sized mountain reedbuck (*Redunca fulvorufula*), a species which is also sometimes depicted in the rock art. Other facial markings have been carefully painted and the lips are visible when viewed at high magnification.

Most interestingly, digital enhancement has made it possible to see that there is a relationship between this grey rhebok motif and the anthropomorph painted directly above it: far from lying down, the anthropomorph seems to be running and, simultaneously, aiming at point-blank range to shoot an arrow with a triangular arrowhead into the animal (Fig. 12). The drawn bowstring, in red, can be seen at high magnification. There is also what looks like a suggestion of pigment right next to the anthropomorph's nose; this detail may be an instance of another well-known motif in southern Africa, interpreted as nasal bleeding (Lewis-Williams 1981).

Such compositions, in which a bowman is depicted apparently hunting an animal, are in fact rare (e.g. Pager 1971: 335; Lewis-Williams 1972: 51; Mazel 1981: 82, fig. 4.6).

Fig. 10a. Colour-balanced image.

Fig. 10b. False-colour enhancement revealed an anthropomorph with bag on back and stick in hand, possibly 'driving' or pursuing a small antelope. The anthropomorph has an 'infibulated' penis.

Fig. 11. False-colour detail of a male grey rhebok (*Pelea capreolus*).

Fig. 12. False-colour image of two grey rhebok with necks extended and heads hanging down. An anthropomorph is pointing a strung bow and arrow at the topmost grey rhebok.

Fig. 13. False-colour image of a squatting bowman with quiver and arrows on his back, and a white face, taking aim at a small antelope. The bowman is drawing back his bowstring (in white pigment). The arrow has a white shaft and a red point. There is a red line associated with his left knee.

But at Vaalekop there are two such bowmen: the other figure, revealed by enhancement, is squatting and holding a drawn bow and arrow (Fig. 13). He seems to be aiming at one of the small antelopes. Intriguingly, this figure is associated with a red line; it is possible that the line branches into two smaller lines that are associated with the anthropomorph's midriff. Enhancement also makes it possible to see that there is a fourth zoomorph—another small antelope, this one painted in red and white, recumbent and looking back over its shoulder (Fig. 14).

There is also a barely discernible and fragmentary area behind the second small antelope that may depict an anthropomorph. The enhanced false-colour and greyscale images show other previously unseen details, not all of which can be readily interpreted.

The sections of painted red lines on this part of the rock face look similar to the intriguing lines at Sorcerer's Rock in the Didima Gorge, some 72 km northwest of Vaalekop. Here Pager (1971: 164) has identified two sets of meandering lines—one in red, the other in yellow—as 'game tracks'; a grey rhebok is painted at the end of each track, in the same colour as the respective tracks upon which they stand . At this

Fig. 14. False-colour enhancement of small, recumbent antelope (a juvenile grey rhebok?).

site are also running anthropomorphic figures (colour coded) that follow the rhebok. The links, if any, between these painted lines at Vaalekop and those in, for example, the well-known Linton Panel in the Iziko SA Museum, Cape Town, are not clear and require further investigation.

THE CPED PROCESS AT VAALEKOP

The CPED process was able to capture the detail of the Vaalekop rock art site in its context on the rock face and within the surrounding landscape (Fig. 15). The 'Art in Context' component (i.e. the 360° panorama) enables one to view the rock face as well as views over the landscape from inside the overhang. The UHR mosaic makes it possible to see the art at magnifications of up to 75 % life-size. The analysis sheets use two processes—false-colour enhancement and pigment colour-range isolation—to show parts of the spectrum of light not visible to the naked, unassisted eye. The Vaalekop rock art site has thus been documented with unprecedented accuracy, precision and resolution.

CPED technology also made it possible to resolve and clarify many of the painted details on the rock face. Initial examination identified three discrete painted areas; many of the details of the painted images were, however, not resolved because they could not

Fig. 15. Composite image showing (from top to bottom): colour-balanced image; false-colour enhancement; greyscale.

be clearly seen. In addition, certain images and details were invisible under ambient light conditions. Using CPED it was possible to recognize details that altered the original impression of the site; what had seemed to be three discrete 'panels' or 'sections' could now be seen as parts of a whole. One may therefore consider the possibility that the art in the Vaalekop overhang is a single 'composition' in which the constituent images should be considered parts of a coherent and interrelated whole. This interpretation can be developed and tested in subsequent research. These data will be valuable when the rock art is removed because workers will be aware of the location of the rock art, visible and invisible, and thus will be able to avoid inadvertently damaging the paintings.

IMPLICATIONS

The use of sophisticated digital imaging at Vaalekop Shelter and the discovery of 'hidden' images have far-reaching implications for the documentation of rock art sites (and other heritage resources). How can one say that one has 'seen' the rock art of a particular site until it has been documented using CPED or something similar? The CPED process changes the way that we look at rock art. It is the new benchmark in recording rock art.

CPED and rock art documentation

Underlying the CPED process is the notion of the site and its surrounding environment as a single entity, the basic unit of analysis, as we now explain. This change in emphasis is a fundamental shift, made possible by digital technology: macro and micro features of the place are integrated in a single file (the UHR mosaic), giving a person complete freedom to move, almost instantaneously, from an overview of the entire rock face to fingernail-size fine details.

Above all, the CPED process represents a shift away from conventional approaches to photography—even from those that do incorporate digital innovations, such as RAW format images and image-enhancement software, but which have tended to be piecemeal adoptions that stop short of developing a new approach to imaging rock art. CPED is a new synthesis that combines elements of disparate technologies (visualization software, astronomy, forensics) and applies these to the specific challenges presented by rock art. The unity of the CPED data means that one has complete freedom to frame and print whatever views one chooses. The process transcends previous methods of site documentation, in which the camera is used, scalpel-like, to slice the site into a series of fixed views; in order to visualize the site from a sequence of photographs one must browse through a succession of individual images, referring back constantly to wide-angle shots in order to see how a micro detail relates to the other motifs.

Implications for researchers and heritage workers

Perhaps the most profound consequence of CPED is that it has improved our vision. The high-quality imaging equipment used to record the images and the use of enhancement techniques mean that rock art (paintings and engravings) that was formerly considered 'indecipherable' is now within our reach and can be studied. We are no longer dependent on 'well-preserved' sites for data; no doubt, even apparently well-known sites will yield previously unseen motifs and details of known images when documented using CPED.

An end to field tracing?

We argue that the CPED process has the potential to change the way that rock art researchers work in the field. Until recently workers dealt with the lack of visual information from rock art sites like Vaalekop by resorting to direct tracing, a process of interpretation in which the tracer attempts to resolve details through close visual inspection, sometimes with the use of magnification and extra lighting in order to render faint details more clearly. While the field-tracing technique undoubtedly enables the tracer to become well acquainted with the motifs and is an intrinsically satisfying experience, it has limitations. The tracer's vision is restricted to a particular band of wavelengths: all light reflected above and below these frequencies is invisible. Tracing is an interpretive process and recorders often disagree on how to resolve features of the art. Nor is it easy to adjudicate on differences in the interpretation of painted details by different recorders. In addition, it is difficult to incorporate into a tracing the colours used in the rock paintings as well as features of the rock face; tracers have developed techniques and conventions to accommodate these data but these corrective measures make use of signs and other visual conventions that do not have the same dramatic and immediate perceptual impact of the objects themselves.

The CPED process obviates the need for field tracing. Tracings can be made using the digital images obtained through CPED. Not only does this procedure eliminate entirely the need to touch the rock face, but it also pre-empts one of the biggest problems of tracing: the distortions introduced when reducing the three-dimensional rock face to a two-dimensional drawing (see Hagen 1986: 202–6 for general discussion of this problem which is, of course, not limited to tracing). In addition, the use of false-colour and greyscale enhancements enables the tracer to incorporate 'hidden' data, while the computer's ability to zoom in to minute details enables more detailed and precise copies to be produced. Importantly too, the tracings can be checked against the images for accuracy.

Need to improve skills and equipment

The development of the CPED process places researchers and heritage workers in a quandary as regards their work in documenting rock art sites. We know that rock art is inexorably disappearing and would probably all agree that it is imperative to record the art as accurately and precisely as possible, for posterity, and for research and management purposes. Yet most collections of rock art photography in museums and universities comprise photographs taken by the researcher or fieldworker who records the site and lodges the information with the appropriate institution. These recordings are invaluable and are often the sole record of the rock art and its context. But they are seldom, in our experience (yet there are exceptions), of a high technical standard. Most rock art researchers and heritage workers do not profess to be expert photographers. They may not have the time or the skills necessary to record the site thoroughly, nor are they necessarily equipped to record rock art to the highest possible standards.

As a consequence, most rock art has been inadequately recorded. Quite apart from the lack of expertise in the field, there are the limitations built into photographic equipment. Camera equipment and certain file formats remove information from the 'bucket' of potential data available and introduce distortions that can result in poor

quality images. Workers may justifiably be despondent about their own recording efforts and what they are able to achieve given such limitations. It is clear that we are losing important data.

Sharing the benefits of CPED

How can the benefits of CPED be shared as widely and as quickly as possible? One approach is to create a national centre for CPED imaging, one that is appropriately equipped and which provides imaging services to the country. Universities, heritage institutions and any other interested parties could then contract the services of this institution. The benefit of a centralized institution is the economy of scale achieved by pooling equipment and expertise, and offering these services to interested parties. It would enable researchers and heritage specialists to budget for imaging projects.

A complementary approach to harnessing the benefits of CPED technology is for people (e.g. rock art researchers) to improve the quality of photographic equipment owned by the organizations to which they belong. Individuals need to improve their knowledge of the fundamentals of photography and to become better acquainted with their cameras and their capabilities. Further training would help heritage workers and researchers to take better pictures. In addition, CPED technology, which is continually developing new features, could eventually be made commercially available in the form of a dedicated computer with the required hardware and software. This would enable people to process their images themselves and reduce their dependence on a central service provider. With the development of CPED, we argue, these challenges—the requirement for (expensive) highest-quality equipment and the skills necessary to produce accurate images—are starting to be addressed systematically, in South Africa at least. And while the enhanced false-colour and greyscale images appear to be the most exciting and dramatic component of the process, this kind of digital manipulation depends on the quality of the images. The imperative for quality and quantity of data has practical implications. The sensitivity and precision of the equipment used to gather the visual data are critical. The adequate recording of rock art demands the best equipment.

ACKNOWLEDGEMENTS

Thanks to Marthina Mössmer for suggesting that we write this paper. Mitigation was funded by the Trans Caledon Tunnel Authority. Janette Deacon, Aron Mazel, Gavin Whitelaw and Justine Wintjes made valuable comments and suggestions that improved the manuscript. All photographs by Kevin Crause, except Figures 1b, 2 and 4.

REFERENCES

Estes, R.D. 1999. *The safari companion: a guide to watching African mammals*. White River Junction (VT): Chelsea Green Publishing Company.

Hagen, M.A. 1986. *Varieties of realism: geometries of representational art*. Cambridge: Cambridge University Press.

Hollmann, J.C. 2010. Report on the Vaalekop rock art site (292BD 025). Compiled for Business Enterprises at the University of Pretoria (Pty) Ltd. Pietermaritzburg: Natal Museum.

Lewis-Williams, J.D. 1972. The syntax and function of the Giant's Castle rock-paintings. *South African Archaeological Bulletin* **27**: 49–65.

Lewis-Williams, J.D. 1981. *Believing and seeing: symbolic meanings in southern San rock paintings*. London: Academic Press.

Marshall, L. 1969. The medicine dance of the !Kung Bushmen. *Africa* **39**: 347–81.
Mazel, A.D. 1981. Up and down the Little Berg: archaeological resource management in the Natal Drakensberg. Final project report to the Department of Water Affairs, Forestry and Environmental Conservation. Pietermaritzburg: Natal Museum.
Pager, H. 1971. *Ndedema: a documentation of the rock paintings of the Ndedema Gorg*e. Graz: Akademische Druck.
Vinnicombe, P. 1976. *People of the eland: rock paintings of the Drakensberg Bushmen as a reflection of their life and thought*. Pietermaritzburg: University of Natal Press.
Willcox, A.R. 1978. So-called 'infibulation' in African rock art: a group research project. *African Studies* **37** (2): 203–25.