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Rock Art vs Cultural Stone: Some Geomorphological Perspectives On Weathering And Conservation Under A Changing Climate

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ABSTRACT

While concern for the conservation of cultural stone and rock art continues to grow, so the gap between knowledge of the processes causing deterioration and those assumed to be operating increases. At the same time, in many instances, cultural stone and rock art are considered within the same conceptual framework. From a geomorphological perspective, such stone and rock art can be affected by weathering in fundamentally different ways as a result of the environment they are in and that which they generate themselves. Further, knowledge of, and data regarding mechanical weathering processes, especially under accelerated climatic change, is far from adequate. A brief attempt is made to identify the geomorphological differences between rock art and cultural stone, and to see how these may affect conservation practices at this present time. It is suggested that the weathering environments may not only be quite different but that lack of adequate (appropriate) data may be potentially deleterious to conservation practices due to the (often) unsubstantiated assumptions regarding weathering that are adopted.
Key words: rock art, cultural stone, weathering, climate change, conservation

Background

From many perspectives, including geomorphology (e.g. Pope *et al.*, 2002), rock art and cultural stone (i.e. dressed stone found in monuments and edifices of human origin) are often considered under the same broad conceptual umbrella. However, although they may have a number of comparable geomorphic attributes, the dissimilarities may be such that they require different monitoring protocols as well as having individual implications for preservation/conservation. In the context of rock art, given the frequently simplistic approaches to weathering (e.g. Hoerlé, 2006) coupled with the current reconsideration of many of the mechanical weathering processes (e.g. Hall and Thorn, In Press), the question arises as to our realistic ability to manage and conserve. Although much has been achieved internationally regarding conservation of cultural stone, the same basic issues in the assumption of weathering processes, and hence what remedial/protective measures to take, still applies in many instances (e.g. Lawrence, 2001). With respect to San rock art in southern Africa, experience has shown that the assumption of this comparativeness (between art and stone) has led to some misconceptions that may, ultimately, be deleterious to that art. Here brief consideration will be given to the geomorphic dissimilarities between cultural stone and rock art as well as some misconceptions regarding the state of geomorphic knowledge regarding weathering.

Although this topic is being dealt with in detail elsewhere (Hall and Sumner, Forthcoming), it is worth noting here that there appear to be some misconceptions within the non-geomorphological sciences as to the state of knowledge regarding weathering processes as they apply to either cultural stone or rock art. It was noted by a referee in a recently reviewed submission on weathering of San rock art (Anon, 2009) that although weathering "rates may indeed change…the processes will not" and that "the same processes will be in operation but to different levels/extents." From a geomorphological perspective I would have to argue that these assumptions are naive at best and dangerous at worst. The sad reality is that, in terms of weathering, we may have a good handle on chemical processes but mechanical weathering processes remain largely a refection of outdated and untested assumptions (Hall *et al.*, 2002; Hall and Thorn, In Press). Researchers continue to put data into mechanical weathering 'boxes' (Sumner *et al.*, Forthcoming) on the assumption that these boxes (the processes) have meaning and indeed comprise all that exist. In the vast majority of cases the processes are assumed and data made to fit – a case of the self-fulfilling prophecy (see Hall, 2006a for a discussion). Indeed, with respect to rock art in South Africa and elsewhere, a number of workers (see Vinnicombe, 1966; Rudner, 1989; Batchelor, 1990) have assumed that freeze-thaw weathering was affecting the art or used unsubstantiated 'evidence' based on attributes of the weathered clasts (e.g. van Zinderen *et al.*, 1973). The reality is that in the case of the former, data collected over more than a decade (Meiklejohn *et al.*, 2009) showed not one event where the temperature went below 0ºC to cause freezing and, in the latter, that clast shape is no indicator whatsoever of process (e.g. Hall, 1995; Hall and Thorn, In Press). In reality, mechanical weathering processes are in a state of 'review' and we are starting to realize just how outdated and 'wrong' are many of our long-cherished notions. For example, André *et al.* (2004), and Hall *et al.* (2008) showed how translucent minerals may greatly influence the thermal regime of rock, and that this has implications for rock art (Hall *et al.*, In Press; Hall, In Press). Further, following early studies of high-frequency ($\geq$1 min) thermal changes to rock (Hall, 1999, 2006b; Hall and André, 2001, 2003), McKay *et al.* (2009) and Molaro and McKay (In Press) have shown how monitoring at 1 sec and 0.375 sec intervals completely changed the perception of the weathering environment and the nature of the weathering. We are now at the stage where we might (hopefully) see the creation of new mechanical weathering processes and certainly a revision of the long-held concepts.

Thus, contrary to some opinions (Anon, 2009), it is clear that we are not yet in the position to make assumptions regarding weathering rates or processes, and how they may respond to a changing climate. To accept such arguments would necessitate that we *do* actually know both what processes are active and what their current rates are; sadly, this is simply not so. To assume this information and go down such a road is but to fulfill the paradox of the 'Self-fulfilling Belief' (Clark, 2002: 182) where 'If I believe that I am believing this, where "this" refers to that very belief, my belief necessarily makes itself true'. However, the reality is, here, that (Clark, 2002: 182): 'I cannot hold this as a belief, since it has no genuine content' (see Hall, 2006a and Hall and Thorn, In Press for a discussion). Simply put, we do *not* unequivocally know what processes are affecting much of our rock art or cultural stone, or at what rates. We dare not assume process(es) and/or rates and base our conservation protocols on these assumptions.

The geomorphic difference between cultural stone and rock art

At first glance, the geomorphic difference between (dressed) cultural stone and rock art may seem more semantics than science. However, there are more than subtle distinctions. First, and fundamental to this distinction, is that any pigments applied to the rock will operate as both a barrier (Thomas, 1991) and as a 'surface modifier' (Bullet and Prosser, 1983). Thus pigments may significantly change the chemistry, porosity, permeability, albedo, thermal conductivity, thermal capacity, thermal gradient, and thermal coefficients of expansion and contraction with respect to both the surrounding rock and adjacent pigments (Hall *et al.*, 2007b). Just as knowledge of the petrological aspects of the rock in cultural stone are significant (e.g. Dreesen *et al.*, 2006), so too are the chemical attributes of the pigments (Zoppi *et al.*, 2002; Chalmin *et al.*, 2003). In fact, as noted by Hao and Iqbal (1997) and Casellato *et al.* (2002), conservation requires an understanding of the physico-chemical attributes of the pigments in order to elucidate the nature of any modification or means of conservation. Thus, while each rock type may have quite different properties, in most instances the very nature of the edifice is such that the component materials are relatively large in dimensions, may have contacts that are themselves able to accommodate some physical changes in the constituent rocks (e.g. Ninis and Kourkoulis, 2006), and the rocks themselves are likely dressed prior to installation and thus this provides for a lesser degree of heterogeneity upon which weathering then (initially) operates. The surface modifier effect of pigments can be highly important in terms of moisture transfers. If the main source of moisture is from the atmosphere (e.g. MacLeod and Haydock, 2008) then the pigments are a barrier to the ingress of moisture as compared to the surrounding pigment-free rock; the more so if the pigments are also located on a smoothed surface with a cover of clay ground, as is the case with some San rock art (Hall *et al.*, 2007a, b). Equally, if the moisture source is from within the rock (a situation not really analogous to any edifice) then, again, the pigment creates a barrier to the free flow out of that moisture. Such situations may have marked effects on both chemical and mechanical weathering processes.

Another distinction is that, in essence, rock art is a two-dimensional object while cultural stone is three-dimensional. A consequence of this difference is that, as suggested by Bakkevig (2004), the edifice of cultural stone itself may well change the local environment (e.g. wind speed and direction, radiation receipt, temperatures, and moisture). More recently, Gómez-Heras *et al.* (2008: 547) have shown that 'adjacent areas of stone with very different surface properties may have (an effect) on the thermal response of a patch of stonework' but that such situations have 'received relatively little attention'. This dimensional difference can thus play a significant role in terms of weathering and, hence, conservation. Indeed, such must be kept in mind if, for rock art, any conservation approach includes the addition of any structures (e.g. viewing stands, walkways, signage, etc) for these may, while minimizing some effects (e.g. dust), increase or change others (e.g. albedo, wind flow, etc). Equally, the removal of, or change to, vegetation surrounding a rock art site, either naturally through fire or succession and/or anthropogenically for such as tourism (e.g. Bakkevig, 2004; Hall *et al.*, 2007a) could also have significant impacts on the weathering regime (Díez-Herrero *et al.*, 2009). Indeed, as Bakkevig (2004) has argued, the vegetation at a rock art site today may well not be the same as it was when the art was created; climatic variation and natural succession could play a role as equally as human impacts through such as farming, burning, or tourism. Indeed, in some ways, the nature of impacts on vegetation may play a larger role in affecting rock art than hitherto recognized. For example, it has been argued (Hall *et al.*, 2007a, b) that the removal of vegetation for tourist access has exposed some rock art to direct sunlight and thus significantly changed the weathering regime; loss of protective vegetation would also affect the wind and moisture regime on the nearby rock surfaces. Even where vegetation has been removed, the site may still be prone to damage from fires due to burning of wooden structures associated with tourism, as was the case at Tandjiesberg (Morris *et al.*, 2001). Equally, where vegetation has not been removed, so fires (natural and/ or deliberate) may still be a potential source of damage to rock art (the recent fire at Giants Castle almost set the walkways and viewing stands adjacent to the rock art in Main Caves alight, which would have caused more fire damage than that due to ignition of the vegetation alone). The very size and composition of many cultural stone edifices may make them less prone to fire damage.

The impact of current climatic change on weathering

Given the present perspectives on accelerated climatic change, so a number of environmental repercussions may impact the weathering of both rock art and cultural stone. Contrary to some opinions, our inadequate knowledge of present weathering is indeed confounded the more by changes in climate such that it is *not* so that 'those working on weathering processes can plan for climate change based on our knowledge of the likely effects of factors such as increased temperature and decreased precipitation' (Anon, 2009). Again, this simplistically assumes we in fact have any knowledge of the present processes and their relationship to *rock surface* and *rock sub-surface* conditions. Further, statements such as 'Some new processes (*sic*) may be encountered in South Africa, but these will be processes that have faced conservators in other places. We will not therefore be faced with a problem for which there is no applicable research' (Anon, 2009) are simply not adequately cognizant of our scientific knowledge. The above statement has so many assumptions and flaws as to be of grave concern. Not only is it continuing in the assumption of process knowledge and appropriate data, but it also assumes 'all the problems are solved and that conservators are on top of the problem'; this is not only intellectually arrogant, but it is also naively dangerous to our heritage and scientifically unsound at every level. Lastly, that 'professional conservators have to find working solutions to these problems on a daily basis' (Anon, 2009) is somewhat confounded by the extensive academic/ applied concern and on-going scientific investigation in the international forum (e.g. Hocquette *et al.*, 2002). Clearly, there is a profound dichotomy between the thinking of some conservators (e.g. Anon, 2009) and those of us actively involved in trying to understand processes and find remedial/ conservation approaches that will not inflict even more damage (e.g. Houck and Scherer, 2006).

An on-going confounding factor between rock art and cultural stone will be the two- versus three- dimensional attributes respectively and the changes (or lack of) in weathering responses as a result of this. One issue is the baseline ("the present") from which to extrapolate the character of weathering. With, in many instances, current data being inadequate for a meaningful determination of weathering processes, so the problem is the ability to create a "baseline" at the present time when the environmental conditions are in such a (relatively rapid) state of flux. For cultural stone, it is clearly imperative that some understanding be gained of the influence of the structure itself on the current weathering, without which it is impossible to begin to estimate changes. Given that neither weathering processes nor the nature of self-impact are yet well understood, this too becomes more complex to evaluate under a changing climate. With respect to rock art, consideration of "the present" climate may be further confused by changes to surrounding vegetation. As discussed above, if vegetation is removed, so some art may be exposed to direct sunlight. As a corollary, at another site, natural growth of vegetation (perhaps enhanced by the climatic change) may produce increased shading and protection from wind and rain. In both instances, so the (short-term) changes may significantly influence the 'base line' from which to both determine present processes and to suggest what changes in processes and/or rates may occur in the future. In both instances, it needs to be considered as to what the future weathering impact of chemical or structural conservation methods would be given the changing climate. For example, (hypothetically) protection from frost action may be redundant, and potentially damaging, if the climate is warming such that wetting and drying or oxidation is now becoming more prevalent; the frost retarding method applied today (perhaps) enhancing the new dominant process; all of this assuming that we really knew it was indeed frost action that was critical today.

Given our changing frame of reference, can we be sure what we measure is relevant and that we are measuring *all* that we require? In some ways, these questions are really presupposed upon the assumption that we understand weathering processes and their linkages. Here there is a strong dichotomy between the empirical engineering and, perhaps, conservation approach to weathering and the more theoretical geomorphological approach. Engineering tests certainly work well, as engineering tests, but they do not measure in accord with the attributes associated with the process(es) they purport to replicate and, perhaps more importantly, take no consideration of process synergy. They do not link annual sequences of processes such as, wetting and drying or thermal stress in summer followed by the freeze-thaw in winter and salt weathering in spring, as well as chemical weathering throughout (Hall, 2006a). Further, normally applied to test *new* materials, results may offer little or no insight into previously weathered (i.e. old) stone. This latter problem could be highly significant for the very nature of the rock art or monument under protection may preclude the use of part of it to test present properties. Thus, our theoretical framework, so long dependant on a top-down approach (climate/weather defining specific process to the exclusion of others), may also need to be adapted to appropriately deal with such scale and detail of monitoring.

Conclusions

From a theoretical and practical perspective our way forward is thus constrained on several fronts. In the first instance, defining frames of reference is more than philosophical semantics for it may well be that which comprises wise conservation now may be contra-indicated as the climate changes, and may certainly differ in terms of application between rock art and cultural stone. We also suffer from diverse disciplinary approaches, an unclear framework for field measurement criteria, and an absence of a common, appropriate theoretical framework regarding weathering *per se*. Without a clear grasp of actual process operation and synergy, there is little hope for conservation under a changing climate. At the same time, we need to recognize the fundamental environmental differences between rock art and cultural stone, and set up monitoring protocols appropriate to the relevant situations. The problem is not insurmountable but we need to recognise and create research protocols that take these very issues into account, such that the outcomes are meaningful rather than theory- or, or artifact-, or time- constrained and thus, perhaps, wrong. In addition to supporting detailed and long-term field monitoring, future efforts should also focus on resolving theoretical-empirical relationships, perhaps with a view towards a revised conceptual framework for weathering that encompasses the different approaches by disciplines and reflects the role of the structure itself on the resultant weathering regime of that structure (and/or of its impact on nearby structures or parts of the same structure). Clearly defined field monitoring protocols would also allow for meaningful, but notably scarce, inter- and intra-site comparisons.

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