

Press Release

Study and video documentary on the remains of the Azure Window and its collapse

An interdisciplinary group of researchers has completed a study of the underwater remains of the iconic *Tieqa tad-Dwejra*, or as it was commonly known, the 'Azure Window', which collapsed on the 8th of March, 2017, and has since become a popular diving site.

The aim of the work, led by Prof Joseph Caruana from the Department of Physics and Institute of Space Sciences and Astronomy of the University of Malta, was to gain a better understanding of the collapse event, and to record the present state of the site underwater, which is subject to continued change via erosion.

Arches and stacks are very popular attractions around the world. However, the dynamics of stack formation and evolution remain poorly constrained. In the case of the Azure Window, the stack - consisting of the base that supported the pillar above sea level - is completely submerged, thus presenting an additional challenge to its study. The peer-reviewed work, published in the academic journal 'Geomorphology', was carried out over nearly three years.

It is very unlikely that someone would witness an arch collapse at the moment it happened, partly because such an event is bound to take place during rough weather, when fewer people are present on site. This means that a better understanding of such an event has to come from patient study of the submerged remains, mapping their location and measuring their sizes to enable a reconstruction of the collapse. This required multiple dives by a team of technical divers, led by Prof Caruana and Mr John Wood. The team surveyed the site, taking thousands of high resolution photographs and carrying out measurements underwater. A detailed 3D-model of the seabed and the remains was then constructed via a technique called photogrammetry.

'The idea to carry out this study really came up right as soon as the Window collapsed. We knew the site very well - both above and underwater - and this event presented an opportunity to study the submerged remains, addressing in detail the question of how the collapse transpired, particularly through an analysis of the existing stack and the final resting place of several components', commented Caruana. The work contributes insight into how such events occur, and the methodology that was employed can be used to characterise other similar events, write the authors. This can also help with assessing potential hazards, specifically in relation to the prediction of coastal arch collapse.

Using a purpose-built setup, with cameras and lights mounted on an underwater scooter, the researchers' approach enabled them to efficiently survey the entire site, which approximately measures 8000 square metres. They were able to confirm that erosion at the base of the pillar resulted in the formation of a notch on its north-facing side. The base weakened to the extent that the pillar eventually gave way, falling towards the southwest and breaking into two main sections that separated along the lithological boundary (i.e. the partition delineating two different types of rock). Large sections from atop the pillar broke along existing joints in the rock, remaining relatively intact. The bridge, which used to see many people crossing it, collapsed vertically downwards upon losing the support of the pillar, and fragmented.

The work required undertaking long dives using rebreathers, a type of diving apparatus that minimises both the volume of gases used and the amount of decompression that is required. The latter meant that the divers could devote more of their time underwater to carrying out the required work, while reducing the duration of the slow ascent back to the surface.

Mr John Wood, who led the photogrammetry effort, described how the project entailed several unique challenges: 'The area covered by the Azure Window's remains is many times the size of the large sites I had worked on previously, which include some of the largest shipwrecks in Maltese waters. This entailed multiple visits to the site, each visit focussing on data capture of a separate, relatively

small area. This approach resulted in further complexities and very long processing times to build the 3D-model itself.' An added challenge was the depth range to be covered. Spanning from just below the surface down to 60 metres, this made some specific dives technically quite challenging, explained Wood.

The study also documented changes at the site during the time that has elapsed since the collapse. Certain parts are still experiencing erosion, and particularly unstable sections have since collapsed as well. The 3D-model will now serve as a reference point; any future surveying can be compared against the present state of the site as recorded through this model, enabling the documentation of the site's transformation over time.

Beyond the academic purpose of the study, the 3D-model can serve as a guide for the many divers that visit the site every year to explore the Azure Window's remains. It also allows the non-diving public to view the underwater site, which forms part of the Islands' underwater heritage. 'The public has been very curious about what the former Azure Window looks like today, and for the first time, through this 3D-model, the site is shown and explained in its entirety,' commented Caruana.

More generally, the work helps draw attention to Dwejra's sensitivity: 'It presents a good opportunity to spread awareness about this place, particularly the importance of conserving it. From its geology and ecology, to its archaeology and dark night sky, Dwejra is a very special place to anyone who has our natural and cultural heritage at heart,' said Caruana.

'Arches are generally short-lived features. The Azure Window was but a single facet of the site. It is difficult to overemphasise the importance of the whole of Dwejra - from the unique concentration of sinkholes it hosts, such as *Il-Qawra* (the 'Inland Sea'), to the views it permits of our universe. From this dark site we are able to observe objects so distant that their light started its journey across the cosmos when such geomorphic features had not yet even formed,' he added, emphasising that every effort should be made by the government and authorities to adequately protect this site.

To help the general public learn more about the work, a documentary feature has been produced and is available at www.dwejra.net

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