

# Milos Island: Working with Earth for 9000 Years

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## Introduction

**M**ilos belongs to the island complex of Cyclades in Greece and has a total surface of 151sq. km. Five thousand five hundred inhabitants are currently scattered in seven towns, but life on the island has been strongly influenced by the geologic environment and the exploitation of rocks and minerals for more than 9000 years. In this article we will discuss how the geologic environment affected the life of its inhabitants and present only a few of the many geologic beauties of this island.

## Geologic Features of Milos

Milos is almost entirely a volcanic island. It is estimated that volcanic activity in the island started 2–3 million years ago and ceased 90,000 years ago. Extinct volcanoes can still be seen at Firiplaka while the circular gulf of the island is considered to be a caldera. There are also numerous locations around the island known for gas eruptions and hot springs suggesting volcanic activity.

The island is increasingly popular among the tourists because of the number and the beauty of its beaches. The different geologic conditions and the great variety of rocks form more than 70 unique beaches. Only to mention two: Alogomandra beach (on the cover) is a cave and a natural gulf formed by lahar and Sarakiniko is a famous beach thanks to the white color of the rocks originating by volcanic ash. But if tourists can appreciate the geomorphology of the island, it has certainly a lot to offer for a geologist. Figures 1 and 2 are a small sample of the many interesting geologic features that the authors had the opportunity to observe during a short trip to the island.

The geologic environment has influenced life on the island from the Stone Age. As early as 5500BC obsidian and caolinite from Milos was found in Middle Neolithic settlements in Attica (Gofas, 2000). However, exploitation of obsidian took place in Milos at least since 7000BC and Milian obsidian was found by archeologists in Crete, Peloponnisos, Egypt and Southern Europe. The Neolithic civilizations used extensively the black volcanic glass to manufacture weapons and tools, examples of which can be seen in the archaeological museum of Milos. Today it is forbidden to buy or sell any piece of Milian obsidian, as it could be of archaeological importance. There were three main locations of obsidian mining during this period. The Neolithic workers had a strict quality control on obsidian products. Arrowheads, spearheads and knives with the slightest deficiencies were dumped and were never used. In Demenagaki, there is an area of 20m and 1m — thick with obsidian remains.

The first settlers of the island were certainly occupied with the commerce of obsidian. In around 3300-2300BC some of the settlements expanded in large centers of stone houses, known today as Phylacopi, but the city was burned in around 1600BC by invaders. Phylacopi was rebuilt with strong walls this time that reached a thickness of 3.0m near the main entrance. The walls were built using large stones of andesite and lava, which were



Figure 1. Progressive fracturing of hard stiff rock

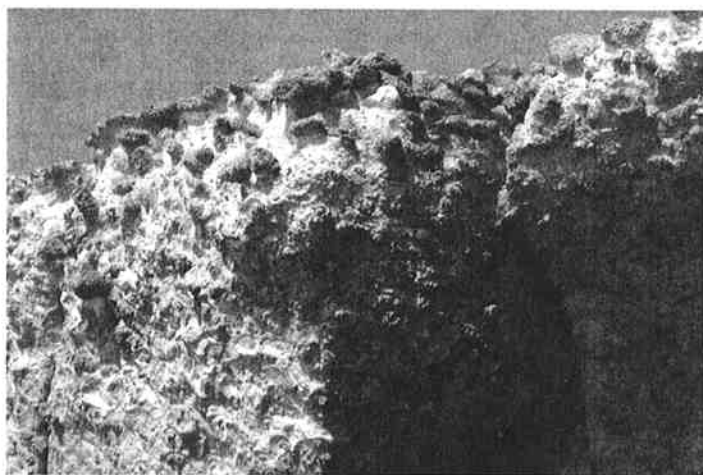


Figure 2. Closer view of the lahar in Alogomandra beach



Figure 3. Obsidian tools from Milos



Figure 4. Remains of a Neolithic building in Phylacopi. Lava blocks and andesite were used for stone and were bonded using volcanic ash (rack sack for scale).

joined carefully together with volcanic ash. The Stone Age workers were very well aware that andesite was strong and resistant to weathering, and therefore it was a good material to be used for the construction of walls (Figure 4).

In around 1470BC, the eruption of the Santorini (also known as Thera) volcano, famous for the destruction of the Minoan civilization, probably caused the destruction of the city of Phylacopi. It is difficult to visualize the consequences of the eruption. It is estimated that 18km of volcanic ash was thrown in the air (for comparison, the eruption of Mt Helen's volcano in 1980 threw 2.7km of ash). It is estimated that the eruption must have created huge waves (tsunamis) that probably flooded all the surrounding islands to a height of 400m (Plimer, 2000). The city of Phylacopi was rebuilt again and was finally abandoned in 1100BC. A new settlement was established, near the village of Klima to the North of the island.

The new settlement near Klima evolved rapidly. Construction of the city starts around 1000BC. Arts flourish and the craft of ceramics using the local clay are considered one of the finest examples of ceramic art during the 8th century BC. Milos has participated in the war against the Persians, suffered during the Peloponnesian war (5th Century BC), became part of the Greek Macedonian empire (4th century BC) and eventually was captured by the Romans.

The increasing importance of mineral trade during the Roman years brought wealth to the inhabitants. Wonderful statues of this period can be seen in the Archaeological museum, and great buildings were constructed like the marble amphitheater. Milos and Kimolos were also the major suppliers of bentonite for the Roman Empire. The ancient Greeks and Romans used bentonite as soap and as a base for cosmetic products, a use known even by the Neolithic period. The use of clay was also recommended to heal the wounds because clay sucks the fluids and impedes the infection of the wound. But it was not only bentonite that the Romans traded. Resources mention extensive trade of sulfur for use in medicine, and caolinite used by artists to create the white color. Dust from pumice was also used to polish marbles, mosaics and ceramics. During this period the city near Klima prospers but in the 5th to 6th century AD an earthquake destroyed it. The harbor of the city is now well below the sea level,

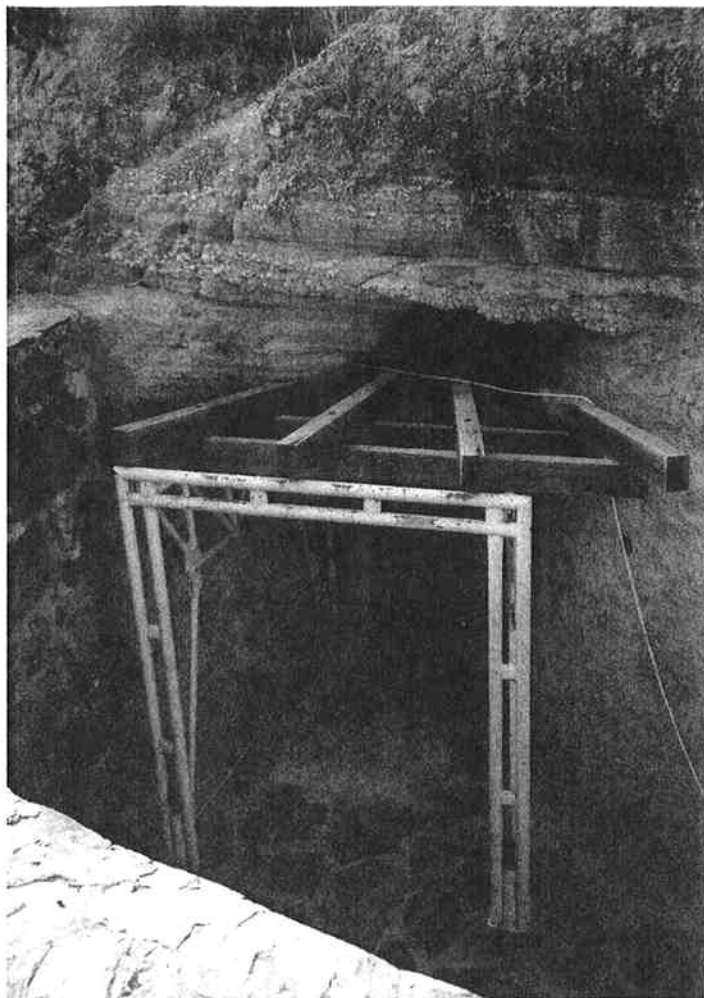


Figure 5. The entrance of the catacombs

partly due to damage during the earthquake and partly because this portion of the island sinks due to tectonic movement.

At first, the ancients were mainly exploiting surface exposures. These resources were later exhausted and the ancients excavated mines. Extensive and deep ancient tunnels of alunite were found as well as many roads, walls and foundations suggesting an extensive exploitation of the deposit. Alunite was used in medicine and also to color textiles. In Agia Kiriaki one can still see remains of tanks used to process alunite.

Christianity made its appearance to the island during the Roman years. The Christians, whose religion was not accepted by the Roman emperors, constructed catacombs in the soft pumice. These were long tunnels excavated in the soft rock where the Christians could hide, practice their religion and bury their dead (Figure 5). The catacombs of Milos are of the biggest in the world and only a very small portion can be visited today.

The island became part of the Byzantine Empire and later on was ruled by the Venetians and Turks. In the middle of the 18th century the geologic environment again played a important role in the history of the island. Earthquakes, noxious gases escaping from the ground, floods and malaria, forced the inhabitants to resettle in Castro and Plaka.

In 1862 the Greek government awarded the first permit for mining operations to exploit sulfur. By 1890 the production of sulfur reached 15,000 tons per year (Oikonomopoulos, 1998).

## PROFESSIONAL CONTRIBUTIONS



Figure 6. Old residential building partly built and partly excavated in the rock.

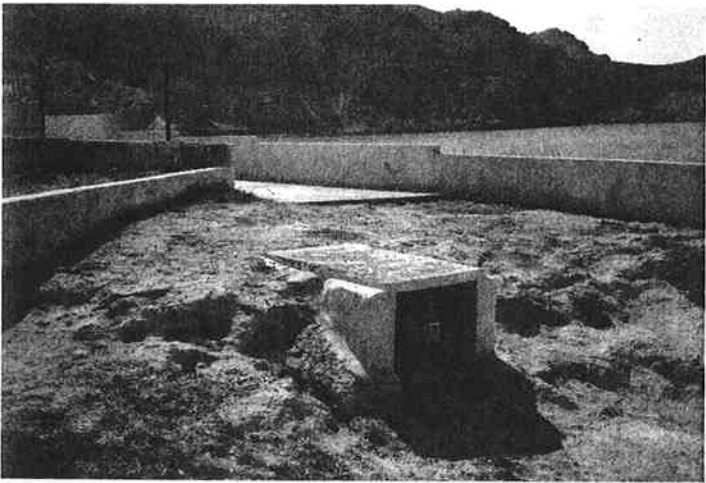


Figure 7. A window on the rock provides clean air and sun in the rooms below.

The extraction and exploitation of other minerals soon became possible. Today, the rich deposits of bentonite (used in drilling operations), kaolinite (ingredient of paper, rubber), perlite (for insulation) and pozzalana (cement industry) but also sulphur, baryte and gypsum are exported every year. Milos is today the largest production center of bentonite and perlite in the European Union.

The habitants of Milos were always finding ways to improve the quality of their life using different geologic materials. Even today, the visitor can observe practices that likely come from the early past. In various locations old residential houses are partly masonry structures (using local stone) and partly are excavated in rock. (Figure 6, 7) Also chambers are excavated in the soft rocks near the sea and are used to protect the fishing boats during the winter. The last years some of these chambers are modified and rent to tourists who may want to stay in them (Figure 8). In the mining museum one can see tools that were used in the mines during the 19th and 20th century. These tools were simple and very similar to those that the ancient Greeks were using. In the same museum there is also documentation of the experience-based approach used in mining. A retired worker vividly describes that in each tunnel there was one worker with the task of placing



Figure 8. View of chambers (called symmata in Greek) used as storage or to protect the fishing boats from the bad weather.

small wooden wedges in any fractures observed along the tunnel. If any of these wedges fell on the ground, it meant that the tunnel was deforming significantly and the workers were ordered to evacuate. One can assume that similar simple observation-based methods were used in the ancient mines.

## Conclusions

Life on Milos has always been strongly associated with exploitation of rocks and minerals. The geologic processes have affected the habitants in many constructive and destructive ways. Nowadays, in addition to the production of useful minerals, the island of Milos provides unique opportunities to observe interesting geologic phenomena and enjoy the beauties of the geologic environment and for that reason is often referred to as "the geologic lab of nature."

## References

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## Note

More information and photos on this topic can be found at the Geoengineer website, <http://www.geoengineer.org>. The Geoengineer website aims to provide useful and educational information for geotechnical engineering and engineering geology.

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