Protective Structures for the Conservation of Archaeological Sites:

environmental considerations on the shelters over the Hagar Qim and Mnajdra temples of Malta

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Abstract

The Megalithic Temples of Hagar Qim and Mnajdra, constructed in Qrendi between the mid-fourth and mid-third millennia BC, are amongst the oldest free-standing stone buildings of such complexity in the world. They are of great local and international significance and they have been included since 1992 on the UNESCO's World Heritage List.

These Temples are currently suffering from a series of severe structural problems as well as different forms of stone deterioration: the *Globigerina Limestone* shows powdering, flaking and scaling of the surface, as well as alveolar weathering, mainly due to salt crystallisation, in particular of chlorides acting on the very porous stone.

Protective structures have long been considered the best in situ measures for preventive conservation of archaeological sites. However, the nature of problems in conserving sites under protective structures varies widely. The design of a new structure should improve the environmental conditions for the archaeological materials and structures themselves and it should also respond to the presentation requirements for visitors to the site.

Between 2008 and 2009 the vulnerable prehistoric structures of Hagar Qim and Mnajdra were protected from the direct impact of environmental factors by means of a reversible, lightweight, open-sided shelter, conceived with minimal visual and physical impact. The main protective features of the shelter are its ability to eliminate the effects of water through rainfall, reducing water runoff and preventing the leaching of infills.The shelters also mitigate the effects of solar radiation by directly shading the Temples, thus reducing thermoclastic weathering. Finally they reduce wind impact and herbaceous growth.

Several microclimatic campaigns have been performed in different locations and periods of times in the two Temples and their surroundings since 2005, before the sheltering, and they are still going on, to assess the impact of the shelters on the microclimatic conditions of the Temples. Air temperature and relative humidity are being recorded in different points inside and outside the Temples to investigate the effects of the shelters on thermo-hygrometric variations, wetting-and-drying cycles, as well as on the hygrometric levels and consequently on the risk of biological growth. At the same time, the thermal behaviour of the stone under the shelter is being investigated in the Hagar Qim Temple, by means of surface temperature measurements of differently oriented model stone pieces.

Moreover, the wind funnelling phenomenon has been studied in the Hagar Qim temple complex. According to the results wind speed does not increase beneath the shelter except at certain points within the temple structure itself.

The performance of the shelters is still currently being assessed by environmental monitoring which already indicates a general improvement of the conditions beneath the shelters to the ones on site before sheltering.