Walter L Friedrich

SANTORINI

Volcano · Natural History · Mythology

The satellite image shows the central part of the Santorini caldera with the islands Palea and Nea Kameni. Photo: EUROPEAN SPACE CENTER.

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Translation Alexander R McBirney

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Santorini – volcano, natural history, mythology

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To my sons Andreas and Michael and my grandchildren
Anna, Jakob, Nanna, Jeppe, Johanne and Esben

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Preface

Tourists who walk over the black lava fields of the Georgios volcano on Nea Kameni in the scorching summer heat have only the weak emissions of hot steam in the crater to remind them that the volcano is still alive, but it could return to life at any time. Earth scientists have already observed changes in the underground of Nea Kameni that might lead to a forthcoming eruption, but an eruption as violent as the Minoan will certainly not occur in the near future.

Jules Verne, in his famous science fiction book, *20 000 Leagues under the Sea*, described how the submarine vessel Nautilus surfaced in the hot water around Santorini volcano. Captain Nemo, and his crew were astonished to see the spectacular 1866 eruption of Georgios volcano on Nea Kameni. Even today one can explore the inner part of the main volcano of Santorini very much in the same way as Captain Nemo did by sailing into the bay and admiring the multi-colored inner walls of the gigantic volcanic caldron where an extraordinary part of the earth's history is revealed. It is not just earth scientists who are irresistibly drawn to this volcanic island; it holds an equal fascination for archeologists as well. Beneath the thick shroud of white pumice that mantles the rim and most of the outer slopes of the volcano lie the remains of an advanced culture – a bronze age Pompeii that, after more than 3600 years, is still being uncovered in the excavations at Akrotiri. This '*Fantastic Island*' will enchant anyone who appreciates the natural world and the history of early civilizations. If it were up to me, I would reintroduce the name the island had in antiquity: Calliste – the most beautiful.

"You must write this book", said the volcanologist Maurice Krafft in 1989 during his visit to Santorini, when I showed him and his wife Katja our latest discoveries and told them about my projected book. Sadly, they never saw the final result because they were both killed a short time later in an eruption of Unzen volcano.

Fourteen years have passed since the first German edition of '*Feuer im Meer*' was published. In this interval, many discoveries have been made and a great number of publications about the island have appeared. When I realized that so much had changed, it became necessary for me to find a new title for the book-project.

In 1975, when I visited Santorini for the first time, the island looked different – at least in the tourist guide-books. At that time, one could read that prior to the Minoan eruption Santorini had a 1600 meter high mountain in its centre and that this catastrophic eruption took place around 1500 BC. But since then things have changed a lot. Today it is generally accepted that a water-filled caldera existed about 10 000 years before the Minoan eruption, and that the people who lived at that time have showed us in the ships fresco from the Akrotiri excavation what their island looked like: There were two harbors in the caldera and there were houses on the central island. The Bronze Age Santorini was similar to the one we see today. This new interpretation has also been supported by geological observations.

The date of the Minoan eruption has also changed: we now have the most direct and precise radiocarbon dates, that were based on the lucky find of two olive trees, which were buried alive, in upright position, by the eruption. The dates show us that the Minoan eruption occurred about 100 years earlier than people thought three decades ago.

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The discovery of the olive tree and the new radiocarbon date for the eruption which we were able to obtain from it, play an important role in this edition. Here I would like to thank my former PhD student, Tom Pfeiffer. Furthermore, I am also very grateful to Jan Heinemeier, Bernd Kromer, Michael Friedrich, and Sarah Talamo. They have been a very inspiring and fantastic scientific team.

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Introduction

Volcanoes leave their mark on the history of the earth through their direct or indirect impact on nature and humans. One need only consider the effects of recent eruptions — such as those of Pinatubo on the island of Luzon, Philippines (1990-93), and those of Mount Unzen on the island of Kyushu in Japan (1991 and 1995). Why are volcanoes concentrated in certain regions? What influence have they had on the climate, glaciation, and vegetation of the earth? These questions have been asked for centuries, and countless geologists, archeologists, botanists, and climatologists have devoted much scientific research to finding answers.

This book deals with the historical development of one of the world's most remarkable active volcanoes, Santorini. Nowhere on earth can we learn so much about volcanism as we can on this island in the Greek Aegean Sea. We find material evidence there that enables us to trace the volcano's activity for nearly two million years and to construct a picture of the devastation it wrought over the course of time. One of the highlights of this history is the Minoan eruption, probably the greatest volcanic catastrophe of the Bronze Age. The event had a severe impact on much of the Western world and contributed to the decline of the Minoan civilization. Scholars continue to discuss some of its possible effects. For example, the question of whether the sudden darkening of the sky mentioned in the *Argonautica* – one of the oldest Greek myths told by Apollonius of Rhodes – could be a reminiscence of this eruption. It is even thinkable that the myth reflects some of the scenes shown in the Bronze Age frescos found at Akrotiri, as they possibly depict a journey from the Nile Delta to Santorini (Callisti) – a route that also Jason and the Argonauts followed.

Another myth by Hesiod tells us about the fight between Zeus and the Titans, where Zeus uses all his power and hurled stones after the Titans. It is still warmly debated whether the ten plagues of Egypt mentioned in the Bible – and even the Exodus of the Israelites from Egypt – could be attributed to this eruption. Similar discussions deal with the question of whether Santorini was the fabled island of Atlantis – described by Plato. Studies of Santorini show that the event had such an impact on the people of that time that the memory of it has been passed down in written accounts or as legends.

Santorini has an unusual geological situation in a zone of intense deformation between the converging continents of Europe and Africa. Like the other Aegean volcanoes that are adding new material to the earth's crust, Santorini is a product of the collision of the two continents. Studies of these Aegean volcanic islands and the natural events that have occurred on them have contributed to the development of a number of basic geological concepts. One of the most famous of these was the theory of 'craters of elevation' which, when it was proposed by Leopold von Buch early in the nineteenth century, stimulated heated discussions, especially among scientists familiar with the geology of Santorini. According to von Buch's theory, large craters, such as the bay of Santorini, were the result of the expansion of a volcano by gas and molten magma; the swelling eventually opened fissures and triggered an eruption. Virtually all the noted naturalists of the day, including Alexander von Humboldt and Charles Darwin, contributed to the discussions, but it was the detailed geological studies of Santorini by Ferdinand Fouqué (1879) that finally put the theory to rest.

Santorini again attracted worldwide attention when Spyridon Marinatos (1939) proposed that the Bronze Age eruption of Santorini was responsible for the sudden demise of the Minoan civil-

ization of Crete. Though received at first with skepticism, Marinatos' hypothesis was viewed with much greater interest when extensive layers of young pumice were found on distant islands and on the floor of the eastern Mediterranean. Although dating later showed that the Minoan eruption occurred well before the decline of the civilization on Crete, the controversy triggered a surge of intense investigations by geologists and archeologists from many nations.

Today, most geological studies of the island are centered on the mechanisms of volcanic eruptions and the relationship of volcanism to large-scale tectonic features in the Mediterranean. Few regions have been the subjects of such intensive study. The great quantities of published work describing this research continue to increase. The wealth of information on Santorini resembles a fractal: no matter which field of science is explored each piece of new knowledge leads to new insights on another level. For natural scientists and archeologists it has been a veritable Eldorado where specialists in different fields can work in close cooperation. In that sense, Santorini is a natural experiment in which almost all the natural sciences play a role: geophysicists determine the structure of the earth's crust and lithosphere; petrologists use the chemical composition of the rocks to define the origin of magmas; and paleontologists find the ages and ecological conditions in which the flora and fauna lived in the past. Thus, Santorini offers the natural scientist many possible windows through which we can gain an insight into the earth's past.

The landscape of Santorini is uniquely fascinating. It resembles a giant circus arena surrounded by circular stands. To geologists, the bay is known as a caldera, the Spanish word for a cauldron or kettle. We now know that even in the Bronze Age the islands of Thera, Therasia, and Aspronisi formed a single ring and from the settlements on its rim the inhabitants had a splendid view of a panorama that differed little from that of today. Santorini, which in ancient times was called Callisti, found itself in the center of a region of old cultures. Lying between the Greek mainland, Crete, Asia Minor, and Egypt, it could quickly pick up and assimilate cultural changes from its neighbors. And in turn, it served as a crossroads where knowledge or innovations developed in one place were quickly disseminated to the surrounding region. Take, for example, the appearance of the island known as Hiera in the second century BC. The event was well recorded by the scholars of that time, and from their descriptions we can easily determine when it occurred. Strabo (66 BC to AD 24) tells us in his work *Geography* (1.3.16): "*For midway between Thera and Therasia fires broke forth from the sea and continued for four days, so that the whole sea boiled and blazed, and an island was gradually elevated, as though by levers. The island was a burning mass with a circumference of twelve stadia. When the eruption came to an end, the first people to venture onto the scene were Rhodians who at that time had maritime supremacy. They erected on the island a temple in honour of Poseidon Asphalios.*" We also have quite similar accounts of the volcanic events at Santorini from other authors. Volcanic events in this region were mentioned by Pindar, Herodotus, Callimachus, Apollonius of Rhodes, Seneca, Pliny the Elder, Orosius, Dio Cassius, Plutarch, Pausanias, Justin, Eusebius, and Ammianus Marcellinus — all well known scholars closely associated with the cultural history of the Old World. The appearance of a new island was for the people of that time, as it is even today, such a remarkable, if not divine, event that it was well recorded. The Greek names Hiera, the 'holy', and Thia, the 'Goddy', that were given to the new islands are good examples of this. The same fascination that such a natural event arouses even today is found in the writing of Seneca, on the formation of islands in the Aegean, when he asked how it was possible that fire in the sea is not extinguished, even when it occurs under a great mass of water. 'Marvels of the seafarer' is another account, in the work of Justin (Justinus *Trogi Pompeii*, 30.4.4), who lived in the second century AD and certainly reported on the origin of Hiera.

A further example is the legend of Atlantis, which Plato gave us in the dialogs 'Critias and Timaeus'. He described the sinking of an island that had a flourishing culture. Some scholars believe that at the core of this legend one can recognize the Minoan eruption that inflicted a very similar fate upon Santorini. Interpretations of the rise of the island complex from the sea changed over the course of time. In ancient times the Gods were

credited for all forces such as this that governed the processes of our earth. For example, Poseidon was said to control the seas and earthquakes. Thus, when the eruption of AD 46 occurred on the night of the eighth-century festival of Rome, it was seen as a clear expression of the Gods' will. At that same time a conspicuous total eclipse of the moon also occurred, and the firebird Phoenix of Arabia (a comet?) appeared to proclaim the birth of a new island in the Aegean. As Aurelius Victor reported in his fourth-century work, *Historiae Abbreviatae*, this series of evil omens could have only one meaning: the decline of the Roman Empire was imminent. In the Christian era, devastating volcanic eruptions were interpreted as signs of God's wrath over the sins of man. Fateful importance was assigned, for example, to the eruption of AD 726 on Palea Kameni, which gave impetus to the crisis between Rome and Constantinople. Today, however, people look to science; they believe in specialists' forecasts of impending eruptions and many trust blindly the ability of volcanologists to inform them correctly as to when to anticipate a catastrophe. If divine forces are involved, they are no longer a factor in these forecasts. Using the example of Santorini, this book traces the development of an active volcanic island. Special importance will be assigned to the timing and variety of the volcanic events that have taken place since the Late Pliocene, a period of about two million years.

We are reminded that the forces responsible for the volcano's activity are still operating today. We shall also examine paleontological discoveries as well as traces of early human settlement, but the main objective is to analyze the Minoan eruption that buried the flourishing Bronze Age settlements on Santorini under a thick layer of ash and left for posterity a prehistoric Pompeii in the Aegean Sea.