CAVE and KARST MANAGEMENT in MALTA

Kent Henderson

The islands of Malta (Malta, Gozo and Comino) are about 80% historic, 90% Catholic and (pretty much) 100% soluble. Situated in the middle of the Mediterranean, about 100 km south of Sicily, Malta is a tourist *mecca* – its history (both prehistoric and medieval), castles, fortresses, food, beaches, and comparative 'cheapness' (my very good 3½ star hotel, with breakfast, cost about $A30.00 per night...), not to mention pretty much year-round 25-30°C sunny weather, make it about as good as it gets. Everyone speaks excellent English! You haven't lived until you've seen the old city of Valetta and the 'Grand Harbour'! ... and of course, from our point of view, the Maltese Islands are almost totally karst! What a place! I visited Malta recently for a ten day stay.

Geologically-speaking, the Maltese Islands are relatively young, with the oldest rock dating back only to the Tertiary period. The Islands are for the most part composed of marine sedimentary rocks. Although the sedimentary platform on which the Maltese Islands are situated was formed during the Triassic, there are no surface outcrops of this age. All exposed rocks were deposited during the Oligocene and Miocene periods dating back to 30 to 35 million years ago. The most recent deposits are the quaternary deposits which are found in minor. The resultant rock formations are relatively simple consisting of five basic layers laid on top of the other in a layer-cake sequence.

Lower Coralline Limestone is the oldest exposed rock in the Maltese Islands, outcropping to a height of 140m in the vertical cliffs near Xlendi, Gozo. It is mainly composed of the remains of coralline algae indicating deposition in a shallow environment. Younger beds show evidence of deposition in more open marine conditions.

Malta lithography

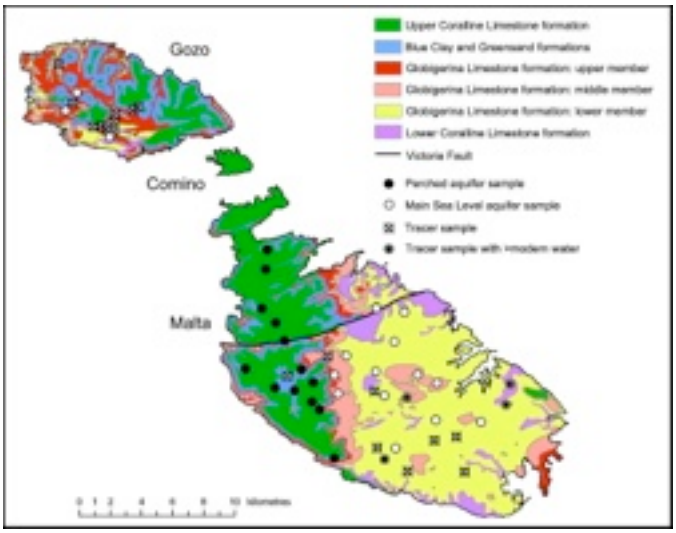
Globigerina Limestone is the second oldest rock and outcrops over approximately 70% of the area of the islands, eroding to give a broad, gently rolling landscape. Variations in the thickness of this formation are considerable, ranging from 23m near Fort Chambray, Gozo to 207m around Marsaxlokk, south-eastern Malta. This rock consists of yellow to pale-grey limestones. The formation is divided into Lower, Middle and Upper Globigerina Limestone by two beds of phosphorite pebbles.

Blue Clay overlies the Globigerina Limestone formation. It erodes easily when wet and forms taluses (i.e: a sloping mass of rock fragments at the foot of a cliff) which flow out over the underlying rock. Variations in thickness are considerable ranging from 75m at Xaghra, Gozo to nil in eastern Malta, where Upper Coralline Limestone rests directly on Globigerina Limestone. Deposition of the Blue Clay may have occurred in an open muddy water environment with water depths up to 150m for the lower part of the formation.

Greensand consists of bioclastic limestones rich in glauconite deposited in a warm sea. Unweathered sections are green but are oxidised to an orange colour when exposed. The deposit attains a maximum thickness of 11m in localised depressions in Gozo, but elsewhere is less than 1m thick.

Upper Coralline Limestone is the youngest Tertiary formation in the islands reaching a thickness of approximately 160m in the Bingemma area, Malta. Local tectonic activity appears to have resulted in the brief emergence of the formation above the sea. The strata are very similar to the lowest stratum in the

Maltese Islands. It is also named because of the abundance of the fossil algae species Coralline. It resembles the Lower Coralline Limestone both on chemical and palaeontological grounds, indicating deposition in shallow waters. The transition from the underlying greensands is gradual, sometimes merging into red and black granular sandstone; or red and white coralline rich limestone, which passes into a white calcareous sandstone-compact, soft or porous but always rich in organic remains. Though some layers are completely crystalline and have lost traces of the organisms from which they originated, other portions are highly fossiliferous containing casts of shells and other organisms.



Malta geology

These rocks are sporadically overlain by terrestrial, aeolian and alluvial deposits laid down following the emergence of the Maltese Islands above sea level. Much of the central and south-eastern portion of the Maltese comprises outcrops of Globigerina Limestone while the northern and north-western regions are characterised by highlands on which upper coralline limestone is the dominant outcrop. The geology of Gozo is more varied than that of Malta, with more frequent outcrops of Blue Clay being a characteristic feature.

The karst geology of Malta has had a major historical effect in terms of human habitation. There are no surface streams anywhere in Malta, and what aquifers exist are located in the blue clay areas. Historically, attempts to build water storages on karst were fraught with failure, as will be appreciated. In Roman and medieval times aqueducts were used to funnel water to the population centres, largely on the coast.

Man first arrived in Malta around 5200 BC. These first Neolithic people probably arrived from Sicily, and were mainly farming and fishing communities, with some evidence of hunting activities. They apparently lived in caves and open dwellings.

Ggantija Prehistoric Temple, Gozo. Note the heavily-weathered limestone.
Photo: Kent Henderson

Ħaġar Qim Prehistoric Temple, Malta. Note the roof – erected to prevent further weathering.
Photo: Kent Henderson

During the centuries that followed there is evidence of further contacts with other cultures, which left their influence on the local communities, evidenced by their pottery designs and colours.

One of the most notable periods of Malta's history is the temple period, starting around 3600 BC. The Ggantija Prehistoric Temple in Gozo is the oldest free-standing building in the world. The name of the complex stems from the Maltese word ġgant, which reflects the magnitude of the temple's size.

There are also several very old temple sites on Malta, and collectively they are World Heritage sites. I visited them all during my stay. The Temple period lasted until about 2500 BC, at which point the civilization that raised these huge monoliths seems to have disappeared. There is much speculation about what might have happened and whether they were completely wiped out or assimilated.

The history of Malta that most takes the tourist's interest today is that of the medieval Knights of Malta, who built most of its walled cities, citadels and fortresses, of which there are many. Interested history buffs can go to google,

but it is the structure of these edifices on which I will dilate here. As would be expected, all structures in Malta of any historical note are made of limestone.

Given the geology of Malta there wasn't too much choice in using limestone to build the massive fortifications one sees; its use was actually quite advantageous. Limestone, particularly the relatively-soft *globigerina* variety, is relatively light and very easily worked; yet it will readily withstand considerable cannon bombardment – a very important medieval prerequisite given the frequency of Saracen attacks from the sea in that period. However, the modern result is a very significant conservation problem. Soft tertiary limestones do not hold up well after upwards of 800 years of weathering, and not surprisingly most historic walls and buildings are looking decidedly past their *use-by date*.

As the Maltese Government is spending many millions of euros on restoration; probably a quarter of the massive walls of Valetta itself are currently under scaffold. Given the nature of the limestone, when (in 100 years time?!) they have finished their conservation work, they may well have to start all over again!

Another legacy of historic long-term limestone construction is that there are a significant number of massive limestone quarries across Malta, many of which are still mined today.

A limestone quarry in central Malta.
Photo: Kent Henderson

Given that the Maltese Islands are very largely karst, you would expect widespread and significant cave development. However, such is not the case. First, we are talking geologically-young limestone (we are probably several million years too early…) and second, given there are no natural surface streams in Malta, phreatic cave development is rare (although Għar Dalam is one notable example, see below).

There are, broadly-speaking, seven caves on Malta and Gozo open to the public; some of which one could probably describe as *show caves* (a general note – *għar* is Maltese for cave). Conversely, what are very common in Malta are sea caves, of which there are many – at least two can be classed as 'world-class' and serious tourist attractions in themselves. I will come to these too.

'SHOW' CAVES AND KARST FEATURES

Għar Dalam

This cave is accessed through a Museum which contains an excellent collection of bones together with an interesting reconstruction of the extinct dwarf elephant *Elephas falconeri*, which was just over a metre high when fully grown. From the museum, a paved foot path 150m long leads to the cave entrance.

Għar Dalam – views out of (top)
and into (bottom) the cave.
Photos: Kent Henderson

Għar Dalam is one of the most significant Maltese prehistory sites. It contains an uninterrupted sequence of fossiliferous deposits extending from the Late Pleistocene to Modern times, a period of 130,000 years. The Neolithic Age 5000 to 4500 BC is represented by pottery.

The cave was one of the sites used by early man who crossed to the Maltese islands from Sicily via a land bridge around 5000 BC. It also contains thousands of fossilised animal bones. The cave was first described in 1647 and excavated in 1865.

Excavations revealed that the floor of the cave had five different layers. In the lower layers were enormous quantities of fossilised bones, tusks and teeth belonging to extinct species - such as dwarf elephants and dwarf hippopotami - along with red deer (*Cervus elaphus*), brown bear (*Ursus arctos*), wolf (*Canis lupis*), fox (*Canis vulpes*) and giant swan (*Cygnus falconen*). As these are all animals associated with Europe this is proof that Malta was once connected to the European mainland rather than the African mainland.

It is suggested that a rise in sea level stranded these large mammals on the island and that the lack of food caused the dwarf versions to evolve. In the upper layers archaeologists found flint tools, sling-stones and pottery which had been decorated by using the rippled edge of sea shells or by pointed sticks or bones.

Għar Dalam is entered via a wide, low phreatic tube, about 10m in diameter which cuts 140 m into the Lower Coralline Limestone, however, this entrance has been considerably enlarged by the above mentioned excavations. Most of the remains were found near the entrance, very little being found further in the cave.

The cave consists basically of a single passage about 140 m long and 7 m wide, of which 80 m is accessible to the public. There is considerable breakdown in the cave, with blocks having fallen from the roof, so much so that a path has had to be excavated to allow visitors to pass.

Relatively large dry stalactites and stalagmites occur in reasonable quantities in cave. These must have formed before the bones were deposited, as they bisect the bone bearing deposits, a factor which has protected the formations.

In the excavations you can still see layers of bone deposits. It is possible that this cave is part of a much larger system which has been bisected by the downcutting of the valley and a small, blocked, opening is still visible on the opposite side of the valley to the cave which lends credence to this theory, as it seems to have developed in the same joint.

The cave is lit with parafloods, although most of the tourist section can be viewed using natural daylight. The interpretation in the cave is quite good, particularly signage on the excavations, strata, etc. The cave is self-guided, and the lights offer no switching; there is thus a modicum of *lampenflora* around light fittings – mitigated by the fact the lighting appears to be of relatively low intensity.

The cave and Museum are run by *Heritage Malta*, a government appendage with manages affair number of historic sites in Malta. Overall, while the infrastructure would be considered 'tired' by Australian standards, I would nonetheless describe this cave as reasonably well managed.

St. Paul's Catacombs

St. Paul's catacombs are part of a large cemetery once located outside the walls of the ancient Greek city of Melite, now Mdina, in central Malta.

St. Paul's 'Cave'
Photo: Kent Henderson

The cemetery probably originated in the Phoenician-Punic period. Like in Roman tradition, Phoenician and Punic burials were located outside city walls. The many tombs discovered in areas outside the known line of the Roman city suggest that the city of Melite was close to equal size.

The early tombs consisted of a deep rectangular shaft with one or two chambers dug from its sides. This type of burial was used well into the Roman occupation of the islands, but the chambers grew larger and more regular in shape over time. It is probable that this enlargement joined neighboring tombs and led to the creation of small catacombs, which became the norm by the fourth century AD.

The site that is currently open to the public comprises two catacombs out of the 24 in the St Paul's cluster. The main complex, covering an area of more than 2000 square metres, is so far the largest catacomb ever to be found on the island. It is large enough to have served as a communal burial ground in successive phases of Malta's history. One of the halls was transformed into an early church following the expulsion of Arab conquerors in the second century AD.

The excavation of the catacombs began in the late 1800s and, other than the construction of protective rooms, no further conservation was undertaken in the twentieth century.

The most significant section of the catacombs is St. Paul's Cave, which is directly under the obligatory church above. St. Paul was, reputedly, ship wrecked on Malta on his way to Rome. While the catacombs themselves are *man-made caves*, if you will, the small St. Paul's Cave (not much bigger than the image, opposite) appears largely natural, with the odd man-made niche in its walls. Access to the cave, during visiting hours, is open slather – so one could not really describe it as managed, or mismanaged…

Għar Hasan

There are many legends about Hasan's Cave, which is located on the southern coast of Malta. All featuring the Saracen, Hasan, who took refuge here, with most of them referring to at least one young maiden that he abducted and imprisoned.

The setting of the cave is quite spectacular – far from a rarity given the many kilometres of spectacular karst coastlines that characterize Malta. From the car park, a footpath over a *karst walk* leads to a flight of 25 precarious steps, heading down the limestone cliff high over the sea. A walk along a narrow path, carved out of the cliff, protected by a rusty guard rail, leads to the entrance.

The Għar Hasan 'balcony'
Photo: Kent Henderson

Hasan, apparently, entered the cave from below via a rope tethered at the entrance. The main entrance to the cave is 5m high and 6m wide and the entrance is of similar dimensions for the first 20m. In the top of this passage is a roof tube, sometimes separated from the main passage by a thin layer of rock and sometimes just a half tube in the roof. Partially enlarged master joints can be seen crossing the main passage.

Most of them come to a dead end but a large one extends for 48m and 73m respectively to two further entrances along the cliff face. At the eastern entrance there is a man made circular chamber, with obvious pick marks on the walls, and a stone bench around the edge, it has been speculated (as it would be) that this was, in fact, where Hasan lived.

The cave is almost devoid of decoration, although it possesses some small stalactites. A broken iron gate bars the inner recess to the cave. Given totally unrestricted access, the cave has been heavily trashed. Obviously, the cave is self guided and you do need a torch, but no gear. Given zero management, the only reason for visiting this cave other than, perhaps, the view out of it, is if you have nothing else to do

The gate 'barring access'(!!) to
the inner sections of Għar Hasan.
Photo: Kent Henderson

Calypso Cave

This cave is on the northern coast of Gozo, near the town of Xaghra. It is said to be the place where Odysseus was a *prisoner of love* for seven years. He was imprisoned by Calypso, who promised him immortality if he would stay with her. But he escaped, as soon as he had the opportunity and returned to his wife Penelope. In Greek mythology Calypso is the daughter of the titan Atlas. She was a nymph living on the magical island of Ogygna.

The cave is located near Ramla Bay. One enters down a 6m flight of steps cut in the rock at the intersection of two rainwater grikes which have been formed along the joint lines. Descending the steps brings you to a platform, the cave is on the western side a few metres lower. It offers a balcony view over the ocean, not too dissimilar to *Għar Hasan*. The cave is currently closed for remedial safety works.

Signage at Calypso Cave.
Photo: Kent Henderson

Xerri's Grotto

This small show cave is located below a residential building in the town of Xaghra, central Gozo. It is well sign posted from the main square. It was discovered in 1924 by the current guide's grandfather while he was digging a well. As soon as he broke into the cave he abandoned the well and began to excavate what is now the show cave.

The entrance is gained via a 10 metre spiral staircase which is the dimension of the original well, thus this cave is not suitable for anybody suffering from vertigo, unsteady on their feet, or significantly overweight… Behind the staircase is a passage 7 m long. At the bottom one undertakes a circular tour about 30 m long. The whole passage has been dug out to about 2m high leading past plenty but mostly small speleothems in side alcoves that are only 25 cm to one metre high. About half way round it is possible to see the replacement well which was formerly used as drinking water and is now used for irrigating the garden. Part of the excavations were carried out during the second world war when the family used the cave as a shelter. The excavations have significantly lowered (and destroyed) the natural cave floor.

The roof of the cave is flat, but contains a series of shallow parallel channels, which do not appear to have been formed by water. One suspects these indicate the direction of the joints along which the cave was originally formed.

The guide to the current owner of the cave. At a cost of 2.50 euros ($A3.50), the tour lasts around 20 minutes, and the guide's patter is totally *fairy castle*, as he gleefully points out speleothems resembling various animals. The lighting features undisguised conduit with light bulbs at intervals, surrounded by thickly coated *lampenflora*. Management is thus ordinary.

Ghar Ninu

This cave is located in the rear of No 15 January Street, about 75 m north west of the parish church, in the village of Xaghra, Gozo. It is, perhaps, 100 metres from Xerri's Grotto. A family member of the discoverer will answer questions and allow the visitor to take a self guided tour. The price of admission is a 'donation' – two euros seems to make them happy.

Inside Xerri's Grotto – the guide gives scale.
Photo: Kent Henderson

The guide in the entrance to Ghar Ninu.
Photo: Kent Henderson

Ghar Ninu, which is formed in the Upper Coralline Limestone, was originally discovered in 1888 whilst the owner was digging a well for water – the same story as Xerri's Grotto. It was immediately considered remarkable because of its prolific decoration.

It is entered via a 4m descent down a flight of steps, which end in a large chamber approximately 20m by 8m. Thick columns stretch from floor to ceiling throughout the cave, and there appears to be a passage to the right with other passages leading off it. It would be impossible to extend the cave, tourist-wise, without unacceptable damage. The viewing area is small, at base of the stairs. 5 minutes, perhaps, is enough time to see it.

There is evidence of numerous straws which have now been broken off. There are a few helictites, as well as some reasonably large speleothems, generally. It would compare favourably to any relatively small single chamber you'd see in an Australian cave. The decoration is now dry and mainly the same colour as the surrounding rock.

The chamber is (over) lit with several large parafloods, accompanied by *lampenflora*. The floor of the small viewing area is concreted; there are metal handrails, and some large gauge chicken wire, though this is quite unnecessary, as the guide accompanies you.

Speleothems in Ghar Ninu.
Photo: Kent Henderson

The Blue Grotto

This is one of Malta's top attractions, and certainly the boat trip along the dramatic cliffs of the south coast is one of the highlights of a visit to Malta. The famed Blue Grotto is located just along the coast from the little fishing village of Wied iz Zurrieq, reached by a spectacular drive along the cliff tops. From here, traditional fishing boats ferry passengers every day, but only if the water is calm. The fishermen tend to cram in as many visitors as they can; eight is supposedly the limit… I am not sure what their definition of stormy weather is, but on the day I went the waves were at least a metre high, and the sea what I would call 'rough'. Still, the trip was fun! Life jackets were mandatory – as you'd expect.

Wied iz Zurrieq harbour consists of no more than a small cluster of houses, shops and cafés, an exhibition of sea shells, a small shrine giving heavenly protection to fishermen and a watch-tower erected by the Knights of Malta to warn of saracen ships. A slipway lined with fishing boats leads down to the minuscule harbour. The boat journey takes a total of about 40 minutes and weaves in and out of a series of limestone sea caves set in the (very) high cliffs. All the caverns have names and the limestone is tinted pink, mauve or orange by coral or minerals.

To reach the Blue Grotto itself, so-called because of the deep blue of the water inside, boats pass under a monumental arch, resembling a flying buttress in a cathedral. From here you glide into the dark grotto, which goes for 50 m deep in the cliff face. For those not wishing to do the boat trip you can walk to the top of the grotto via the coastal path from the village. The Blue Grotto trip is definitely a Malta highlight

The entrance to the Blue Grotto.
Note the boat about enter.
Photo: Kent Henderson

The Azure Window

Rivaling that of the Blue Grotto on Malta, the Azure Window natural arch on Gozo features a table-like rock over the sea, occasioned by collapsed sea caves. The Azure Window has been featured in films, such as *Clash of the Titans (1981)* at the 104th minute and *The Count of Monte Cristo (2002)* at the 13th minute. It can also be seen in the television miniseries *The Odyssey (1997),* and HBO's TV series *Game of Thrones*.

Upon arrival, after viewing the arch, one can then take a boat trip (similar to that at the Blue Grotto). One this occasion, I didn't bother with the boat. Not unexpectedly, the Azure Window arch is disintegrating. Large pieces of rock keep falling off and it is expected that the arch will completely disappear within just a few years. Clearly, the arch is in a dangerous condition and warning notices are placed to stop people walking over the top, although more than a few ignore the signs (see the photo, below). Evidence of its deterioration can be seen when the images of it as shown in *Clash of the Titans* are compared to the more recent images shown in *The*

Odyssey and *The Count of Monte Cristo.* The former images depict the Azure Window arch with a flat underside, whereas the latter clearly show that a significant proportion the flat underside has since broken away.

In April 2012 a large piece of rock was dislocated and made the window larger, more unstable and losing its almost perfect oblong shape. Once the arch has completely collapsed, it will be renamed Azure Pinnacle.

The Cart Ruts

The so-called cart ruts of Malta are something of an enigma. They occur mostly on Malta, although some are found on Gozo. They are up to 60 cm deep and have an average distance between them of 110 to 140 cm. Some cross while others form junctions, and while most are in roughly parallel lines, some are not.

There are numerous theories about how these tracks were created. The most discussed suggests goods were transported on sledges which gouged the tracks into the rock, that the tracks are real cart ruts for transporting goods, and that it was an ancient irrigation system.

Maltese archeologists think that the ruts are devices of the Phoenicians – if so this would mean that the tracks were made about the 7th century BC. Other research suggests that these may have been caused by wooden-wheeled carts eroding soft limestone. An analysis was made of the stresses that would have been caused by a cart which would fit the ruts. Apparently, the underlying rock in Malta is weak and when it's wet it loses about 80 per cent of its strength. The carts would have first made tracks in the soil but when that eroded, the cartwheels ran directly on the bedrock, making it easier for other carts to follow the same tracks – so this theory goes.

One thing that has not been discussed is the possibility that they are natural karst landforms, perhaps a form of limestone pavement? Are they shallow solution pans?

Top. The Azure Window, northern Gozo.
So-called cart ruts, Malta
Photos: Kent Henderson