

Deterioration of our cultural heritage

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Our cultural heritage is being destroyed faster today than at any time in the past. An understanding of the basic processes causing deterioration of ancient artefacts is urgently needed.

A FEW years ago, I visited an important excavation site. The morale of the usually noisy and happy members of the archaeological team was at a low ebb: although there had been good reason to believe that their site might yield important finds, the lengthy excavations had been fruitless. But the next day, enthusiasm was at its highest peak: a gigantic head of a statue of one of the most famous kings, whose images have been but rarely found, was discovered in the very last hours of excavations. Several experts volunteered to complete the excavation, without pay, and to document the find.

The find was considered so important that only members of the team were allowed to approach it. Nonetheless, I was sceptical about such precautions, believing the statue would soon crumble to dust. For my opinion, I was rewarded with an exquisite gaze of contempt, such as only a young humanist can bestow upon an arrogant scientist. My advice was ignored: neither the archaeologists nor their conservators seemed to be aware of the environmental shocks to which their find would be subjected. I recently revisited the site: the head had been removed and the site had been fiercely attacked by a hostile environment. There was no evidence of efforts to preserve the site or the antiquities still buried there.

History is full of similar incidents. Thus, E.A.W. Budge, an eminent Egyptologist who lived between 1857 and 1934 located an Egyptian papyrus. Such papyri, being fragile, have been found only rarely; those few that have been discovered are important sources of historical information. Budge placed his specimen in his strong-box and mounted it on his donkey. On arriving at his camp, he discovered that the bumpy ride had reduced his papyrus to a pile of dust.

Losses of such treasures seemed to be unavoidable in the past. But archaeology is today a professional discipline in a stage of unprecedented sophistication and growth. The archaeological team that found the head of the head of the statue was progressive in its thinking; few archaeologists even now would think of inviting a chemist, concerned with fundamental processes of matter, to visit their sites. Thus, the incident with the statue raises wider questions as to the

fate of excavated antiquities and sites. Was the incident symptomatic of a situation in which our excavated cultural heritage is being destroyed, possibly with participation of scholarly communities? If so, who is responsible, and what are the optimal, cost-effective remedies? To define the scope of these questions, I shall briefly consider a few important and representative cases in several countries where ancient monuments are venerated and where concern regarding their deterioration is unequivocal.

In Africa, the ancient Egyptian civilization flourished for about three millennia: according to UNESCO, about one third of all known antiquities are or have been located there. The Luxor area of upper Egypt is particularly rich in antiquities: the Karnak temples complex, built for 2,000 years between 2000 BC and the Christian era is its principal archaeological site, occupying more than a square kilometre (Fig. 1). For thousands of years these temples were affected by annual inundations of the Nile river but, because the monuments were unexcavated, water damage was minimal. After the monuments became exposed to the elements as a result of excavations, a canal had to be constructed around the entire complex to drain waters from inundated parts of the temples. When the Aswan dam was constructed, inundations became a thing

of the past; the drainage canal appeared to have become superfluous and fell rapidly into disuse. In the 1970s, a new type of salt deposit spread throughout the temples¹, causing disintegration of monuments and the demise of excavated antiquities^{1,2}.

In Asia, a major archaeological complex at Mohenjo-Dara, the centre of the empire of Harappans, in the valley of the Indus river, provides another example of deterioration of important excavated antiquities and sites. The Harappan empire once stretched from the Himalayas to the Arabian coast to Bombay, and was larger than that of ancient Egypt and Mesopotamia combined. Although Mohenjo-Dara was built between 2500 and 1500 BC, settlements in this area dating at least to the sixth millennium BC were discovered, making the Harappan civilization one of the oldest in the world. The excavation of Mohenjo-Dara, began in 1922, had to be largely interrupted because the unearthed structures deteriorated rapidly and in some cases crumbled away.

In Mesoamerica, the discovery about 50 years ago of the Bonampak temple complex yielded for the first time a temple with a completely painted interior with murals of high artistic quality, providing a rare glimpse of the traditions of the Classic Mayan civilization of the late eighth century. Although the murals

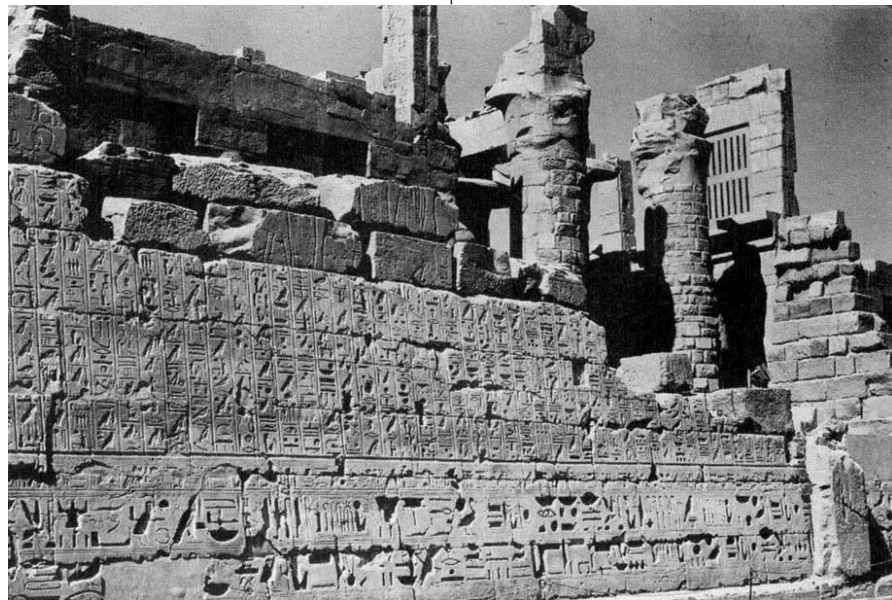


FIG. 1 The Kanak temples complex. On the walls of these temples history of millennia were inscribed.

were originally in good state of preservation following the discovery, environmentally induced deterioration is now occurring at an alarming rate³.

In northern Europe, there are fewer excavated antiquities that are older than one millennium; generally, these antiquities receive much care. Even there, however, there is evidence of rapid deterioration. Thus, the famous Lascaux caves have been closed to visitors for the past 30 years, and a replica cave has been constructed for tourists.

Even the best-known excavated antiquities may not escape rapid deterioration. A bronze statue of Marcus Aurelius survived for centuries in the polluted waters of the Tiber until it was recently discovered and installed in honour on Capitol Hill in Rome. Its deterioration in its new environment was so precipitous that it had to be placed in a protected atmosphere in a museum. Even museums are not always safe, being subject to overcrowding and exposed to fumes and dust of cities — such is the threat to the famous Egyptian National Museum in Cairo, a city that has quintupled its population in the past 15 years.

There are many other examples of deterioration in various parts of the world (see, for example, refs 3–7). Taking into consideration the recent, near-exponential rise in archaeological explorations and the number of newly excavated sites, one can readily see that today the magnitude of the demise of cultural heritage throughout the entire world is unparalleled. Perhaps the most telling testimonies come directly from archaeologists, who almost routinely express their genuine dismay about 'after-care' of monuments, and even suggest that in some cases sites should be better left unexcavated.

This deterioration is particularly evident in some developing countries. Generally, these countries greatly value their cultural heritage, not only out of national pride but also as one of the platforms upon which a new technological society can grow. Therefore, according to governments of some of these countries, excavations which are conducted by archaeologists from the west, if pursued without an adequate back-up ensuring preservation, amount to what is now often referred to as 'archaeological imperialism'. Such factors add complications to an already serious situation: they provide yet another cause for international tension, often in sensitive regions of the world.

Much of our cultural heritage is now being destroyed through wars, natural disasters, grave looting, destructions of rainforests, factors which are outside the domain of science. But this cannot justify deteriorations of cultural heritage in

which scholarly activities are implicated.

Who, or what, is the guilty party? In some cases the accusing finger has been pointed at the science of archaeology itself. In Turkey, for example, archaeologists routinely have to provide a guarantee that their finds will be adequately protected after they are excavated. Such conditions complicate research: archaeologists can claim with justification that studies of deterioration processes of antiquities is not a part of their subject. Archaeologists in the past were not considered responsible for preservation of their finds, although many of them attempted to do everything possible to save them. How can one feel now justified to expect a fundamental change of an already demanding discipline, particularly at a time when financial support is meagre?

Should archaeometrists, archaeological scientists and archaeological chemists take some responsibility for the failure to preserve our cultural heritage? After all, it is they who are supposed to have all the scientific knowledge to be used for studying ancient materials. It is true that archaeometrists undergo periodic soul-searching to define their own responsibilities⁸. Occasionally they even go as far as to accept the possibility that they "should recognize our responsibility to understand the mechanism of decay of (excavated) objects" (page 69 of ref. 8). But for the most part, the mandate of an archaeometrist is "to move from a dominant position (of a scientist) to a subservient one — of a humanist" (page 51 of ref. 8). Consequently, there seems to be little evidence that archaeometrists have become involved with the problems of deterioration of the cultural heritage (see, for example, ref. 7).

It would perhaps be even more unfair to accuse conservators and restorers for failure to provide adequate protection. These specialists, unsurpassed for "precision and patience of the artisans who first tried their hands at the job" (see ref. 7) have been trained to deal largely with conservation of individual monuments or works of art, rather than global problems of massive deterioration. Although the need for them to become involved in fundamental research has been acknowledged, little or no progress has been made⁹.

An easy target for accusation are the governments and administrations who are in charge of excavated antiquities: indeed I was initially inclined to pass such a judgement. But my view changed when I observed one senior administrator in a developing country defending vehemently the cause of preservation of cultural heritage to his superiors, to the point that his entire career became jeopardized.

The responsibility for the demise of

our ancient heritage results, I believe, from inadequate recognition of the problem and its magnitude. Unless the situation is recognized and action is taken, future generations may look back at the present time as that when the cultural heritage of the human race was most extensively damaged.

Everyone is dismayed at the disappearance of cultural heritage. Specialists of all disciplines involved recognize that care of excavated antiquities and sites has been inadequate and that the problem is cumulative, continuous, near-exponentially progressive and dangerously extensive. All agree that money is badly needed, but that there is little hope that it will be forthcoming from poorer countries, where much antiquity is located. Some form of international arrangement is needed. Up to this point, there is agreement among all concerned. But different views are expressed whenever practical steps toward resolution of the problem are considered.

Archaeologists recognize that they may have to reduce their scale of excavation because an extensive demise of cultural patrimony is unpalatable and intolerable for a reputable discipline. Presumably, funds unspent because of a reduction of the scale of archaeological field work could be allocated for preservation of finds and abandoned archaeological sites. Such an approach is painful to accept for any active, vigorous discipline, for it involves a conscious decision to curtail its own activities. Furthermore, under such a scheme, as the number of excavated sites increases, archaeology will lose progressively and cumulatively its funding, as it is syphoned off to protect cultural heritage. In any case, it is hard to see how any 'unspent' money could materialize in a field which is eternally short of funds. Alternatively, archaeologists often 'accept the inevitable' and pronounce that much of our cultural heritage will be lost anyway. People with this view believe that archaeologists should save a few national treasures and let the rest be lost — provided, of course, that all relevant information is properly recorded, documented and studied.

Today, both these approaches are in vogue, and documentation of information on excavated antiquities is an important part of archaeological work. Thus, the epigraphers of the Luxor and Karnak temples resurrect meticulously on paper the semi-obliterated hieroglyphs of the original monuments. Furthermore, many promising archaeological sites still remain unexcavated. For example, an enormous temple of Amenhoep III, of which only the colossi of Memnon are still towering above the ground, remains untouched by archaeologists (Fig. 2). Elsewhere, about three-



FIG. 2 The temple of Amenhotep III with colossi of Memnon, general view.

quarters of Mohenjo-Daro is still buried.

Restorers and conservators are making remarkable progress, yet their work is often handicapped because the fundamental chemical processes responsible for the deterioration are site-specific and often not understood. Consequently, in some cases, their work may even accelerate the demise of monuments (see, for example, ref. 4). Furthermore, the sheer size of the problem is often daunting: how can one attempt to conserve acres of deteriorating antiquities at such enormous sites as Karnak or Mohenjo-Dara?

Although there are several disciplines concerned with the salvage of cultural heritage, this goal is not usually central to them. Thus, archaeologists are generally concerned with purely archaeological problems, and environmental scientists, who recognize deterioration of cultural heritage as an environmental problem, are concerned that the archaeological aspects lie outside their field of expertise. The demise of our cultural heritage is due at least in part to the multidisciplinary nature of the problem and to the weakness in links between disciplines¹⁰. Work directed at strengthening these links, especially the weakest and the most crucial ones, seems promising. In general, the weakest links among various disciplines exist if these disciplines are furthest away from each other in terms of the interest, outlook and educational background of their practitioners. Among the disciplines concerned with the demise of cultural heritage, the widest gap is perhaps between archaeology, a central field, and those physical sciences which can deal with the fundamentals of the deterioration processes of antiquities.

I have argued the value of establishing the subdiscipline of environmental archaeological sciences, or eco-archaeometry^{10,11}, which deals with studies of fundamental physicochemical phenomena which lead to deterioration

of ancient materials. Once harmful processes are understood and quantified, an eco-archaeometrist can identify the most cost-effective ways to protect the cultural heritage. One of the basic assumptions is that deterioration processes must be understood on a fundamental, molecular level so that efforts of conservators and archaeologists are not misdirected. Eco-archaeometry has to rely on 'high-technology' techniques such as advanced analytical methods, physicochemical approaches and computer modelling¹⁰⁻¹².

From the viewpoint of the eco-archaeometrist, archaeological explorations thus need to be preceded by an investigation of physicochemical processes and change of rates of these processes at a potential site. Eco-archaeometry would promote 'rescue' archaeology while discouraging excavations at environmentally stable sites. Even if these sites are promising archaeologically, excavations can be postponed for as long as necessary. An eco-archaeometrist places less emphasis on the excavation of archaeological monuments *per se*, but rather ascertains whether excavation would not be detrimental to excavated monuments or sites. Yet archaeology and eco-archaeometry are not on a collision course: each discipline has something to offer the other. Their symbiotic co-existence is beneficial to excavated antiquities and archaeological sites.

The work of an eco-archaeometrist can suggest the change of direction of work at existing sites. It was eco-archaeometry that made it possible to show that the salinity of the underground waters at Karnak is due to high evapotranspiration at nearby irrigated fields^{1,2}. Once the salinization process in the Karnak area were understood, it became clear that the canal separating the temples from nearby irrigated fields should be cleaned, deepened and reactivated rather than abandoned and filled up to its rims with refuse and even with archaeological debris. The desalination

programme at Karnak has now begun, and environmentally detrimental excavations have been postponed.

In Egypt, there has been a concern about deterioration of the tomb of Nefertari, Valley of the Queens, where the most beautiful murals are now in an extremely precarious state. While a superb job on emergency restoration of these murals was recently completed, our eco-archaeometric study concluded that the murals survived for 3,250 years only because of the extraordinary climatic stability of the tomb. Once these conditions were quantified^{11,12} it was possible to propose a long-term plan¹² for preservation of the tomb, involving the construction (now in progress) of a replica tomb nearby for tourists and construction of a climate control station to stabilize temperature, humidity and biological activity within the tomb to allow limited visits.

At Mohenjo-Dara, the principal effort for preservation of monuments seems to come from agencies planning to divert the Indus river, thereby lowering the water table by about 60 feet. Although this would make excavations easier, an eco-archaeometrist would be concerned that antiquities would thus become desalinized and reduced to dust. At Lascaux, the eco-archaeometrist would be concerned with the nature and rates of decay of the murals caused by environmental stress.

The holistic approach of eco-archaeometry allows the natural scientist to investigate a problem in a way often overlooked by archaeologists. Because eco-archaeometry provides basic information, cost-effective decisions can be made about whether to invest in archaeological or rescue projects (which are usually expensive) or whether such plans should be postponed or altered. I believe that the use of this approach will contribute to the protection of our cultural heritage and prevent much of its deterioration. □

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