Tsunamis Observed on the Coasts of Greece from Antiquity to Present Time

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INTRODUCTION.

In comparison with the great number of disastrous earthquakes which have occurred from antiquity to the present time in Greece, large tsunamis are very rare on the coasts of Greece. A really great tsunami may have started in the Aegean Sea after the tremendous explosion of Santorin volcano, which occurred 3370 $\pm$ 100 years ago ([13]). After the deposit of a layer of pumice 20-30 m thick and the emptying of the volcanic focus, the roof of the cavern thus formed collapsed. The central part, consisting of an area of 83 sq km, of the former island Stronghyli thus became a gigantic caldera 300-400 m deep.

There is no evidence indicating whether the collapse took place gradually or all at once. In the second case a huge tsunami should have started greater by far than that generated by the explosion of Krakatoa, on August 27, 1883. At that time depths of 200-300 m were formed by the sinking ([24]) of 2/3 of the former island of an area of 33 1/2 sq km. Thus the cavity formed by the explosion of Santorin is about 4 times greater than that of the Krakatoa.

According to the archaeologist, Professor MARINATOS ([20, 21]), there is evidence that all the Minoan cities and localities on the north and east coast of the island of Crete, as Amnissos — the naval station of Knossos — Nirou Chani, Malla, Psira, Ghournia and Zakros, were swept clean by the huge waves started by the explosion of Santorin which occurred in about 1500 B. C. As a matter of fact, the destruction of Minoan Crete, started by severe earthquakes on the south, east and north side of the island, which possibly induced the explosion, was completed by the great earthquake, which accompanied the birth of the caldera ([15]).

However, it should be noted that the relatively great depth and the gentle slope of the sea floor near the north coast of the island of Crete,

the lack of inlets and the presence of Dia Island about 10 km to the north of Knossos, prevent the tsunamis from surging to destructive heights on the coast.

The total and sudden collapse of the central part of the former island Stronghyli should have been accompanied by a great earthquake. The fact that the walls of the houses of the former occupants were found upright in quarries, under the lower pumice layer, does not establish a convincing reason that destructive earthquakes have not occurred either with or after the paroxysm of the eruption of Santorin ([24]). As the Santorin caldera was formed after the first pumice deposition, it was impossi ble for any earthquake, however great, to throw down houses already entombed in a thick pumice layer.

Origin of the Deluge of Deukalion and the myth of Atlantis.

The volcanic eruption, the collapse of the central part of the former island of Stronghyli and the tsunami which followed, for first time open well the question of their bearing on the tale of Atlantis and the Deluge of Deukalion. The exaggeration in the size of the island (*), which vanished in the sea, and in the time of its occurrence is quite a usual process due to 11 centuries which lapsed from the time of the collapse up to the epoch of Plato (B. C. 428-347). The exaggeration in the time is clearly indicated by the fact that bronze had been very largely used for the decoration of the metropolis of Atlantis; consequently, the destruction of Atlantis can not have occurred before the Bronze Age. The Bronze Age is referred to the interval time of 2100-1200 B. C. ([23]). The exaggeration in the size of Atlantis, i. e. of the insular States of Atlantis, is clearly indicated by the description of the ancient metropolis.

The description of the ancient metropolis (**) is quite the same of a volcanic island after a long time of quiescence; it fits perfectly to the

(*) The exaggeration in the size of Atlantis may have been made partly by purpose for justifying the great army of Atlantis and emphasizing so the importance of the victory of Old Athens. The exaggeration in the time may be partly due to an error or an oversight on the translation of the egyptian scripts by a factor 10, i. e. it was translated 9000 instead of 900 years before Solon's epoch.

(**) The description of the metropolis made on the basis of the documents which were inherited from Solon to Kritias, is awefully accurate. The discripancies in the description of the other land, which was vaguely known and merely by tradition, are quite justifiable.

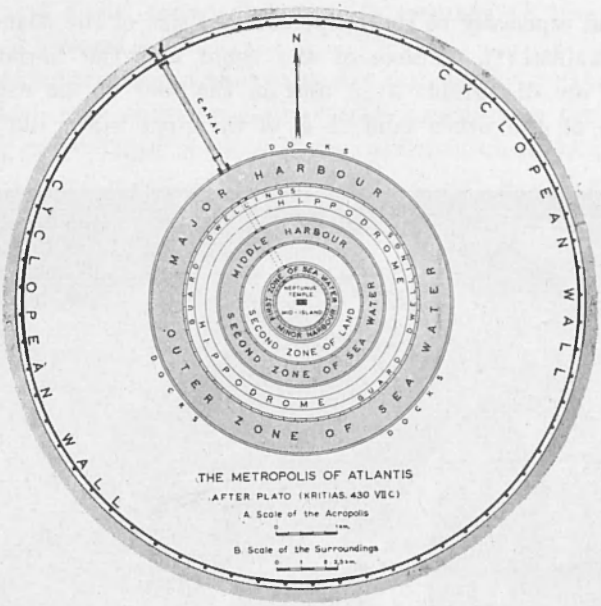

Fig. 1. – The Metropolis of Atlantis according to the data given by Plato in his Dialogue " Kritias ".

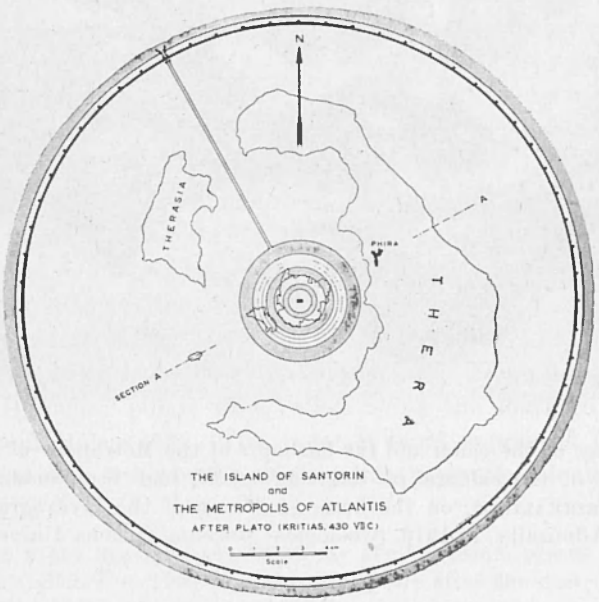

Fig. 2. – The Metropolis of Atlantis in comparison with the shape and size of Santorin Island. There is an alternative that Acropolis being in the middle of the island was 50 stades inland; in that case the radius of the island should have been 2 km smaller.

features and especially to the shape and the size of the island of Stronghyll or Kallisti (*). Traces of the canal and the harbours of the metropolis are discernible even now on the floor of the caldera. The description of the other land, i. e. of the royal state, fits well to the

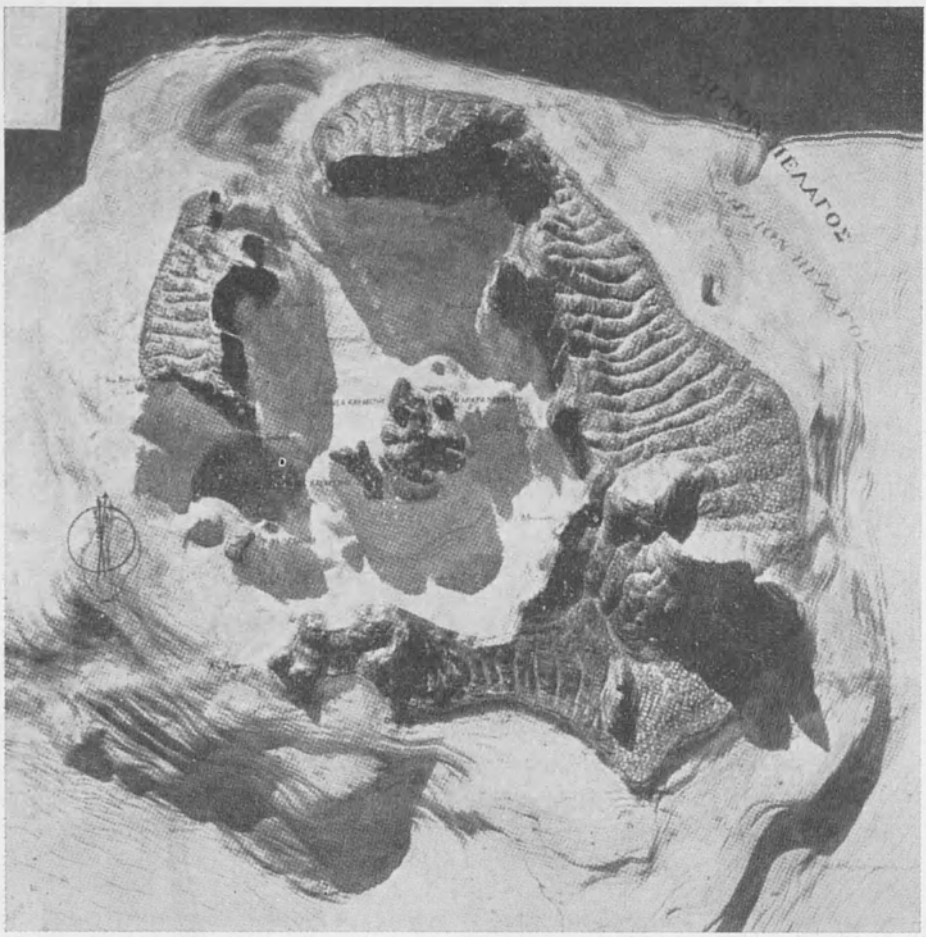

Fig. 3. – Traces of the canal and the harbours of the Metropolis of Atlantis. The relief of the caldera of Santorin Island had been made by Prof. Dr. J. TRIKKALINOS, on the basis of a map of the Hydrographic Office of the Admiralty, in 1916. (Geological Museum, Athens University, Greece).

(*) In Greek Stronghyli means round and Kallisti the best.

morphology of Crete Island and strongly reminds of the features of the plain of Messara.

The sinking of a land within " one day and one night " is a geological process, which may occur on a small scale and only in the case of an earth slump or a collapse of the roof of a subterranean cavern. A gradual sinking of a great island and even of a continent should have passed unnoticed. The great shocks and the large floods which have accompa-

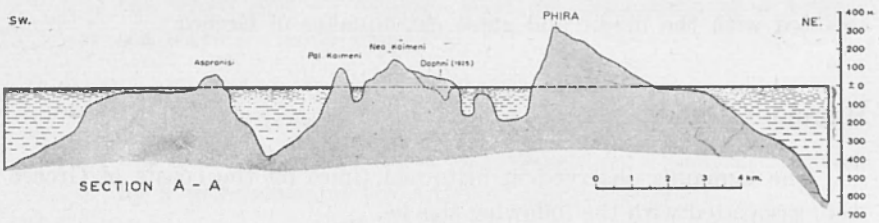

Fig. 4. – Traces of the middle and major harbours of the Metropolis of Atlantis in a section A-A through Aspronisi and Phira on Thera Island on the basis of a map of the Hydrographic Office of the Admiralty, 1947.

nied the birth of Santorin caldera may have affected the north coasts of Egypt to such an extent as the memory of this event to be kept — enlarged in the cource of the time — among the priests (*). It is quite impossible a geological event in the Atlantic Ocean to have affected the army of Old Athens.

Any story, however strange, can not produce a great impression, if there refers to a known, accessible place. For that reason, a real event occurred in the Aegean Sea was purposely displaced beyond Hercules ' pillars, in the Atlantic Ocean, in an inexplorable space and in a time, which could not be checked. However, considering that Peloponnesus was the main field of Hercules' doings, and that the part of the land, which was nearest to the Hercules' pillars was called in Greek " *Εὐμηλος* " — meaning probably the island Melos — there is a great possibility that Hercules ' pillars were called rather the southern peninsulas Tainarum and Maleas (**). This point is fairly supported by the fact that Neptune was not worshipped beyond the greek colomes.

(*) The story was written down by the egyptian priests 8000 years before Solon's visit, i. e. 1000 or rather 100 years after the destruction.

(**) The sailing across the cap Maleas in ancient times was considered a great achievement.

The occurrenee of the Deluge of Deukalion (*) all around on the coasts of the Aegean Sea in the epoch of the birth of the caldera is another strong argument for the idea that the Deluge of Deukalion and the myth of Atlantis (**) have their origin in the strong raining, which may have followed the volcanic explosion, as well as in the tsunamis, and in the collapse of the central part of Stronghyli Island. However, the extraordinary wave, which was possibly started by the collapse, is an exceptional case, which has no relation to the ordinary tsunamis occasionally associated with the major and great earthquakes of Greece.

Historical cases.

The tsunamis observed in historical times on the coasts of Greece were associated with the following shocks.

479, Spring, B. C. — Macedonia (Chalkidiki), 40°1/4N, 23°1/2E.
A seismic sea wave in the Gulf of Kassandra devastated Potidaea; the wave was preceded by a large withdrawal of the sea ([27]).

426, Summer, B. C. – Central Greece (Phthiotis), 38°3/4N, 23°E.
A destructive shock in the Gulf Maliakos and on the island Euboea, with large effects on terrain, was followed by three devastating tsunamis. They say, the waves overwhelmed Orobiae (now Roviae), swept clean the island Atalanti (now Talantonisi), and entered in Opous (near Kyparissi) a half mile inland ([27]).

373, Winter, B. C. – Peloponnesus (Achaia), 38°1/4N, 22°1/4E.
Boura and Helice on the south coast of the Gulf of Corinth were ruined by a severe shock. A large slump sent Helice to the bottom of the sea. 10 warships were wrecked by the tsunami which followed ([26]).

(*) According to A. Stagirites ([30]) Deukalion was born in B.C. 1573, he reigned in B.C. 1541 and the Deluge took place in B. C. 1529.

(**) It seems fairly probable that plugs of lava solidified were supporting the roof of the volcanic cavern before the collapse; these plugs found eventually by the excavation of the harbours or the canal of the metropolis were presumably considered as the shoulders of Atlas.

About 330, B. C. – Eastern Sporades (Lemnos), 40°N, 25°E.

It is rumoured, that Chryse Island and the volcano Moschylos near the island of Lemnos were sunk by a shock. If it is true, a huge tsunami should have been generated [28].

220, B. C. – Dodecanese (Rhodes), 36°1/2N, 28°E.

A great shock on Rhodes Island, with a large meizoseismal area, destroyed the famous Colossus of Rhodes, the fortress, the wharf and — possibly with the association of a seismic sea wave — many ships [28].

46, A. D. – Cyclades (Santorin), 36°1/2N, 25° 1/2E.

An earthquake, which triggered an explosion of Santorin, was felt on Crete; the shock was followed by a tsunami preceded by a withdrawal of the water of about 100 m [28].

66, Spring, A. D. – Crete, 35°1/2N, 25°1/2E.

A shock strong enough to cause extensive damage at Knossos was followed by a tsunami on the north coast of Crete[28]

365, Juli 21. – Crete, 35°N, 23°E.

A really great, probably intermediate shock, with a very large area of perceptibility, destroyed Knossos, Gortys and 8 other localities on Crete Island. A devastating tsunami was reported from Crete and Alexandria. In Alexandria, after a large withdrawal of the sea, ships were carried over the buildings and left among them [26]. A shipwreck was found near Methoni, on the southwest coast of Peloponnesus, about 2 km inland [5].

551, Juli 7. – Central Greece (Phokis-Boeotia), 38°1/2 N, 22°1/2E.

A very destructive earthquake on the north coast of the Gulf of Corinth with really large faulting — the first adduced in the Earthquake History of Greece — ruined many localities and 8 cities, among which Chaeronaea, Koronaea, Patras and particularly Naupaktos. A devastating tsunami started by the shock in the Gulf Maliakos was preceded by extensive withdrawal of the water near Echinaeos (now Achinos) in Thessaly and near Skarphia in Boeotia [26, 27].

554, A. D. – Dodecanese (Kos), 36°1/2N, 27°1/2E.

An earthquake ruined Kos and the Esculapius Sanctuary. The tsunami which followed swept clean what was left untouched by the shock [28].

1389, March 20. – Eastern Sporades (Chios), 38°1/4 N, 26°1/4E.

A shock with a large meizoseismal area destroyed the greater part of the fortress of Chios and caused severe damage to nearly all churches of the city. After a withdrawal of the sea, the water entered half the marketplace ([10]).

1481, October 3 – Dodecanese (Rhodes), 36°N, 28°E.

A seismic sea wave was set off by a devastating earthquake on Rhodes Island ([28]).

1604, A. D. – Crete, 35°1/2N, 25°1/2E.

A destructive earthquake on Crete Island, associated with a depression of the coast near Heraklion, may have been followed by a seismic sea wave ([28]).

1612, November 8 – Crete, 35°1/2N, 25°1/2E.

Extensive damage in Heraklion and other localities by a severe shock on Crete Island. Ships were destroyed on the north coast of the island, presumably by a tsunami started by the shock ([28]).

1622, May 5. – Ionian Islands (Zante), 37°1/2N, 21°E.

The greater part of Zante was destroyed by a violent earthquake. On the south coast of the island the cape St. Sostis was swept by the sea ([11]).

1629, February, .27 – Crete, 36°N, 25°E.

Extensive damage by a severe shock on the whole island of Crete. A tsunami was reported from Cythera ([28]).

1633, November 5. – Ionian Islands (Zante), 37°1/2N, 21°E.

A seismic sea wave was set off by a destructive earthquake associated with slumps and large faulting on Zante Island ([22, 27]).

1650, September 29. – Cyclades (Santorin), 36°1/2N, 25°1/2E.

A submarine explosion on the banc of Coloumbo, about 16 km north-east of Kaimeni (Santorin), was preceded by a destructive earthquake with large area of felt shaking. The shock was followed by a devastating tsunami, preceded by a large withdrawal of the sea, particularly on the east coast of Santorin Island. On Sikinos the water entered more than 100 m inland and on Ios the waves rose as high as 16 m. On Kea a ship was thrown up the coast. On Crete Island row-boats were sunk in the harbour of Heraklion. There is a rumour largely

spread among the people of Patmos, that the water rose on the west and east coast of the island to heights of about 50 and 30 m, respectively ([2, 28]).

1672. – Cyclades (Santorin), 36°1/2N, 25°1/2E.

Cyclades and especially Santorin were shaken by a violent earthquake. The island Kos (formerly Stanchio) was "swallowed up " ([22]), presumably by a sea wave started by the shock. (Probably this shock is the 1672 shock on Tenedos Island; at least the effects on Kos Island appear to have been caused by the same sea wave).

1672 or 1673, mid-Aprll. — Eastern Sporades (Tenedos), 40°N, 26°E.

A shock with very large area of perceptibility caused severe damage on Tenedos Island ([28]). On Kos Island some houses vanished into the sea ([22]), presumably by a tsunami started by the shock.

1748, May 14. – Peloponnesus (Achaia), 38°1/4N, 22°1/4E.

A severe shock, followed by a destructive tsunami, ruined Aeghion ([11]).

1804, January 8. – Peloponnesus (Achaia), 38°1/4N, 21°3/4E.

Moderate destruction at Patras and great in the environs. The shock was followed by a tsunami ([11]).

1817, August 23. – Peloponnesus (Achaia), 38°1/4N, 22°1/4E.

A severe shock ruined Aeghion. A sea wave swept the downtown section and the Cape Aliki ([11]).

1821, January 6. – Ionian Islands (Zante), 37°3/4N, 21°1/4E.

Severe damage at Patras by a seismic sea wave set off by a very strong aftershock centered between Zante and Elis ([11, 22]).

1853, August 18. – Central Greece (Boeotia), 38°1/4N, 23°1/2E.

A destructive shock in Attica and Boeotia, particularly at Thebes and environs, was associated by a tsunami in the Gulf of Euboea ([22, 27]).

1856, November 13. – Eastern Sporades (Chios), 38°1/4N, 26°1/4E.

A large tsunami was set off by a destructive shock on Chios Island ([10]).

1861, December 16. – Peloponnesus (Achaia), 38°1/4N, 22°1/4E.

A very destructive earthquake on the south coast of the Gulf of Corinth, with large effects on terrain, was followed by five tsunamis, which caused much damage to merchantships and row-boats anchored in the bay of Itea. On the north coast of the Gulf the waves rose at many points to heights of about 2 m and entered 15-60 m inland. The strong disturbance continued in the harbour of Galaxidi for about 2 1/2 hours. On the south coast of the Gulf the water entered the harbour street of Aeghion and rose to a height of about 1 m ([26]).

1866, February, 6 – Peloponnesus' Marginal Islands (Cythera), 36°N, 23°E.

A seismic sea wave set off by a severe shock on Cythera Island rose at Avlemonas (Viaradica) to heights of over 8 m ([22, 28]).

1867, September 20. – Peloponnesus (Laconia), 36°1/2N, 22°1/4E.

A large tsunami in Paganea (Kalyvia), Gythion and Skoutari, on the western coast of the Gulf Laconikos, reached Crete, Syra, Corfou, Brindisi and Messina. The disturbance of the sea continued in Chania, Zante and Argostoli for 4 1/2 hours. The earthquake associated, probably an intermediate one with a large meizoseismal area, caused severe damage on the Peninsula of Maina, particularly at Maroulia, Areopolis and the Monastery of Gola ([26, 28]),

1869, December 28. – Ionian Islands (Leukas), 38°3/4 N, 20°3/4 E.

Three tsunamis in front of Valona. The earthquake associated was very destructive on Leukas Island; the area of slight damage reached Durazzo ([7]).

1883, Juni 27. – Ionian Islands (Corfou), 39°1/2N, 20°E.

A sudden withdrawal of the sea near the coast of St. Georges (Rhoda) on Corfou Island left over three row-boats. The shock associated was damaging at Ano Garouna ([8]).

1886, August 27. – Peloponnesus (Messenia), 37°N, 21°1/4E.

A really great, probably intermediate shock with a very large meizoseismal area on the western coast of Messenia, was followed by a tsunami observable as far away as Smyrna. In Jalova (northwards of Pylos) some row-boats were thrown up the coast and near Agrili (northwards of Philiatra) the sea entered 10-15 m inland. The shock was associated by a cable break between Zante and Strophades ([3, 4]).

1887, October 3. – Peloponnesus (Corinthia), 38.°1/4N, 22.°3/4E.

A damaging shock on the south coast of the Gulf of Corinth; a tsunami started by the shock, entered between Xylokastron and Sykia 20 m inland ([8]).

1893, February 9. – Thrace's Sporades (Samothrace), 40.°1/2N, 25.°1/2E.

A shock strong enough to cause extensive damage on Samothrace was followed by a tsunami on the northern coast of the island and the neighbouring coasts of Thrace. On Samothrace the water rose at Agistron to a height of about 1 m and entered 25-30 m inland; some animals were killed by the collapse of two small houses left intact by the shock. On the opposite coast of Alexandroupolis (Dedeagatsch) the wave had about the same height and entered 40 m inland ([1]).

1894, April 27. – Central Greece (Phthiotis), 38.°7N, 23°.1E.

A major earthquake, with considerable development of faulting along the western coast of the Channel of Atalanti. The earthquake was preceded by a strong and locally destructive shock on April 20. Large slumps accompanied the main shock. A tsunami started by the main shock rose in front of Atalanti to heights of over 3 m and spread northwards at least up to St. Constantine. A 50 m withdrawal of the sea preceded the tsunami on the coast of St. Constantine ([29]).

1915, August 7. – Ionian Islands (Ithaca), 38.°1/2N, 20.°1/2E.

An earthquake of magnitude 6 — 6 1/4 was followed by two tsunamis between Cephalonia and Leukas ([11]).

1947, October 6. – Peloponnesus (Messenia), 36°.9N, 22.°0E.

A tsunami entered near Methoni 15 m inland. The shock associated was of magnitude 7 ([6]).

1948, February 9. – Dodecanese (Karpathos), 35.°1/2N, 27°E.

An earthquake of magnitude 7.1 was followed by a destructive tsunami on the eastern coast of Karpathos Island. After a withdrawal of the sea, the water entered near Pigadia about 1 km inland ([11]).

1948, April 22. – Ionian Islands (Leukas), 38.°1/2N, 20.°1/4E.

A seismic sea wave on the southern coast of Leukas followed an earthquake of magnitude 6.4. The wave rose in the bay of Vaslliki to a height of about 1 m ([9]).

1956, July 9. – Cyclades (Amorgos), 36.°9N, 26.°0E.

Three large tsunamis started by a great earthquake of magnitude 7.8 near the southeastern coast of Amorgos Island caused severe damage on the neighbouring islands Astypalaea, Amorgos, Kalymnos, Leros, Lipsos, Ios, Sikinos, Nisyros, Karpathos and Kos. Minor damage was reported from the islands Crete (Palaeokastron, Sitia, Elouda, Heraklion, Rethymnon, Souda), Patmos, Ikaria, Tilos, Alymia, Milos, Seriphos, Antiparos and Tinos. More than 80 small ships and row-boats were wrecked, sunk or vanished. 2 injured, 1 drowned. The waves were particularly high on the south coast of Amorgos and the north coast of Astypalaea; reported heights of over 25 m and 20 m, respectively. On the north coast of Amorgos and the south coast of Astypalaea the waves rose to much minor heights of about 2 m and 4 m, respectively. It seems so intuitively evident that the source of the tsunamis was situated between Amorgos and Astypalaea (36.°8N, 26.°2E). This evidence is supported by the time of arrival of the wave and the speeding from north to south of an ungoverned boat reported from Astypalaea. An additional wave started by a major shock of magnitude 6 3/4, which occurred 13 minutes later near the northwest coast of Ios Island (36.°8N, 25.°2E), may have been responsible for the relatively great height of 10 m reported from Pholegandros. A second strong fall of the water 2 m below the normal sea-level at Lakki harbour (Leros) 2 1/2 hours after the first minimum of the same amplitude seems to have been set off by two successive aftershocks of magnitude 5.7 (36.°9N, 26.°0E) and 5.6 (36°.9N, 25.°5E). The strong fluctuation of the sea level continued at Lakki harbour on the whole for 6 1/2 hours. The presence of a submarine trench with steep slopes near the southeast coast of Amorgos Island and the unusually long duration of the strong disturbance at the near-by coasts of Astypalaea and Leros point out that submarine slides set off by the main shock and the aftershock sequence may well account for the generation of the tsunamis. The disturbance spread from its source in every direction reached Smyrna and Skopelos northwards, Argos and Cythera westwards and the coast of Palestine southwards ([12]).

1956, November 2. – Thessaly (Magnesia), 39.°5N, 23.°0E.
At Volos harbour the sea rose to a height of over 1 m. The shock associated was of magnitude 5 3/4 ([14]).

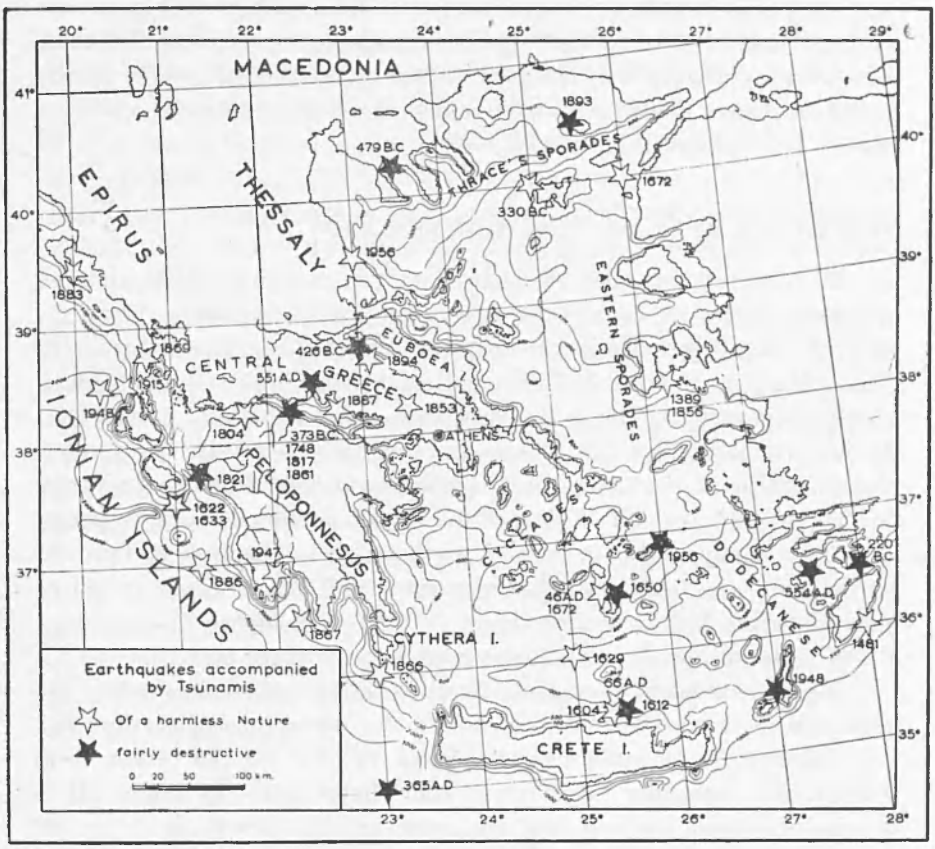

Fig. 5. – Sources of Tsunamis which have affected the coasts of Greece from B.C. 479 to 1956.

STATISTICS.

Of 41 earthquakes accompanied by tsunamis on the coasts of Greece during a period covering B. C. 600-1958 only 16 were followed by really damaging or disastrous tsunamis. This number is too small compared to 613 known earthquakes with $Io \geqslant$ VI on Mercalli-Sieberg scale, or 281 earthquakes with $Io \geqslant$ VIII, which occurred during the same period ([15]); the ratio is 1 : 15 and 1 : 18, respectively. During the relatively

well-known period of 1801-1958, there took place 482 earthquakes with $Io \geqslant$ VI and 170 with $Io \geqslant$ VIII ([14]). The corresponding earthquakes accompanied by tsunamis amount to 20; of these tsunamis 6 were damaging or disastrous. The ratio of this period is then 1 : 24 and 1 : 28, respectively. The frequency for the last period is 1 : 8 per year for the whole of the tsunamis and 1 : 26 per year for the damaging or destructive ones. From these statistics it is fairly clear that the seismic sea waves on the coasts of Greece do not constitute a serious danger against which there should be established a warning service.

Operating agent in starting the tsunamis.

It is remarkable that although there are numerous inlets and the frequency of large shocks in the area of the Ionian Islands is very high, the corresponding tsunamis are very few and of a harmless nature. On the contrary, in the Gulf Maliakos and particularly in the Gulf of Corinth the corresponding tsunamis are relatively many and fairly destructive. It is worth noting that great masses of loose material are transported yearly by the rivers flowing in the afore-mentioned Gulfs, particularly in the region of Aeghion. This fact and the association of cable breaks ([3]) and large slumps with destructive earthquakes in the Gulf of Corinth, as weli as in the Ionian Sea (between Zante and Elis or Zante and Strophades), leave little room for doubt ([16, 17, 18]) that sliding of unconsolidated material may account for at least some of these tsunamis.

There is no positive evidence for the operating agent in starting the tsunamis in the Aegean Sea. However, the occurrence of earthquakes accompanied by tsunamis near the Saros Trench and the Cretan deep furrow, and especially the starting, some hours later, by minor aftershocks of seismic sea waves of the same amplitude with those set off by the main shock favour the explanation of the generation of these tsunamis rather by submarine slides than by displacement of submarine blocks or any other factor ([19, 25]) directly connected with the earthshaking.

Acknowledgments.

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ABSTRACT

In comparison with the great number of disastrous earthquakes which have occurred from antiquity to the present time in Greece, large tsunamis are very rare on the coasts of Greece. A really great tsunami may have started in the Aegean Sea after the tremendous explosion of Santorin volcano, which occurred 3370 ± 100 years ago. After the deposit of a layer of pumice 20-30 m thick and the emptying of the volcanic focus, the roof of the cavern thus formed collapsed. The central part, consisting of an area of 83 sq km of the former Island Stronghyli, thus became a gigantic caldera 300-400 m deep.

The destruction of Atlantis, not before the Bronze Age, and the occurrence of the Deluge of Deukalion all around on the coasts of the Aegean Sea in the epoch of the birth of the caldera leave little room for doubt that the Deluge of Deukalion and the myth of Atlantis have their origin in the strong raining, which may have followed the volcanic explosion, as well as in the tsunamis, and in the collapse of the central part of Stronghily Island, respectively. This idea is well substantiated by the traces of the canal ant the harbours of the Metropolis of Atlantis, which are discernible even now on the floor of the caldera.

Of 41 earthquakes accompanied by tsunamis on the coasts of Greece during a period covering B. C. 660-1958, only 16 were followed by really damaging or disastrous tsunamis. There is much evidence favouring the explanation of the generation of these tsunamis rather by submarine slides than by displacement of submarine blocks or any other factor directly connected with the earthshaking.

RIASSUNTO

In confronto al grande numero di terremoti avvenuti in Grecia dall'antichità ai giorni nostri, i tsunami risultano molto rari sulle coste elleniche.

Un tsunami di intensità veramente considerevole è molto probabile che sia avvenuto nel Mar Egeo dopo la tremenda eruzione del Vulcano di Santorino, circa *3.370 ± 100 anni fa.*

Dopo la formazione di uno strato di pietra pomice di uno spessore di 20-30 m, evacuatosi il focolare vulcanico, crollò la volta della cavità formatasi. La parte centrale che costituisce un'area di 83 km² della già Isola Stronghili divenne in questo modo una gigantesca caldera profonda circa 300-400 m.

La scomparsa dell'Atlantide, avvenuta non prima dell'età del bronzo e il sopravvenuto Diluvio di Deucalione su tutto il litorale del Mar Egeo, all'epoca della formazione della caldera, fanno dubitare che il Diluvio di Deucalione e la leggenda dell'Atlandide abbiano la loro origine dalla pioggia torrenziale che seguì probabilmente all'eruzione vulcanica, come pure al tsunami o al crollo della parte centrale dell'Isola Stronghili.

Questa idea viene pienamente confermata dalle tracce del canale e dei porti della Metropoli dell'Atlantide, che ancora oggi si mantengono distinguibili sul fondo della caldera.

Su un numero di 41 terremoti seguiti da un tsunami, avvenuti sin dal 600 a.C. fino a tutto il 1958 sulle coste elleniche, solo 16 furono accompagnati da tsunami, veramente distruttivi e disastrosi; vi sono molti indizi che favoriscono la spiegazione dei tsunami causati piuttosto da scivolamenti sottomarini che da spostamenti di blocchi sottomarini o da altri fattori, direttamente collegati col movimento del suolo.

RÉSUMÉ

De 41 tremblements de terre suivis par des raz de marée sur les côtes de la Grèce au cours de la période 600 a. C.-1958, seize seulement ont été accompagnés de tsunamis réellement endommageants ou destructeurs. Ce nombre est trop petit par rapport aux 613 séismes connus avec Io $\geqslant$ VI de l'échelle Mercalli-Sieberg, ou aux 281 séismes avec Io $\geqslant$ VIII, qui eurent lieu dans la même période; la proportion en est respectivement 1 : 15 et 1 : 18. Pendant la période 1801-1958, relativement bien connue, eurent lieu 482 séismes avec Io $\geqslant$ VI et 170 aver Io $\geqslant$ VIII. Les tremblements de terre suivis par des tsunamis montent à 20; de ces tsunamis les 6 ont produit des dégâts ou furent destructeurs. La proportion pendant cette période devient respectivement 1 : 24 et 1 : 28. La fréquence pour cette dernière période en est 1 : 8 par an pour le nombre total des tsunamis et 1 : 26 par an pour les tsunamis, qui ont produit des dégâts ou désastres. Il résulte assez clairement de cette statistique que les raz de marée sur les côtes de la Grèce ne constituent pas un danger sérieux contre lequel un système d'alerte devrait être établi.

Il est remarquable que malgré le grand nombre des baies et la haute fréquence des secousses violentes dans la région des Iles Ioniennes, les raz de marée correspondants sont bien rares et de nature inoffensive. Au contraire, dans le Golfe Maliakos et particulièrement dans le Golfe de Corinthe les raz de marée y correspondants sont relativement nombreux et

assez destructifs. Il faut noter que des grandes masses de matériaux incohérentes sont annuellement transportées par les rivières, qui se jettent dans les golfes susmentionnés, particulièrement dans la région d'Aeghion. Ce fait et l'association des ruptures des câbles et des grands éboulements avec des secousses destructives dans le golfe de Corinthe et dans la Mer Ionienne plaident en faveur de l'idee selon laquelle au moins quelques uns de ces raz de marée furent déclenchés par des glissements des materiaux non consolidés.

Il n'y a pas d'évidence positive à l'égard du mécanisme causant le déclenchement des tsunamis dans la Mer Egée. Pourtant, l'occurrence des séismes suivis de raz de marée près de la fosse de Saros et du sillon profond de Crète et spécialement l'entraînement par répliques de moindre intensité, quelques heures plus tard, des raz de marée de la même amplitude que ceux entraînés par la secousse principale, invoquent une explication plutôt par des glissements sous-marins que par des déplacements des blocs sous-marins ou d'autres agents directement liés au tremblement de terre.

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