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Understanding an unique conservation work environment. The case of the Côa Valley rock art outcrops.

António Pedro Batarda Fernandes

*Archaeologist, Côa Valley Archaeological Park, Vila Nova de Foz Côa, Portugal
abatarda.pavc@ipa.min-cultura.pt or batarda@hotmail.com*

SUMMARY: The Côa Valley rock art constitutes one of the most significant archaeological sites in Portugal and Europe as its inscription in the UNESCO's World Heritage List illustrates. Therefore, the Côa Valley Archaeological Park, as the state body responsible for the preservation and management of the Côa rock art, created a Conservation Program that aims to ensure, as far as possible, the continued existence of this heritage. Understanding environment dynamics – geological, geomorphological, mechanical, biological as well as socio-economical – and their different rhythms of evolution is crucial to the development of an informed and consequent conservation philosophy. Moreover, the pioneering character of in situ schist outcrops conservation work further stresses the necessity of accurately understanding all dynamics that determine the perennity of the Côa art..

KEY-WORDS: Rock art; Conservation of rock art.

INTRODUCTION

Since 2000, the author has been developing and coordinating a conservation project for the Côa Valley rock art. This project aims to understand, monitor and prevent effects that could influence the stability of the rocky outcrops with rock art motifs dating from the ancient artistic cycle of the Côa Valley. In another paper, it has been explained the importance of a preventive system of visitation for the preservation of this heritage (Fernandes¹). The rock art corpus in the basin of the lower Côa is one of the most important archaeological and artistic heritage sites in Portugal: in fact, it is the only Portuguese archaeological site included in the World Heritage List. It contributes to the development of local tourism (and consequently of the regional economy), to job creation, to culture as a whole, to archaeological research, and to the study of human evolution, as well as raising the profile of the region and the country internationally. This is an irreplaceable archaeological heritage that subsists in a delicate balance with the surrounding environment. Furthermore, little is known about the weathering dynamics - geological, biological or mechanical - that affect its preservation. Hence it is necessary to address holistically the questions connected to the conservation of an heritage that, as it will be shown, subsists in a unique (conservation work) environment and therefore requiring a fresh and original methodological approach. A transversal approach is fundamental when dealing with the interdependent issues of the preservation/conservation and the management of Côa rock art. To preserve is to manage, to divulge is to preserve, successively and reciprocally.

THE CÔA VALLEY ROCK ART OVERALL CONTEXT

The PAVC is situated in northeastern Portugal, in an area with several frontiers: first of all, the border with Spain, but also the administrative, regional, natural and socio-economic divisions between the provinces of *Beira Alta* and *Trás-os-Montes e Alto Douro*. Geomorphologically, the PAVC area is part of the northern extremity of the Iberian Meseta (the 'bony' structure of Iberia), and of the hydrographical basin of the Douro. Geologically this region has attributes that contribute to a particular climatic, morphological, topographic and even social and economic cluster. Among these particularities, the dry warm climate with medium annual temperatures between 12,5 and 15 C° and low precipitation, less than 500 mm per year should be highlighted (IA²). These characteristics were instrumental in the establishment over the last two millennia of an economic model of land exploitation traditionally based on three major monocultures (olives, almonds and wine) adapted to these harsh conditions, complemented by sheep-farming. If Côa rock art indicates the beginning of the interaction between *Sapiens sapiens* and this particular landscape, signalling also the different stages (Upper Palaeolithic, Iron Age, Historical Period) in the evolution of this 'companionship', it is not the only manifestation of this age-old relationship.

The inaccessibility of some riverside areas, and the hard work needed to cultivate the sometimes very steep slopes, has meant that human activity in these zones has been basically non-intrusive. This is presumably the reason for the survival of most of the rock art motifs engraved on the outcrops, although we will never know the precise number engraved outcrops that might have been totally lost. Up till now, 28 rock art sites with more than 2000 individual motifs have been identified, on approximately 400 different rocky surfaces.

However, the modern economic model of land exploitation has more destructive characteristics. For instance, there is a schist quarry above the *Canada do Inferno* rock art site. The normal schist extraction work involves the use of explosives that obviously affect the stability of the engraved outcrops in the area. Another potential hazard is illegal extraction of river sand, which may result in dramatic changes to the natural path of the Côa. This factor, together with the dams in the Douro river basin, such as Pocinho, which have in recent years made the water level rise in the final section of the Côa, have caused great disturbances in the natural flow of the river. The Pocinho dam has already submerged some engraved surfaces along the shores of both the Douro and the Côa. The existence of this dam system, together with winters of heavy precipitation, has meant that some engraved outcrops in different rock art sites become temporarily submerged by the rise of the river level. As one might imagine, this sometimes sudden variation of the water level has a negative impact on the preservation of these outcrops.

Sheep farming can also influence the preservation of Côa rock art. In fact, when summer comes some shepherds set fire to bush areas, convinced that the vegetation will grow stronger and greener the following year, giving more pasture to the animals. If in a short period this is true, in fact in the medium and long term this practice results in the progressive impoverishment and erosion of soils. It is easy to see that these summer fires can have a devastating effect on the engraved panels. Heat, if inflicted directly upon the engraved surfaces, may hasten weathering dynamics, as well as possibly blackening the panels and even eroding the engraved motifs. Fortunately, thanks to the constant vigilance that the Park staff maintains over the territory, the nature of combustible matter (mostly bush) and good communication with local fire brigades, up till now no fire has in fact directly affected any of the rock art sites.

Another factor that can affect the stability (and even the existence) of the engraved outcrops is when vast terrains are scarified, especially if this practice is done in an illegal and chaotic fashion. Foz Côa is in the Port wine production district, and therefore a high percentage of agricultural soils are vineyards. The characteristics of this production imply huge soil movements, often near watercourses, in order to create the terraces necessary to plant the vineyards. Within this context, it is of paramount importance to keep a tight watch over areas near rock art sites in order to prevent unlicensed scarifying procedures from destroying the rock art heritage. Hence PAVC staff closely monitors the Park's territory in order to identify, acting accordingly, illegal scarifying procedures or to follow licensed ones.

GEOLOGY, GEOMORPHOLOGY AND SEISMICITY

A large portion of PAVC territory is composed of metamorphic formations (some meta-greywaches) belonging to what is commonly known as the *Complexo Xisto-Grauwáquico* (CXG – Schist-Greywachian Complex), although, in the region where the PAVC is located, the more correct designation would be to refer to it as the *Dúrico-Beirão* lithostratigraphic Super Group. The deposition of this complex, which occupies a large portion of Portugal, began in pre-Cambrian times, some 540 million years ago. As a result of the variety of original sedimentary environments, it is lithologically very diverse (Ribeiro³). The existence of this metamorphic bedrock determined the emergence of the 'ideal' surfaces used for Côa Valley rock art. The gradual, South to North, Côa down-cutting process took advantage of a pre-existing, NNE-SSW oriented, regional fracture family. At the same time, it triggered the surfacing of smooth vertical schist panels. Fracture and exposure of these surfaces are precisely consequences of the tectonic and down-cutting processes upon the previously deposited metamorphic rocks. Among the tectonic faults in the area, the *Vilariça-Longroiva* fault is the most prominent one. This feature "is a complex accident, with fractures of kilometric band width (...), [and] judging by the deformation of the relatively recent sediments and contemporary seismic activity records" (Ribeiro⁴) its activity continues up to the present day.

SCHIST WEATHERING MECHANISMS AND GEO-MECHANICAL DYNAMICS

Schist is a metamorphic rock with a distinct, even 'idiosyncratic', quality: its schistosity. This is the natural schist tendency to auto-fracture, which decisively determines the approach to *in situ* conservation work. One has to bear in mind that it is impossible to completely stabilize schist outcrops. The present precarious equilibrium is the specific natural equilibrium of these outcrops, which are not in essence immutable monoliths.

It is therefore essential to monitor the development of weathering dynamics and of the stability of the outcrops, in order to understand the real impact of the action of these dynamics, and to collect information to ascertain the urgency of embarking on conservation work. The real necessity of carrying out such actions must be fully demonstrated, since a margin of error is virtually non-existent. The temptation to implement such actions in an extemporaneous or ill-advised way should be resisted, for such action could hasten the present natural dynamics and their negative effects on the preservation of the monumental rock art of the Côa. Therefore, the objective of conservation work should be not to try to arrest the normal evolution of the weathering patterns resulting from these dynamics, but to reduce their negative effects, even neutralizing them, if technically, mechanically or ethically possible.

It must also be considered that any conservation action, even if minor, always implies a change in the intrinsic physical appearance of the outcrops and panels. This could raise important aesthetic or even ethical issues. It is of course possible to re-create the visual and texture characteristics of the panels and outcrops, trying to disguise the alterations made. Nonetheless, if the result is an unambiguous mitigation of the action and development of the weathering processes, the implementation of such necessary conservation work should be strongly considered, even if it has a variety of effects on the object itself.

Different scales, different problems

It will be helpful to distinguish between the different scales where the diverse dynamics that directly or indirectly affect the preservation of the engraved outcrops manifest themselves. An informative and holistic description of the dynamics at work, the product of a multidisciplinary approach, must go beyond classical typology by subject division (Geology, Biology and so on).

The macro local scale

In a macro local scale all the conditions at work in the surrounding area, which are mainly dictated by the topographic position of the carved outcrops can be placed. If the natural propensity of schistous outcrops is to self-splinter, the tendency of the slopes, where the outcrops are located, is to dismantle them. That is, since the outcrops are situated at the base or half-way up relatively steep, high hills which slope down to the Côa and the Douro or to their minor tributaries, all materials that fall from these hills exert critical pressure on the outcrops. Furthermore, as the slopes are very steep, the outcrops at their base adversely affect the stability of the hills: only the gradual decay of the outcrops will stabilise the hillside sufficiently. It is easy therefore to imagine the enormous effort which the outcrops are subjected to, and the origin of most of the weathering dynamics that affect the stability of the outcrops in the micro and medium local scales. An example is toppling, a type of horizontal fracture that results in the progressively echeloned advance of the upper broken slabs, forming a kind of inverted staircase (Rodrigues⁵). (see Fig. 1)

The topographic position of the outcrops also contributes to aggravate present damage, and leads to other geological and structural weathering dynamics caused by the natural flow of rainwater, with all the negative impacts associated with percolation. Nonetheless, current rainfall figures for the region are low (see below, results from the weather station in place in the PAVC). In fact, since Upper Palaeolithic times, when precipitation was also very moderate, weather patterns may have evolved in a useful way (Aubry⁶). This has contributed to partly reduce the effects of the flow of rainwater, which may explain the survival of the surfaces and their engravings up to the present.

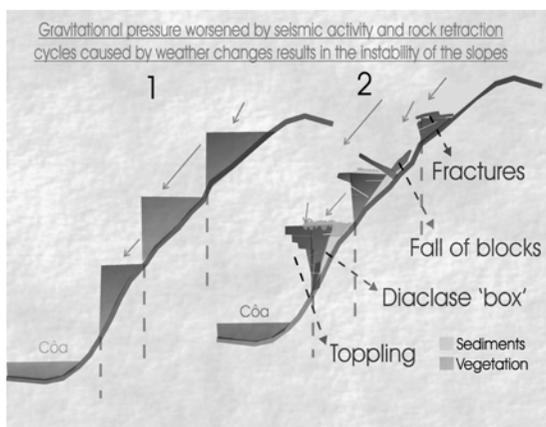


Figure 1

The medium local scale

In the medium local scale all the biological dynamics active in the surrounding area and directly in the massifs have to be considered: flora (trees, bushes, smaller plants) and fauna (small rodents and birds). The natural behaviour of these organisms (movement of roots, nests or burrows) can all be factors in the disintegration of the outcrops and panels.

Also in this scale, the precise weathering processes of each outcrop (open or closed fractures, diaclasites, disconnected blocks, toppling) are seen in a much more tangible fashion (see Fig. 2). These processes operate together and as a result of the macro scale dynamics mentioned above. That is, most of the weathering processes originate in the dynamics resulting from the topographic position of the carved outcrops.



Figure 2 – The tangled horses of Piscos.

Nonetheless, even if these processes have a common origin, their

consequences on this scale are seen in a different mode in each outcrop. This disparity therefore contributes decisively to the different set of weathering processes that specifically affect each of the engraved outcrops.

The micro local scale

In this scale the biological dynamics that act directly on the panels have to be considered: lichen colonization, growth of small plants or fungus on the existing fractures or on top of the panels, or the presence of insects that colonize the concavities of the engraved faces. In general, the sum of the effects of the action of these factors, known as biodegradation, is manageable. The negative consequences of their activity can be minimized on the whole (if necessary by cleaning), even those resulting from lichen colonization. Nevertheless, only a meticulous, *vis-à-vis* analysis of the benefits and harms of lichen cleaning actions can determine if it would be more damaging to remove the lichens than to let them stay (Romão⁷; Vänskä⁸).

There are other factors that affect the preservation of the carved surfaces on this micro local scale. Some are geological, such as exfoliation, alveolization, scaling, or the development of fissures or microfissures. All these weathering dynamics, although resulting from factors that work on other broader scales, emerge and affect microlocally, and again dissimilarly, the condition of the engraved motifs and of the surfaces that host them.

At this level, the siliceous skin that covers the engraved panels also has to be taken into account. This layer, due to complex and little-understood deposition, erosion and re-

deposition processes, (Zilhão⁹), is the origin of the patina on the engraved motifs (Aubry¹⁰), and has contributed, in differing degrees according to particular cases, to the conservation of surfaces and engraved motifs.

ESSENTIAL IMPLICATIONS FOR FUTURE CONSERVATION WORK

In this complex conservation work environment, every action taken to avoid the slow disintegration of the outcrops and panels or the effects of inexorable schistosity will necessarily be anti-natural. Moreover, such action will not indefinitely protect the rock from the expression of its own nature and from the effects of its topographic position. If successful it will only lessen the effects, but if disastrous - due to deficient analysis or to lack of data - it will seriously aggravate them and there is no margin of error. An error might have irreversible, and therefore dramatic, consequences, further complicating an already tangled context of conservation. Devlet and Devlet briefly describe measures which severely affected the preservation of South Siberian rock art motifs also engraved on schistous rocks. According to these authors “attempts to stop deterioration of the surface (crack filling, impregnation of the surface) were not very fruitful and this [sic] conservation measures had lamentable and irreversible results and became a complementary factor of rock art deterioration” (Devlet¹¹).

In fact, *in situ* crack filling, reattachment, massif consolidation or impregnation of the surface of any kind of rocky surface are today universally approached with great caution. This is because a great deal of unintentional but undeniable damage has resulted from past interventions, as can be seen in the accounts of, among others, Finn¹², Walderhaug¹³, Andersson¹⁴ or Rosenfeld¹⁵, besides the episode mentioned above. In a framework where hypothetical conservation actions are of such a complex and delicate nature, it must also be kept in mind that there is as yet no data on long term changes to new materials and methods of stabilization and consolidation as used within a natural, largely uncontrollable environment.

The different dynamics at work that influence the stability and endurance of the engraved outcrops act together: none of the weathering dynamics seen in each outcrop works single-handedly, and their total effects must be regarded as interdependent but as altering each outcrop in a different way. The approach must therefore be systematic, trying to identify the entirety of the dynamics at work, the way in which they affect the stability of each outcrop, and the possible conservation actions to be taken. While trying to understand all the dynamics at work, a case-by-case approach should be followed, attempting firstly to understand how these dynamics act in each outcrop, so that afterwards the best methodology and materials can be chosen for each situation. References in the specialized literature to specific actions of *in situ* schist conservation are few and not very helpful, recommending a prudent approach in planning the actions to be taken step by step.

There is a vast number of rock art surfaces, engraved and painted both on schist and granite, in the Côa Valley. According to the latest available information there are more than 400 different engraved surfaces scattered along the banks of the final 17 kms of the Côa and some others along the Douro immediately after the mouth of the Côa. These surfaces are often located in remote and inaccessible areas, and this poses important logistical problems for the implementation of conservation actions. If all the identified hazards mentioned above are considered, together with others yet unidentified or unnoticed, a very delicate context for conservation work is complete.

TOOLS TO BETTER UNDERSTAND AND FOLLOW THE EVOLUTION OF WEATHERING DYNAMICS

Documentation

Comprehensive recording is fundamental for understanding the evolution of the geological, biological and mechanical dynamics that directly or indirectly affect the state of conservation of rock art outcrops and panels. This requires the use of many existing methods, such as photography, drawing, topography and 3D techniques (namely stereophotogrametry), besides others that might appear in the future. A documentation method specifically designed for use in conservation assessment and work is being developed, together with several international students and archaeologists who have done internships in the Côa (Huang¹⁶). This method is intended to portray the lithic weathering dynamics and micro and medium local biological dynamics in each engraved panel or outcrop, as well as the ones present Type-Rocks (these are surfaces without engravings but with analogous weathering dynamics to the engraved ones). Such documentation is useful, not only to identify and locate the dynamics in each panel, but also to record future conservation work to be done on the panels and on the Type-Rocks. Digital high resolution photography of particular areas of the panels and outcrops is also being employed as a documentation method.

Monitoring outcrops

The documents described above allow regular systematic monitoring of the general and particular state of conservation of the rock art panels and their outcrops. Data collected by observation of changes in the conservation state of the outcrops can be easily included, and comparisons regularly made. In the case of maps, new digital copies are created to receive the updates required by observations of changes in weathering dynamics and dynamics.

High resolution photos are used to trace changes in fissures and fractures of the panels. Points of easy reference are digitally located in the photos so that later *in situ* periodical measurements can be taken. Comparison between the data gathered by these periodical readings provides a way of assessing the development of these weathering dynamics. This method can be adapted to trace changes in other dynamics, such as colonization by lichen or erosion of the siliceous layer. To measure the distance between reference points a Quantum¹ digital pachymeter with a resolution of 0.01 mm and 0.03 mm of accuracy is used.

The implementation of a monitoring system based on topography is still in a study phase. Basically this system consists in expanding the measurement of the changes in the panel fractures to a broader scale. This expansion is intended to ensure that any movements in engraved outcrops in a medium and macro local scale can be observed.

Monitoring seismicity

Since October 2003, a seismic activity monitoring system has been operating at the Canada do Inferno site. This seismic station resulted from a protocol established with CGUL (University of Lisbon Geophysical Centre). It aims to measure natural or man-made seismic activity in the area of the PAVC. It is important to monitor such activity in the Canada do Inferno area since several schist extraction companies are working above and near it, and this involves regular detonation of explosives. Thus the objective is to measure the intensity of these explosions and of local and regional natural seismicity, so as to correlate changes in

the condition of the engraved outcrops with seismic activity. First results available indicate that the magnitude of the explosions in the Poio quarries isn't acute enough to greatly disrupt the stability of the engraved outcrops (Fernandes¹⁷).

Monitoring weather patterns

Understanding climate change, and the annual, monthly and even daily variability of the weather between and in the different rock art sites or on one or several engraved surfaces, is instrumental to the conservation of Coa Valley rock art. Therefore at the beginning of 2004 a WatchDog 700 weather station, which monitors temperature, precipitation and relative humidity, was installed in the *Penascosa* rock art site. It also measures temperature inside two different non-engraved outcrops, so as to give an idea of the temperatures that schist outcrops can reach at their core. First results concur with the regional weather patterns as defined for the region (IA¹⁸). The readings from the sensors implemented in the core of two different outcrops also indicate, according to the position of the outcrops and of the sensors, notable daily and monthly temperature fluctuations. It is also shown that schist can accumulate and maintain high temperature values. This data is important to understand how temperature variations can affect the stability of the outcrops, namely connected with daily, monthly and annual expansion and retraction cycles of the mineral materials that constitute the engraved outcrops (see Fig. 1).

PRIOR TESTING

In order to evaluate the reaction of the schistous outcrops to consolidation, stabilization and cleaning materials as well to techniques and methodologies that may be useful in minimizing the outcome of weathering dynamics on the carved outcrops it is very important to begin by experimenting on Type-Rocks. The outcome of this experimentation, which should also be monitored, is instrumental in understanding the development of the mechanisms that influence the conservation state of the outcrops, and also in assessing the value of different conservation materials, techniques and work methodologies in possible future conservation work. For this purpose, previous experimentation is crucial, since there is almost complete ignorance of the reaction and behaviour of granite and schist in *in situ* outcrops when subject to conservation treatments involving either traditional or newly-developed materials and techniques. Therefore, when evaluation determines that it is necessary to implement conservation treatments in any of the outcrops, there will already be some preliminary data that can ensure, as far as possible, that the conservation actions will be successful and do not trigger an undesirable acceleration of the weathering dynamics.

FINAL CONSIDERATIONS

This article must close with a word of optimism and another of warning. In spite of the apparently poor condition of a few panels and outcrops, as CXG is particularly resistant and durable (Ribeiro¹⁹), then in regular conditions (little and well monitored human activity, few and rare earthquakes) the Coa rock art panels and outcrops are likely to survive for a very long time. Therefore, any future conservation work has to be sanctioned by further and thorough research on suitable methods and materials.

Nevertheless, despite different time-schemes (geological and prolonged; human and brief), time is, as Margarite Yourcenar might have put it, an all-sculpting chisel. Human beings have a limited lifespan - the traces that we leave behind, testimonies of our journey through history, will last considerably longer than any individual lifetime. Yet they are not eternal,

and in due course the living entity “Earth” will dismantle them. This does not mean that all our efforts are useless, dispensable or doomed. Within a human time-scale it makes perfect sense to preserve the traces of our own history, this memory of what we are, want to be and of the processes we employ to accomplish our ends. If these testimonies demonstrate our evolution, giving a meaning to this (Hi)Story that we tell ourselves about ourselves and providing an (illusory?) sense of depth and importance to our existence, they may lead us to meditate on the relative weight of our brief human history when compared with that of the Earth or the Universe. Might this reflection lead to us back to a lost humility and acceptance of the role and place of *Sapiens sapiens* in a global time and space that transcends and stimulates him, that makes him transcend himself, but that also obliterates him? For it is this attitude that Cõa art illustrates so well, even though, paradoxically, it was created just at the dawn of our hegemonic appropriation of the planet. The available data shows that the most ancient motifs inscribed in the schist during the ultra-millenary Cõa Valley artistic cycle survived for the last 25 000 years (Baptista²⁰). Now that they were revealed and are being cared for can our efforts make them endure at least some 25 000 years more?

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