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# Tsunamis in the Mediterranean Sea 2000 B.C. – 2000 A.D.

By

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## CHAPTER 1

### MAIN TSUNAMIGENIC ZONES IN THE MEDITERRANEAN SEA

About 300 descriptions of tsunamis and similar phenomena are known for the Mediterranean Sea. One can conventionally single out the following zones of origin and manifestation of tsunamis in the region, based on the seismotectonic conditions (Fig. 1):

- SM** - the Sea of Marmara, the Bosphorus and Dardanelles Straits;
- NG** - the Aegean coast of northern Greece;
- EG** - the coast of eastern Greece;
- AM** - the Mediterranean coast of Asia Minor;
- AS** - the Aegean Sea;
- HA** - the Hellenic Island Arc;
- IC** - the Island of Cyprus;
- NE** - the coast of the Near East;
- WG** - the coast of western Greece;
- AL** - the coast of Albania;
- DL** - the coast of Montenegro and of Croatia;
- GV** - the Gulf of Venice;
- EI** - the eastern (Adriatic and Ionian) coast of Italy;
- CA** - the Calabrian Island Arc, *i.e.* the Calabria district within continental Italy and the Island of Sicily;
- WI** - the western coast of Italy, washed by the Tyrrhenian Sea
- LS** - the Ligurian Sea;
- SP** - the coast of Spain;
- AF** - the coast of northern Africa.

The co-ordinates of the epicentres of earthquakes that generated tsunamis and their magnitudes for Greece and its vicinity are taken from the Greek sources [Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986], for the Near East — from the Ben – Menahem catalogue [1979], for Italy and its vicinity — from the Caputo and Faita catalogue [1982, 1984]. The tsunami intensities are estimated in accordance with the Sieberg – Ambraseys 6 – grade scale [Ambraseys, 1965a,b; Sieberg, 1923]. The estimates of intensity for tsunamis in

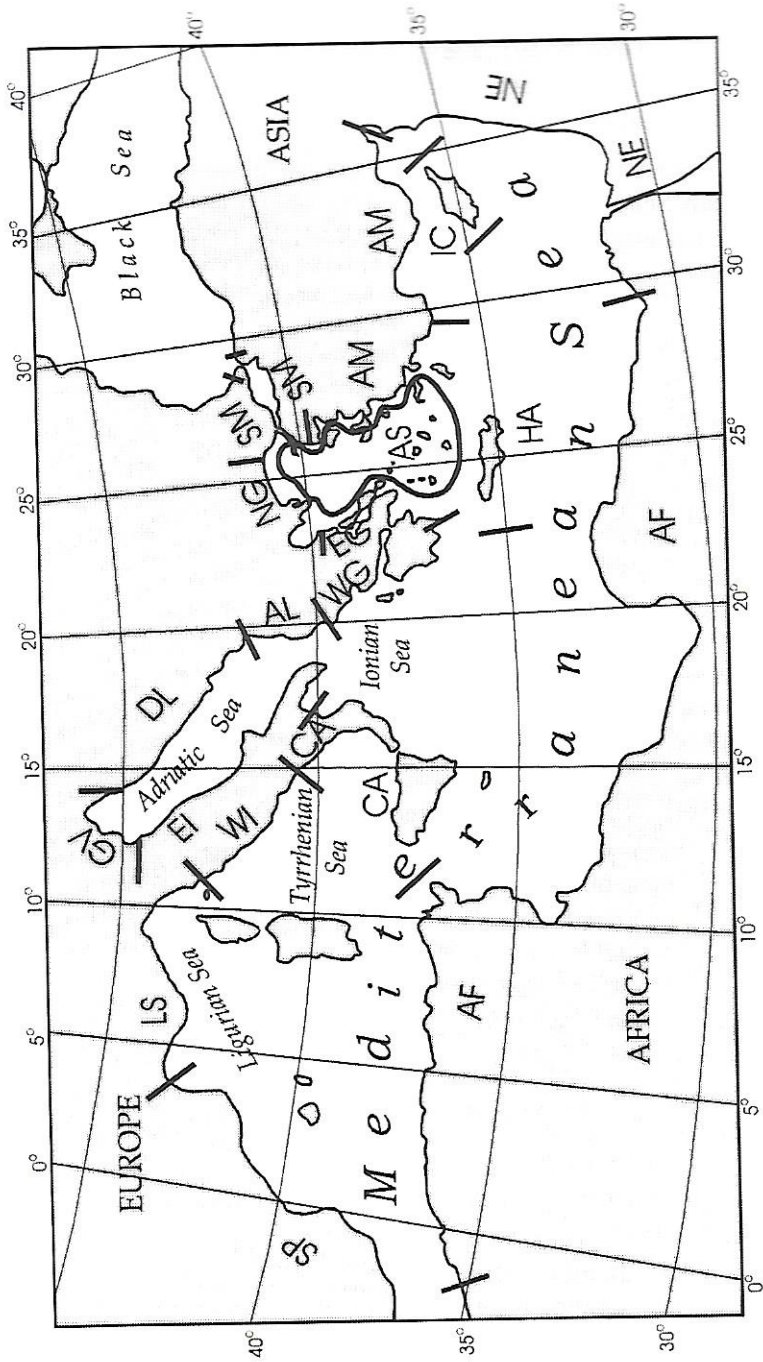


Figure 1. Zones of origin and manifestation of tsunami in the Mediterranean Sea



## CHARACTERISTICS OF THE SOURCE OF TSUNAMI GENERATION AND DESCRIPTION OF TSUNAMI

### ANCIENT TSUNAMIS

#### Second millennium B.C. AS.

According to excavated cuneiform texts on clay boards, a tsunami of intensity  $i = 6$  [?] occurred in Syria [Knudtzon, 1915; Virolleaud, 1935; Schaeffer, 1939, 1948; Antonopoulos, 1979, 1980a,b].

These writings most likely referred to the events of **1380 B.C.** ( $1380 \pm 100$ ) B.C., and to the period between 1700 B.C. and 1380 B.C. in accordance with other sources.

Aegean Sea, Island of Thira, Hellenic Arc, Island of Crete. The catastrophic eruption of the volcano of Santorini accompanied by earthquakes and a powerful tsunami. As a result of natural disasters, the potent Minoan Kingdom of the Late Bronze age ceased to exist on the islands of the Aegean Sea.

No eyewitness account of these events has reached modern times. The reconstruction of events is based on the data of marine and ground geology, geochemistry, archaeology, in combination with fragmentary allusions in annals and legends written considerably later.

Santorini belongs to the chain of Cyclades Islands crossing the southern part of the Aegean Sea in the sublatitudinal direction. It is situated 120 km to the north of the Island of Crete. Its caldera of a radius of 4 - 6 km is under water, with the exception of its edges rising above the water surface as three islands, the largest of which, Thira, closes the caldera from the east. Santorini is one of few active volcanoes in the Aegean Sea. It was formed 100 - 200 thousand years ago as a result of stretching of the Earth's crust and of subsidence of the future bed of the Aegean Sea. Repeated eruptions of the volcano are encountered in testimonies of contemporaries. At present, the caldera of the volcano has sunk to a depth of 370 m and is the deepest and most impressive caldera on Earth, but the volcano is assumed to have had a conical form 16 km

in diameter before the described eruption took place; the island it occupied was called Strongyli (Spherical).

Traces of formidable palaeoeruptions of a volcano have been revealed, during studies of the upper sedimentary layer of the sea - bed, about 10 m thick, in the eastern Mediterranean, in the form of two buried interlayers of tephra, *i.e.* volcanic ashes mixed with volcanic bombs, agglomerated coagulum of the same ashes [Ninkovich and Heezen, 1965]. The more extended lower interlayer does not quite reach the eastern coast of the Apennines Peninsula; its boundaries are about 1000 km away from the volcano; the upper interlayer occupies a lesser sea - floor space (the largest distance to the edges to the volcano is 700 km), but its thickness near the volcano is greater: up to 200 cm as compared to 20 cm in the lower layer. The chemical composition of tephra demonstrates that the ashes originated from Santorini. Apparently, clouds of ashes were lifted up to heights of 20 - 40 km, from where the ashes fell down to the sea surface and then for the most part settled down on the sea - bed. The peculiarities of the configuration of the interlayers, taking into account the predominant direction of winds above the Aegean Sea, allows one to suggest that the first gigantic eruption occurred in winter, the second in summer. Application of the methods of chemical analysis of isotopes has led to the conclusion that the first enormous eruption occurred earlier than 25,000 years ago, the second not earlier than 5,000 years ago. More accurately, the eruption has been dated at  $(1410 \pm 100)$  B.C. using the Carbon - 14 isotope inside the fragment of an ancient tree found under the ash layer on the present day Island of Thira [Ninkovich and Heezen, 1965]. An estimation of the age of this sample, performed later, by the same method resulted in the earlier date of the eruption and of the ashfall: between 1700 and 1620 B.C., most likely, in 1640 - 1620 B.C. [Antonopoulos, 1992].

The explosion of the volcano of Santorini and formation of the caldera completed the active phase of the volcano, lasting tens or, possibly, hundreds of years, which followed the very long period of rest. Analysing the form and painting of pottery, archaeologists relate the beginning of the volcano revival to 1550 B.C. At that time, the roughest, largest - sized ashes had been thrown out, and had formed the basis of the tephra layer.

At the turn of the 19th and 20th centuries, excavations began on the Island of Crete of the ancient civilisation centre — the Knossos settlement — which had been located near the modern main island city of Heracleon. They came up with phenomenal results: a rich royal palace was dug out with splendid wall paintings and rich decoration, which closely resembled in design the labyrinth known from the Greek legend on Theseus (of a later period). The palace was first covered with ashes and, later, buried under cultural layer. The well - known French seismologist De Montessus de Ballore [De Montessus de



Ballore, 1923, 1924] suggested that the destruction of the Minoan civilisation was caused by a series of strong earthquakes and devastating tsunami waves. In the thirties, the manager of archaeological excavations at Cyprus, the director of the National archaeological museum in Athens Sp. Marinatos, confirmed and updated the assumption that the most important harbours on the Island of Crete and, together with them, the whole Minoan culture had been ruined because of the powerful tsunami which originated from an explosion of the volcano of Santorini [Marinatos, 1939]. As a result of later excavations performed on the Island of Thira, a city housing system was revealed, from under a 30 - meter layer of volcanic ashes, that consisted of one - , two - and three - storey stone buildings of the Minoan age with excellent wall frescoes and with extremely rich utensils. These and other findings strengthened the hypothesis of Sp. Marinatos and his predecessors.

Observations of volcanic eruptions of in the world carried out during the last hundred years have revealed that if the layer of fallout ashes exceeds 10 cm, then harvests are lost and the soil becomes unsuitable for use for decades. Undoubtedly, a thick layer of ashes fell out in the central and eastern parts of the Island of Crete and on the Cyclades Islands, and only because of this disaster the inhabitants of the country had to abandon the inhabited sites leaving all their belongings.

The clarification of the Santorini palaeohistory has made it possible to assume the presence, on the island that existed before the explosion, of a prosperous city, namely Metropolis. Its suburbs were found during excavations on the Island of Thira. A bolder assumption, put forward by Galanopoulos [1957a], was that the submersion of this city under water gave rise to the legend of Atlantis.

The story of Atlantis was written in the 4th century B.C. by the philosopher Plato in his dialogues of Egyptian priests Critias and Timaeus based on the story written by Egyptian priests. Plato did not know the Egyptian language and had to employ an interpreter. The priests had said: "You do not know that the most excellent nation of all nations existed in your country. You trace your origin to it. But then great earthquakes and floods occurred, and in one day and one night all your soldiers fell through the earth, and the Island of Atlantis vanished under sea waters in the same way..." According to Plato's writings, the living conditions and organisation in Atlantis are very reminiscent of the Cretan - Mycenaean culture. Modern geological concepts do not provide grounds for searching for a city - state recently submerged somewhere in the Atlantic Ocean.

According to the version of Galanopoulos [1957a] and others, Plato made errors of a factor 10 in the translation of all the numbers (both concerning the dimensions of Atlantis and, also, the time of the catastrophe). If this assumption

is adopted, then the ancient Atlantis fits well into the caldera of Santorini, and the time of its catastrophe, in accordance with the Egyptian legends, coincides with the time of the explosion of Santorini derived from geological data. On the other hand, the plane relief of the legendary Atlantis is not consistent with the assumed conical form of the volcano of Santorini before its explosion.

In the late fifties, 5 - meter layers of white pumice, formed after the eruption of Santorini, as shown by chemical analyses, were revealed during archaeological explorations on the Anafi Island, situated 24 km to the east of the Island of Thira, at four sites investigated along the valleys of brooks at high altitude above sea - level [Marinos and Melidonis, 1961]. At the three sites on the western coast of the island, pumice was located at a height of 30 - 50 m and at a distance of 350 m from the coast, but at the apex of the funnel - shaped bay on the north - eastern coast, at a height of 250 m. The pumice that covered the surface of water after the eruption of the volcano was presumably deposited during the retreat of the tsunami wave. Some specialists expressed their doubts concerning the reality of the value of 250 m [Pararas - Carayannis, 1988, 1992], but one must always bear in mind that, for example, the great 1958 landslide in the Lituya Bay (Alaska) resulted in a splash of water of a height over 500 m [Soloviev and Go, 1975, 1984b].

At the northern and eastern coasts of the Island of Crete the water rose to a height of 12 m, in accordance with the estimations by J. Antonopoulos. Here, the cities of *Amnisos*, the harbour of the city of *Knossos*, *Gournia*, *Zakros*, *Katsamba* (ref.), *Nirou - Hani*, *Ianos*, *Palaiakastro*, *Kato Zakros*, *Malia*, *Psira* ceased to exist. Settlements suffered, also, on the southern shore of the island (in *Ay. Trias*\* (Triada ?) and *Thesta*), apparently, from the diffracted tsunami waves. Three of the four known palaces in the Minoan kingdom — in Kato Zakros, Malia and Thesta — were washed away; only the palace in Knossos, at present situated 5 - 6 km from the shore line, escaped destruction.

During excavations of Amnisos, Sp. Marinatos revealed that the lower floors of the house standing on the sea shore were filled up with pumice, stones, sand, while in the Villa of Frescoes situated just slightly higher than Amnisos the walls and corners of the building were destroyed in an unusual way: the walls became convex, as if they had been under the influence of outward pressure, the massive posts 2 m long and 1 m wide were broken out and, sometimes, carried away; Sp. Marinatos drew the conclusion that this was the consequence of the "suction" effect of the huge mass of retreating water. According to J. Antonopoulos, one can consequently assume that the velocity of the retreating flow of water was not less than 2.5 m/s.

In continental Greece, the strength of the tsunami waves was apparently weaker. In any case, the cities of Mycenae and Tyrinth, which were at elevated sites, underwent no harm and survived as centres of subsequent cultures.



The fields of floating pumice generated by the volcano were dispersed by streams far away from the volcano throughout the Aegean Sea, up to the faraway northern Island of Samothraki. These events are reflected in one of the legends of Ancient Greece: there was mentioned an island that had been seen in many places and that cruised all around the sea.

The destructive tsunami also reached the shore of Egypt: a papyrus survived that was related to the 18<sup>th</sup> dynasty of Pharaohs (between 1580 and 1350 B.C.). The following is said in it: "Chaos reigned around... During 9 days it was not possible to go out of palaces. These 9 days bore calamities and storms: no one, neither God nor man, could see the faces of each other... An unceasing boom... Cities have been destroyed..." Most likely, here, the ashfall which accompanied the eruption of Santorini is described together with the sound wave from the volcano explosion and the destruction of buildings, most probably, due to the tsunami impact. Apparently, recollections of the ashfall, previously unheard of, and of the great tsunami helped the Egyptian nations to remember the legend about the city of Metropolis itself submerged under the sea. "Water came from the north, rose as a huge flow and flooded the whole country".

Antonopoulos (manuscript materials) surmised that the well-known episode of the Exodus of Israelites from Egypt (presumably, in 1495 B.C.), described in the Bible, reflects an event that actually took place: the arrival of the Santorini tsunami on the coast of the Near East. The stretching before the Israelites suddenly dried out, and they safely passed over to the eastern coast. But when the Egyptians pursuing the Israelites came down to the dry sea - bed, the sea returned and swallowed up the soldiers and their 600 carts.

The general opinion is that the case in hand is the Red Sea. According to Antonopoulos a mistake was made during translations and it is more accurate to speak of the "sea of algae" ("reed sea"); large lagoons along the Mediterranean coast situated toward the east of the Nile comply fairly well with this definition: the Serbonis Lagoon, which is mentioned in connection with these events in an inscription on a board excavated in El Arîsh; the Manzala Lagoon, located immediately to the east of the city of Raamses (Tanis) built by the Israelites. The Serbonis Lagoon, with semi-salty water, was separated from the Mediterranean Sea by a long sand bar and was connected to it by a canal 1.5 - 3.0 km wide. (This assumption seems doubtful, because only in the English language the words "reed" and "red" are close in spelling).

More reliable evidence that the tsunami generated by the eruption of Santorini did reach the shores of the Near East, actually retaining its destructive force, was obtained during the geological exploration carried out in the region of the Syrian city of Ugarit, which used to be the capital of the ancient North - Phoenician state. A library of clay boards filled up with cuneiform was excavated. Scientists deciphered one of the poems with an account of how the

harbour and half of the city of *Ugarit* were washed out by a strong wave approximately in 1380 B.C. It is quite possible that precisely this date should be considered the most probable date for the paroxysmal eruption of Santorini and the tsunami that followed it.

As to the height of the tsunami on the shore of the Near East, a sea - carried pumice layer with the chemical composition corresponding to the eruption of Santorini has been found at several points on the shore of Israel, and, also, in postglacial sediments to the north of Jaffa (now Tel Aviv) on a terrace 7 m high [Pfannenstiel, 1960]. It is this value that one can take as the height to which the water rose on the shore of the Near East.

There is no doubt that the actual chain of events was a great deal more complex than the simple scheme presented above. Four stages embracing several centuries are distinguished in the development of the caldera. In this time interval not only one tsunami took place, apparently. The theory of the formation of powerful tsunami waves during the disintegration of volcanic constructions has not yet been developed. But it should nevertheless be noted that the grandiose events that occurred in the Aegean Sea in the Minoan age are very similar to the less significant, but also catastrophic, events related to the eruption of the Krakatau volcano in Indonesia on August 26, 1883 (the newly formed caldera of Krakatau is four times smaller than that of Santorini) [Marinatos, 1939; Galanopoulos, 1957a, 1961; Ambraseys, 1962; Marinatos and Melidoni, 1959, 1961; Ann. Bibl., 1964, Nos. 369, 385, 779, 875, 1409, 1693; Ninkovich and Heezen, 1965; Galanopoulos and Bacon, 1969; Pararas - Carayannis, 1973, 1974, 1988, 1992; Antonopoulos, 1979, 1980b, 1992; Heiken and McCoy, 1984].

S89, 90:  $i_{\max} = 10$  [?]. R.

### (1365 ± 5) B.C. AS, AM.

Aegean Sea, Asia Minor. According to writings of Demokles, Strabo and others, strong earthquakes in Asia Minor covered the Greek regions Ionia and Lydia, up to Troy. Many cities were wiped out in the north. Mt Sypilos (*ref.*) was destroyed. Marshes became lakes. The tidal wave flooded *Troy* [Ambraseys, 1962]. (Probably, these were the same events as in 1380 B.C.).

### 1300 B.C. [?]. AM.

Ionian and Aegean Seas [?]. References to tsunami along the shore of the Ionian Sea and in Asia Minor [Ambraseys, 1962].

AS62: Troy,  $i = 5$  [?]; PD93: M = 6 [?]; C89:  $i_{\max} = 5$ , P.



**760 B.C. NE.**

Levantine Sea, coasts of Israel and Lebanon. Possibly, tsunami. At *Amos* (*ref.*) i = 1 [?] [Ambraseys, 1962].

S89, 90:  $i_{\max} = 3$ , P.

**590 B.C. NE.**

Levantine Sea, Near East. Possibly, tsunami [Ambraseys, 1962].

AS62: *Sür*, i = 4 [?]; S89, 90:  $i_{\max} = 4$ , P.

**525 B.C. NE.**

Levantine Sea, Near East, **Saïda** [?]. Tsunami [Sieberg, 1932a,b; Ambraseys, 1962].

S89, 90:  $i_{\max} = 2 - 3$ , P.

**479 B.C., spring. NG.**

Aegean Sea, northern Greece, Chalkidiki Peninsula including Kassandra. After a series of defeats of the Persians in Greece, the Greek city of Potidaea, located at the base of the Pallene (Kassandra) Peninsula in the lowest place and blocking the entrance to the peninsula, rejected Persian rule. The Persian commander Artabaz besieged Potidaea, which was surrounded by sea. After three months of siege, a strong and persistent drop in the sea level set in. The Persians saw that the coastal sand - bank had become a marsh and advanced along the Pallene coast. When they had covered two fifths of the distance to **Pallene** through the marsh, huge sea flood began, such as had never occurred here, according to inhabitants, although high floods of tide had been observed quite often. Those who could not swim drowned, and others were killed by inhabitants of Potidaea, who rowed up to them. The tsunami wave devastated the city. Artabaz withdrew the surviving warriors to Thessaly and Macedonia [Carter, translation of Herodotus, 1962; Schmidt, 1881; De Montessus de Ballore, 1906; Galanopoulos, 1960b, 1961; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 373, 475; Papazachos and Papazachou, 1997; Papazachos *et al.*, 1986; Papadopoulos and Chalkis, 1984].

GP60a,b: 40° N, 23° E, I = IX; AS62: i = 3; PC, PZ: 39.7° N, 23.3° E, I = IX, M = 7; S89, 90:  $i_{\max} = 3$ , L.

**426 B.C. (possibly 425), summer. EG.**

Aegean Sea, eastern Greece. Island of Euboea, Gulf of Maliacus. Evidence provided by Thucides indicates that a series of earthquakes occurred in the regions of Attica, Boeotia, Euboea in the autumn of 427 B.C. during the fifth year of the Peloponnesian war, which caused the Spartans, who interpreted underground shocks as a bad omen, to abandon attempts to conquest Attica,

although their forces had already reached the Isthmus of Corinth. Especially strong shocks occurred in Orchomenos. Earthquakes continued till the summer of 426 B.C. The shocks weakened by summer and autumn to an extent that the Spartans renewed their military operations, even in the focal zone of the earthquakes (in the region of Heraclea). Several shocks in the summer and autumn of 426 B.C. occurred in the strait separating the Euboea Island from the continent.

The cities of Phalara\* (Stylis), Lamia, Larisa were completely destroyed as a result of a sole earthquake or a series of earthquakes. Terrible destruction took place in Heraclea (*ref.*). Skarfia, where 2,500 people were killed, suffered the same fate. The cities of Alope\*, Heraclea, Cynos, Opus, Echinos suffered serious damage. The fortress of Okum\* towering above Opus was broken down. The wall of the city of Elatia came down in parts. In Alponous\*, towers and walls in the harbour crashed, dragging many inhabitants down with them into the water [Jones, translation of Strabo, 1966 - 1970]. The walls and 700 houses nearest to the coast tumbled down in Oreon on Euboea Island. The Orobies (*ref.*) settlement (Rovies today) was also destroyed. Atalanti, Peparithos and Skopelos suffered damage, the walls of the city assembly hall and some houses were partly destroyed there.

As a result of the earthquake, the outflow of hot springs was interrupted at Aedeptos and Thermopyles for three days; they started flowing again later, but one of them in Aedeptos started gushing at a new place. Springs and rivers dried up everywhere for several days. The River Spercheios began to flow along a new course.

According to eyewitness Demetrios Kallatianos (*ref.*), a significant part of the **Lichades Island** and the **Cape Ceneaeon** (*ref.*) sank under water. The shore near **Orobies** (*ref.*) also sank and the coastal line shifted deep into dry land. The base of one of the peninsulas opposite the continental shore sank, and the Island of Atalanti appeared (Talantonissi) [Jones, translation of Strabo, 1966 - 1970; Crawley, translation of Thucides, 1952].

After one of the earthquakes, the sea in Orobies (*ref.*) retreated from the coastal line, but later on, coming back in the form of huge "swelling", it partly flooded the settlement, and this was repeated many times. According to Strabo, the waves flooded the shore three times, penetrating the continental coast of Greece 3 - 4 miles inland. Gullies in the vicinity of Tarfi, Thronium\*, Thermopyles and Daphus\* were flooded, and many settlements were destroyed. A similar flood took place on the **Atalanti Island**: here, waves caught up extremes and dragged them along the shore for more than 2 miles; another extreme was torn away from a moorage and smashed against the walls. The sea also retreated from the coast in **Peparithos** and **Skopelos**, too, but no flood accompanied this process. The wave was observed in **Opus** near Kiparissi. On



the eastern shore of Euboea Island no waves were observed. Judging from descriptions, a tectonic collapse occurred in the strait between the Euboea Island and the continent, resulting in great seiches. One must agree with Antonopoulos that possible local landslides of friable material were not the main cause of variations in the water level in the strait [Jones, translation of Strabo, 1966 - 1970; Crawley, translation of Thucydides, 1952; Schmidt, 1881; Krummel, 1911; Sieberg, 1932a; Heck, 1947; Galanopoulos, 1960a, b, 1961; Ambraseys, 1960, 1962; Papazachos *et al.*, 1986; Antonopoulos, 1992; Papadopoulos and Chalkis, 1984].

GP60a, 61: 38 3/4° N, 23° E, I = X; AP92: 38 3/4° N, 22 3/4° E; AS62: i = 5, Island of Euboea, Gulf of Maliaicus (Maliakos - *ref*) i = 4, Island of Skopelos i = 3; PC, PZ: 38.9° N, 22.7° E, I = XI, M = 7.1; S89, 90: i<sub>max</sub> = 4, L.

### 373 B.C., winter, night. WG.

Ionian Sea, Gulf of Corinth. A strong underground shock destroyed Boura and Helike, situated on the southern coast of the gulf. *Helike* was completely flooded with water and all its inhabitants were killed [Jones, translation of Strabo, 1966 - 1970; Schmidt, 1881; Pavlov, 1924; Sieberg, 1932b; Heck, 1947; Galanopoulos, 1960a; Ambraseys, 1960, 1962; Ann. Bibl., 1964, Nos. 373, 1523; Papadopoulos, 1998].

GP60a,b: 38° N, 22° E, I = XI; AS62: i = 5; CP82, PC, PZ: 38.3° N, 22.1° E, I = XI, M = 7.3; PD98: 38.2° N, 22.3° E, M ≥ 6.6, I = IX, i = 5; S89, 90: i<sub>max</sub> = 5, P.

### 330 B.C. AS.

Aegean Sea, Sporades Islands. It is said that the *Chrysi Island* together with the volcano of Moschylos disappeared as a result of an underground shock near the western shore of Limnos Island. Such a shock must have generated a strong tsunami [Galanopoulos, 1960b, 1961; Ambraseys, 1962; Ann. Bibl., 1964, No. 373].

GP60b, 61: 40° N, 25° E, I = IX; CP82: 40.0° N, 25.0° E, I = XI, M = 7.0; S89, 90: Q.

### 220 (possibly, 222 or 227) B.C. HA.

Aegean Sea, Island of Rhodes. A strong earthquake destroyed the lighthouse - statue of Colossus of Rhodes, the fortress and the landing pier. Presumably, tsunami waves originated that could have been observed on the northern shore of the *Islands* of *Rhodes* and *Tilos*; many ships were destroyed [Sieberg, 1932a; Galanopoulos, 1960b; Ambraseys, 1962].

GP60b, 61: 36° N, 28° E; CP82: 36.5° N, 28.2° E, I = X, M = 7.2; S89, 90: i<sub>max</sub> = 3, P.

### 198 B.C.

Eastern coastal area of Mediterranean Sea. Shortly after the appearance of a big comet an earthquake occurred that was accompanied by an overflow of the sea water [Cazolis, 1498; Ann. Bibl., 1964, No. 101].

### 138 B.C. NE.

Levantine Sea, Near East. After an earthquake the sea overflowed the shore between the cities of *Akko* and *Sūr*; i = 5 [Ambraseys, 1962; Ann. Bibl., 1964, No. 1523].

S89, 90: i<sub>max</sub> = 3, P.

### 58 or 57 B.C. AL.

Adriatic Sea, Albania. Tsunami in *Durrës* [Ambraseys, 1962; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986; Papazachos and Papazachou, 1997].

PZ: 41.5° N, 19.4° E, M = 6.6; S89, 90: i<sub>max</sub> = 3, P.



that "...the sea was violent and hostile". Excavations in *Pompei* allow the hypothesis that many citizens who ran to the sea coast, when escaping from the ashfall, were flooded by the arriving wave, carried by it up inland and buried under red - hot lava [Mallet, 1850-1858; Krummel, 1911; Baratta, 1931; Ann. Bibl., 1964, Nos. 47, 101; Antonopoulos, 1980a; Radice, translation of Pliny the Younger, 1972; Caputo and Faita, 1982, 1984].

CF82, 84: 40.48° N, 14.27° E, I = XI; S89, 90:  $i_{\max} = 4$ , L.

#### 120. SM.

Sea of Marmara. Tsunami in *Nicomedia* [Papazachos and Papazachou, 1997].

PZ97: 40.7° N, 29.1° E, M = 7.2,  $i_{\max} = 2$ .

#### 142 (148). HA.

Island of Rhodes. The town of *Rhodes* was destroyed by an earthquake, and its ruins were washed away by the wave that rushed in so quickly that the citizens suffering the earthquake had no time to find their relatives; the sea water penetrated deep into dry land for several miles ( $i = 4$ ). The towns on the islands of *Kos*, *Symi*, *Serifos* suffered from the earthquake ( $i = 3$ ) and tsunami [Ambraseys, 1962; Antonopoulos, 1980a; Papazachos and Papazachou, 1997].

GP61: 36° N, 28° E, I > VIII; CP82, PC, PZ: 36.7° N, 28° E, I = X, M = 7.0; PZ97: 36.3° N, 28.6° E, M = 7.6; S89, 90:  $i_{\max} = 4$ , L.

#### 177. CA.

Calabrian Arc, northern coast of Sicily. An extremely strong earthquake occurred. The sea ran high, a wave arose and swallowed up many cities [Mongitore, 1743; Baratta, 1901; Ann. Bibl., 1964, No. 76; Caputo and Faita, 1984].

CF82, 84: 38° N, 15° E, I = IX,  $i = 5 - 6$ ; S89, 90:  $i_{\max} = 6$ , P.

#### 258. WI.

Tyrrhenian Sea, Italy. An earthquake destroyed more than 1,000 houses in *Rome* and was accompanied by a high rise of water in the sea [Baratta, 1901; Ann. Bibl., 1964, Nos. 76, 99]; Caputo and Faita, 1984].

CF84: 42° N, 12 1/2° E, I = VIII,  $i = 4$ .

#### 262. HA.

Eastern coastal area of the Mediterranean Sea (Hellenic Arc [?]). A series of strong earthquakes in Asia Minor, on the Island of Rhodes and in Libya. The biography of Gallien states: "During the fifth consulatus of Gallien and Faustian a terrible earthquake was also added to many calamities of war... It

## CHARACTERISTICS OF THE SOURCE OF TSUNAMI GENERATION AND DESCRIPTION OF TSUNAMI

### 1st - 16th CENTURIES

#### 62 (possibly 46 or 66). AS.

Aegean Sea, Island of Thira. The eruption of the volcano of Santorini was accompanied by an earthquake felt strongly on the Island of Crete. Considerable destruction in Knossos. The sea in *Lebena* on the southern coast of the Island of Crete retreated approximately 100 m from the waterline [Schmidt, 1881; Sieberg, 1932a,b; Galanopoulos, 1960b; Ambraseys, 1962; Ann. bibl., 1964, No. 373].

GP60b, 61: 36 1/2° N, 25° E, I > VII or 35 1/2° N, 25° 1/2° E, I = IX; AS62:  $i = 4$ ; CP82: 36.4° N, 25.4° E, I = VIII, M = 6.7; S89, 90:  $i_{\max} = 3$ , P.

#### 76 (or 77). IC.

Levantine Sea, Island of Cyprus. A destructive earthquake. According to not very reliable data it was noted that the earthquake was accompanied by tsunami waves which were seen mostly on the south - western, southern and south - eastern coasts of the island: in *Kition*, *Paphos*, *Salamis* [Oberhammer, 1903; Sieberg, 1932b; Ambraseys, 1962, 1965a,b; Antonopoulos, 1980a; Ann. Bibl., 1964, No. 1144].

AS62:  $i = 4$ ; S89, 90: Q.

#### 79, August 24(23), 07<sup>b</sup>. WI.

Tyrrhenian Sea, Bay of Naples. The next day after the powerful eruption of the volcano of Vesuvius that completely covered with ashes the cities of Pompei, Herculaneum, Stabiae. A strong earthquake occurred with its focus, possibly, in the Bay of Naples. "It seemed that all houses did not shake, but fell down". Variations in the sea level arose.

An eyewitness of the events, the well - known Roman writer Pliny the Younger, wrote the following in a letter to the historian Tacitus concerning these events: "...we saw the sea retreating; it was as if the earth, shuddering, was pushing it away; the coast could be clearly seen to move forward; many sea animals got stuck on the dry sand". In another letter to Tacitus, Pliny mentioned



was dark for many days. The earthquake was accompanied by a loud roar, but not such as Jupiter's thunder (*i.e.* like the thunder during a thunderstorm), but coming from the Earth's interiors. The earthquakes swallowed up a great number of buildings together with their inhabitants; many people died of fright". In particular, nature raged in the cities of Asia Minor. The earth opened and water appeared in cracks. Many cities were flooded by the sea. Possibly tsunami. [Carpentin, 1880; Krummel, 1911; Ambraseys, 1962; Ann. Bibl., 1964, No. 179; Antonopoulos, 1980a].

AS62: i = 4 [?], P.

### 342. IC.

Island of Cyprus. The city of *Paphos* was completely destroyed by an earthquake. The harbour part of the city slid down into sea with all its constructions. Many small rivers changed their beds. Oberhammer supposed that tsunami waves were observed on the south - western, southern and south - eastern shores of the island and in the Bay of Famagusta after the earthquake [Oberhammer, 1903]. A check of the initial data demonstrated that this conclusion was wrong [Ambraseys, 1962, 1965; Antonopoulos, 1980a]; tsunami was observed on the shore of *Thrace*, i = 3 [Ambraseys, 1962, 1965a,b; Ann. Bibl., 1964, Nos. 1144, 1614].

S89, 90: i<sub>max</sub> = 3, Q.

### 348. NE.

Levantine Sea, Near East. A tsunami was observed on the *Arwad Island*, the *Syrian coasts* and in *Beirut* [Sieberg, 1932a; Ambraseys, 1962].

S89, 90: i<sub>max</sub> = 3, P/L.

### 362. NE.

Near East. Tsunami on the shore of the *Dead Sea*. On the coast of Jordan: waves, i = 3 [Sieberg, 1932b; Ambraseys, 1962; Ann. Bibl., 1964, No. 991; Antonopoulos, 1980a].

### 362 (possibly, 365, or 369, or 376). CA.

Calabrian Arc, *Sicily*. An earthquake destroyed many cities on the island and killed many people. The sea severely flooded the dry land [Baratta, 1901; Ann. Bibl., 1964, Nos. 76, 991; Caputo and Faita, 1984].

CF82, 84: 38° N, 15.5° E, I = IX, i = 4 - 5. (Most likely, the description relates to the events of June 21, 365).

### 365 (possibly 355; 358, August 24; 362; 369, 376, 425), July 21, before sunrise. HA.

Eastern part of the Mediterranean Sea, Hellenic Arc. A strong earthquake and a catastrophic tsunami with its source near the Island of Crete.

*Knossos*, *Gortis* and eight other settlements were destroyed on *Crete*. The tsunami wave started with a large drop in water level; ships were left high and dry; many sea animals were beached; citizens rushed to the exposed shore to pick up fish with their hands. About 15 minutes later a large wave appeared with a roar, sweeping everything in its path. This turned out to be unexpected for the many thousand people crowding the coast and resulted in their death. Broken ships were found 2 km from the coastal line on the *south - western shore of Peloponnesus* near *Methone*. Achaia and other districts (Boeotia, *Pipirus*) in the north of Peloponnesus were damaged. About 5,000 people were killed in Greece.

The earthquake was also felt in the north of Italy (in Verona, Bergamo, Mantua, Trevi and other cities). In the *northern part of the Adriatic Sea*, rivers flowed backwards; the sea retreated from the coastal line. Sailors testified that, as they navigated through the Mediterranean Sea, ships suddenly happened to go aground, but soon the water returned and they continued their voyages. The *coast of Sicily* was flooded.

Cities were damaged in Libya. In *Alexandria* (probably this was not Alexandria in Egypt, but Alexandria Troas in Asia Minor [Ambraseys, 1962]) the sea retreated to a great distance; big and small ships ran aground. Many people gathered to watch the spectacle. The ships were thrown over the coastal dam by the subsequent swift water roller; 700 people were killed according to chronicles, and about 5,000 — from other data.

The earthquake caused serious damage in Nicomedia near Constantinople. Sea waves were observed in *Asia Minor*.

In Malaga, Spain, the sea retreated far from the coastal line, returned later and threw ships over buildings; many citizens drowned. However hypotheses have been voiced that the July 21, 365 tsunami in *Malaga* was generated by an earthquake in the south of Spain [Mongitore; 1743; Perrey, 1850; Mallet, 1850-1858; Schmidt, 1881; Baratta, 1901; Dück, 1904; Krummel, 1911; Sieberg, 1932a,b; Ann. Bibl., 1964, Nos. 3, 76, 179, 186, 373, 396, 1614; Antonopoulos, 1980a; Morcira, 1988; Papazachos and Papazachou, 1997].

GP60a, 61: 35° N, 23° E, I = X; AS62: i = 4 in *Methone, Epidaurus*, on the *Island of Crete*, i = 3 on *shores of Boeotia, Epirus, the Adriatic Sea, Sicily, Alexandria*.

CF82, PC, PZ: 35.3° N, 25.7° E, I = XI, M = 8.0; AS62: 35 1/2° N, 23° E; CF82, 84: 35° N, 25° E, I = XI, i = 3; S89, 90: i<sub>max</sub> = 4, R.



**407, April. WI.**

Tyrrenian Sea, Island of Ischia near Naples. A strong earthquake. "The earth shuddered so that the cross of the Capitol crashed down to the ground. Many ships were wrecked and many corpses were carried out by waves to the coast of *Hebdomon*" [Grablowitz, 1903].

S89, 90:  $i_{\max} = 3 - 4$ , Q/P.

**426. EG.**

Aegean Sea, eastern Greece, Gulf of Euboea. An earthquake accompanied by tsunami waves [Jones, translation of Strabo, 1966 - 1970; Ann. Bibl., 1964, No. 1523].

S89, 90:  $i_{\max} = 4$ , L.

**447, November 8 (possibly 450, January; 454, September?). SM.**

Sea of Marmara, Straits of Dardanelles and Bosphorus. Earthquakes occurred in Constantinople over a period of four (or six) months. Inhabitants gripped by fear left the city, but nobody was killed. One of the earthquakes was destructive and was felt from Thrace in the north up to Troy in the south. The earth was cracked; the sea receded from the shore. The waves flooded many islands in the Sea of Marmara; fish were cast ashore. Sailing vessels ran aground when the water level receded [Perrey, 1850; Schmidt, 1881; Grablowitz, 1903; Ambraseys, 1962; Papazachos *et al.*, 1986].

AS62: the Sea of Marmara and the Strait of Dardanelles,  $i = 4$ ; *Constantinople*,  $i = 3$ ; CF82:  $40.2^\circ \text{N}$ ,  $28.0^\circ \text{E}$ ,  $I = \text{IX}$ ,  $M = 7.3$ ; S89, 90:  $i_{\max} = 4$ , L/R.

**542 (possibly 543, September 6), winter. SM.**

Region of the Sea of Marmara. An earthquake. Cyzicus was destroyed. In some places, the shore of *Thrace* was flooded for 3 - 4 km including *Odessus*, ( $i = 4$ ). The sea returned to its normal state after many people were killed and much damage done. Waves were observed in *Dionysioupolis* (*ref.*), *Aphrodesion* (*ref.*), in the *Gulf of Edremit*, in *Asia Minor* where many towns were flooded. There exists no reliable information on the preceding earthquake, but the values of its parameters are available:  $40.3^\circ \text{N}$ ,  $27.8^\circ \text{E}$ ,  $M = 6.8$  [Carpentier, 1880; Schmidt, 1881; Galanopoulos, 1954; Ambraseys, 1962; Jones, translation of Strabo, 1966 - 1970; Ann. Bibl., 1964, Nos. 186, 396, 1614; Papazachos *et al.*, 1986].

S89, 90:  $i_{\max} = 4$ , L/R.

**551 (possibly 552), spring or July 7. EG.**

Aegean Sea, eastern Greece, Strait of Euboea (between the Island of Euboea and the continent). The destructive earthquake embraced both coasts of the Gulf of Corinth, also. In the pleistoseismal zone, the earth opened and closed again, but part of the deformation of the Earth's surface was conserved including an upthrust system along the northern shore of the Gulf of Corinth. Patras, Nafpaktos, Corinth, Chaeronea and other towns were destroyed. There were thousands of victims, including 4,000 people in Patras. The same area as during the earthquakes on October 12, 1856, and on August 1, 1860, was shaken. In the apex of the Gulf of Maliacus, the sea suddenly rushed up the dry land and reached far inland destroying buildings in Echinus, Tarfi and in Boeotia. According to other sources the tsunami started with the drop in water level. After the water went away, fish, including rare specimens, were left stranded. The low water lasted so long that citizens had time to reach the islands located in the apex of the bay [Schmidt, 1881; Sieberg, 1932b; Ambraseys, 1961, 1962; Galanopoulos, 1960b, 1961; Ann. Bibl., 1964, No. 373; Antonopoulos, 1980a; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986].

GP60b, 61:  $38.3^\circ \text{N}$ ,  $22.30^\circ \text{E}$ ,  $I = \text{XI}$ ; AS62:  $i = 4$ ; CP82, PD93, PZ:  $38.4^\circ \text{N}$ ,  $22.3^\circ \text{E}$ ,  $I = \text{X}$ ,  $M = 7.1$ ; S89, 90:  $i_{\max} = 4$ , P

**551, July 9. NE.**

Levantine Sea, Near East. A tsunami occurred in *Botrys* near Jubeil (Byblos), *Beirut*, *Tripolis* (Tarābulus esh Sham). It started with the sea retreating by 1 km. Tidal waves destroyed many houses. It is possible that this and the preceding description are related to the same event [Schmidt, 1881; Sieberg, 1932a,b; Kallner - Amiran, 1951, 1952; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 186, 735].

AS62:  $i = 3$ .

**554, August 15. AS.**

Aegean Sea, Island of Kos. A destructive earthquake occurred on the island and on the south - western shore of Asia Minor. It was felt up to Constantinople, Mesopotamia, Alexandria; considerable areas suffered great losses. Many houses, temples, city walls were destroyed; many people were killed. Destruction was reported from Palestine, Araby and other regions. Underground shocks lasted 40 days and nights.

This caused a tsunami. The water receded from the coast for a distance of 2 km (according to other data, 2 miles), and then it flooded the coasts for a distance of 1 km. Many ships were wrecked; many sea animals and fish perished. Waves were possibly observed on the shore of Syria. On the *Island of*



*Kos* and in the *Gulf of Antalya*  $i = 4$ ; on the Islands of *Southern Sporades*  $i = 2 - 3$  [Düek, 1904; Sieberg, 1932a,b; Mihailovič, 1933; Galanopoulos, 1960b; Ambraseys, 1961, 1962; Ann. Bibl., 1964, Nos. 186, 278, 396, 1485, 1614; Antonopoulos, 1980a].

GP60b, 61:  $36\frac{1}{2}^\circ$  N,  $27\frac{1}{2}^\circ$  E,  $I = XI$ ; AS62:  $i = 4$ ; CP82, PC:  $37^\circ$  N,  $27.7^\circ$  E,  $I = X$ ,  $M = 7.0$ ; PZ97:  $36.8^\circ$  N,  $27.3^\circ$  E,  $M = 7.0$ ,  $I = X$ , Island of Kos; S89, 90:  $i_{\max} = 4$ , L.

#### 558, October 11 (December 14). SM.

*Sea of Marmara, Strait of Bosphorus*. Tsunami [Ambraseys, 1962; Papazachos and Papazachou, 1997].  
PZ97: December 14,  $40.9^\circ$  N,  $28.8^\circ$  E,  $M = 7.0$ ,  $I = IX$ , Constantinople; S89, 90: P.

#### 740, October 26, 08<sup>h</sup>. SM.

Zone of the Sea of Marmara. A strong earthquake occurred in Thrace and in Constantinople that destroyed many houses, temples, monasteries. Inland fortifications collapsed; statues fell down from public buildings. A great number of people were killed. The earthquake was also destructive in Izmit. Underground shocks lasted 11 months. The sea receded from the coast in many places, soon came back and flooded cities;  $i = 3$  on the *Thracian coast* of the Sea of Marmara and in *Izmit* [Perrey, 1850; Mihailovič, 1933; Düek, 1904; Davison, 1936; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 179, 186, 1485, 1614; Papazachos *et al.*, 1986].

AS62:  $i = 3$ ; CP82:  $40.7^\circ$  N,  $29.3^\circ$  E,  $I = X$ ,  $M = 7.3$ ; PZ97:  $41.0^\circ$  N,  $28.7^\circ$  E,  $M = 7.6$ ; S89, 90:  $i_{\max} = 3$ , L.

#### 746 (possibly 743, 745), January 18. NE.

Levantine Sea, Near East. A destructive earthquake in Syria. Ships were lost near the coast, possibly because of a tsunami. Waves were observed in *Lebanon* and *Egypt* [Sieberg, 1932a,b; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 308, 309; Antonopoulos, 1980a].

AS62:  $i = 3$ ; S89, 90:  $i_{\max} = 3$ , P/L.

#### 792 (possibly 793), April 30. GV.

Adriatic Sea, Gulf of Venice. A strong earthquake enveloped the gulf and the north-eastern shore of the Adriatic Sea — in Istria and Dalmatia. From other data, a huge sea wave following a disastrous earthquake in the regions of *Friuli* and *Istria*, came upon the coast and devastated it; the shore of the Gulf of Venice was flooded.

During the earthquake, the sky in the direction from Dalmatia to Istria assumed a bright flame-like red colour, long flame-coloured stripes appeared. The sea overflowed its shores, with the result that buildings were destroyed and lives were lost.

In the catalogue by Caputo and Faita [1984] a supposition was made that the tsunami was caused by the April 30, 793 (or 792) earthquake with its epicentre at  $45.5^\circ$  N,  $11^\circ$  E, *i.e.* located near Verona, and with a maximum intensity  $I = IX$ . In the papers by Radics [1902] and Guidoboni and Tinti [1989] it is demonstrated that this earthquake is extremely questionable and, apparently, it was introduced into the literature by one of the medieval chroniclers in 1596 to explain why the city walls collapsed in Verona. In the paper, a proposal was made that the tsunami was possibly caused by the February, 792 earthquake with a maximum intensity  $I = VIII$ , mentioned in the catalogue of Slovenian earthquakes [Ribarič, 1982]; however these data are also not very reliable [Von Valvasor, 1689; Radics, 1902; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 1284, 1679; Caputo and Faita, 1984].

CF82, 84:  $45\frac{1}{2}^\circ$  N,  $11^\circ$  E,  $I = IX$ ,  $i = 5 - 6$ ; AS62:  $i = 3$ ; S89, 90:  $i_{\max} = 2 - 3$ , Q.

#### 859 (possibly 861), November. NE.

Levantine Sea, Near East. A strong earthquake occurred on the coast from Antiochia to Akko. Large rockfalls and landslides. In the region of Samandagi (some references give Akko), the sea receded and then flooded the coast [Heck, 1947; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 52, 308, 309; Antonopoulos, 1979, 1980a].

AS62:  $i = 3$ ; S89, 90:  $i_{\max} = 3$ , P.

#### 881 - 882 (the correct date is not known; erroneously 811). NE.

A tsunami in Palestine and in Egypt was observed according to certain data. A tidal wave was observed in *Akko*. The sea level rose in *Alexandria*, and ships were cast ashore. *The Nile* overflowed its banks and washed ashore wooden barges moored at the river bank [Tholozan, 1879; Willis, 1928; Sieberg, 1932a,b; Kallner - Amiran, 1951, 1952; Ann. Bibl., 1964, No. 375].

AS62:  $i = 3$ ; S89, 90:  $i_{\max} = 3$ , P.

#### 963, July 22. CA.

Sicily. A strong earthquake. Many cities and villages were destroyed, ploughed fields were ruined. The sea flooded dry ground, and thousands of inhabitants perished [Mongitore, 1743; Baratta, 1901; Ann. Bibl., 1964, Nos. 76, 991; Caputo and Faita, 1984].

S89, 90:  $i_{\max} = 5 - 6$ , L.



**975, October 26. SM.**

Sea of Marmara, Strait of Bosphorus. Tsunami on the *Thracian coasts* and in *Constantinople*,  $i = 3$  [Düek, 1904; Ambraseys; 1962; Ann. Bibl., 1964, No. 278; Antonopoulos, 1980a].  
S89, 90:  $i_{\max} = 3$ , P.

**1034, January 4; 1032, March 6; 1039; 1035, May. NE.**

Levantine Sea, Near East. A strong destructive earthquake occurred in the vast region from Syria in the north - east to Egypt in the south - west. Half of the city of Nablus and one third of the city of Ramallah were destroyed. In Jerusalem, walls were destroyed, the temple was badly damaged, other buildings suffered damage. In Gaza the mosque and the light - house were damaged, heavy damage was caused in Ashkelon.

After one or several earthquakes the sea retreated from the shore and returned swiftly. Tidal waves were observed in *Gaza* and in *Ashkelon*. The seaport of *Akko* became dry for a long time, then it was half destroyed by a wave [Willis, 1928; Perrey, 1850; Sieberg, 1932a,b; Kallner - Amiran, 1951, 1952; Ambraseys, 1961, 1962; Ann. Bibl., 1964, Nos. 3, 735; Antonopoulos, 1980a].

AS62:  $i = 4$ ; S89, 90:  $i_{\max} = 4$ , P.

**1039, February (January) 2. SM.**

Zone of the Sea of Marmara. Smyrna became a terrible spectacle, because the most beautiful buildings collapsed and many people were killed. A tsunami in *Constantinople* is mentioned [Düek, 1904; Ambraseys, 1962; Ann. Bibl., 1964, No. 278; Antonopoulos, 1980a; Papadopoulos and Chalkis, 1984; Papazachos and Papazachou, 1997].

PZ97: 38.4°N, 27.3°E,  $M = 6.8$ ,  $I = VIII$ ; S89, 90: Q.

**1050. AS.**

Aegean Sea, Island of Thira. Small tsunami caused by underwater eruption of the volcano of *Santorini* [Heck, 1947; Ambraseys, 1961, 1962; Antonopoulos, 1980a].

**1065, September 23. SM.**

Zone of the Sea of Marmara. A destructive earthquake in Constantinople was accompanied by sea waves of huge dimensions that devastated *Nicolidea*, the *Princes Islands*, *Constantinople*, *Nicaea* [Mihailović, 1933]. No reference to the tsunami is found in any other catalogue.

**1068 (possibly 1067, 1069), March 18. NE.**

Levantine Sea, Near East. A strong earthquake in Palestine, that also extended over Egypt and Syria. In *Ramallah*, it seems, 25,000 citizens were lost. Tsunami in *Holon* (Holots - ref.), *Ashdod*, *Yavne*. Sea receded far away from the coast, and people rushed to gather fish left on the dry ground. When the subsequent tidal wave arrived many people were killed. Considerable damage was done [Perrey, 1850; Tholozan, 1879; Kallner - Amiran, 1951, 1952; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 4, 51, 52, 735; Antonopoulos, 1980a].

AS62:  $i = 4$ ; S89, 90:  $i_{\max} = 4$ , L.

**1106, March. GV.**

Adriatic Sea, Gulf of Venice, *Malamocco* (it was on the island of the same name formed by silt deposits and located at the south entrance of the Gulf of Venice). According to descriptions of eyewitnesses, the town found itself almost submerged as a result of the earthquake and the floods accompanying it. "The sea, as if moved off from its bed, gushed out onto coasts penetrating threateningly into all the sea ports and through all the openings of the lagoon and flooded everything. Most houses were overturned, many pavements along canals were damaged. The whole island was engulfed by currents of water". [Baratta, 1901; Montandon, 1953; Ann. Bibl., 1964, Nos. 76, 183, 228, 1336]. In other sources, it is added that the earthquake was also felt in Venice. In the article by Feliziani and Marcelli [1965], the intensity of the earthquake is estimated as  $I = VIII$ , the magnitude as 5.3 [Caputo and Fatta, 1984].

In the article by Guidoboni and Tinti [1989], it is noted that no Venetian source of this epoch contains information on the earthquake. Such information is found for the first time only in the 14th century in a description by the well - known historian Andrea Dandolo, which is most likely erroneous. In the opinion of the authors of the paper, the flood on the Malamocco Island was not caused by the earthquake, but by an intensive transgression of the Adriatic Sea, that occurred at the beginning of the 12th century, in combination with sea storms and high tides. The authors of the paper consider that the event should be excluded from the list of tsunami [Baratta, 1901; Ann. Bibl., 1964, Nos. 76, 183, 228, 1336; Feliziani and Marcelli, 1965; Caputo and Fatta, 1984; Bedosti and Caputo, 1987].

CF82, 84: 45°28' N, 12°20' E,  $I = VIII$ ,  $i = 6$ ; S89, 90:  $i_{\max} = 3$ , W.

**1112, June 20. WI.**

Tyrrhenian Sea, Bay of Naples. Near the foot of Vesuvius, the sea receded from the coast by 200 yards (no information was reported on the



eruption of the volcano) [Mercalli, 1897; Caputo and Fatta, 1984; Bedosti and Caputo, 1987].

BC87: 40° N, 14° E, I = IX; S89, 90:  $i_{\max} = 3 - 4$ , P.

#### 1109 (possibly 1135, 1157, 1183, 1186), February 4. CA.

Calabrian Arc, Strait of Messina. A destructive earthquake occurred on the Island of Sicily and in Calabria. Catania and Lentini were destroyed. Cathedrals crashed down in Catania and Syracuse. 15,000 citizens were lost under the wreckage of buildings. Cosenza was partly destroyed. In *Messina*, the sea first receded from the coast, then, some time later, overflowed the coast line, gushed out onto dry land, surged up to the walls and penetrated into the town through the gate [Mongitore, 1743; Beryyat, 1761; Baratta, 1901; Ann. Bibl., 1964, Nos. 76, 101, 991, 1338; Caputo and Fatta, 1984; Bedosti and Caputo, 1987].

CF82, 84: 37°30' N, 15°20' E, I = XI,  $i = 4 - 5$ ; BC87: I = IX; S89, 90:  $i_{\max} = 4 - 5$ , L/R.

#### 1169, February 11. CA.

Calabrian Arc. Part of the volcano of Etna collapsed in the direction of Taormina; the sea in Messina stormed. A tsunami was observed on the coast of the Ionian Sea [Bedosti and Caputo, 1987].

#### 1172. CA.

Calabrian Arc, Island of Sicily. The sea bed became dry after an earthquake, many lives were lost [Mongitore, 1743].

#### 1202 (possibly, 1222), May 22, morning (at sunrise). NE.

Levantine Sea, Near East. A destructive earthquake in Palestine with its focus, possibly, near Nablus where no single wall remained intact. Even the foundations of walls did not remain in whole Beit Jala — everything was mixed up with earth. Most cities in the province of Hauran were completely destroyed. Yirka and Tyre were razed to the ground.

In the mountains of Lebanon, two peaks guarding a gorge seem to have been drawn together, and, as a consequence, all citizens (about 200 people) perished. Peaks "swung in different directions", and it seemed to everyone that Judgement Day was arriving. In Damascus the earthquake lasted so long that one could read the story from the Koran about "A cave". The oldest men in the town had never felt anything similar. Many dwelling houses and the hospital collapsed; people were killed under the rubble. One of the minarets and 16 merlons of the city wall crumbled down. Another minaret cracked. Fortresses in

Hamah and Baalbek were damaged. No significant destruction occurred in Jerusalem.

In Cairo, the earthquake was prolonged and so strong that all citizens were afraid. The shocks were like the movements of the wings of a bird landing or flying up. Beams and roofs cracked, doors opened. Destruction threatened buildings which were ramshackle or high, or located on high places.

The earthquake inflicted much damage on the Island of Cyprus, in Paphos, in Nicosia, in Limassol. In Paphos, a church collapsed during a service.

The area where the earthquake was felt embraced all Syria, Egypt up to Alexandria and Cush, a part of Mesopotamia, the southern part of the Sporades Islands. The earthquake was accompanied by numerous underground shocks including destructive ones.

Near the coast of Syria, after the earthquake, the water in the sea opened slightly in various places and was divided into hill-like masses, ships found themselves on dry ground; a great number of fish were thrown out on the shore. On the Island of Cyprus a harbour in *Paphos* was dried, after which the city was flooded also, like *Limassol*, also [De Sacy, 1810, translation of Abd - Al - Latif, 1202; Oberhummer, 1903; Sieberg, 1932a; Ambraseys, 1962, 1965b; Ann. Bibl., 1964, Nos. 1, 1144; Antonopoulos, 1980a, 1990].

AS62: the *shore of Syria*,  $i = 5$ , the *Island of Cyprus*,  $i = 4$ , Egypt,  $i = 3$ ; S89, 90:  $i_{\max} = 5$ , P.

#### 1265, August 11. SM.

Sea of Marmara. Tsunami on the *Island of Proconnesus* [Papazachos and Papazachou, 1997].

PZ97: 40.7° N, 27.4° E, M = 6.6,  $i_{\max} = 2$ .

#### 1273, September (March). AL.

Adriatic Sea, Albania, *Durrës* (*Durrachium - ref.*). Tsunami [Schmidt, 1881; Ambraseys, 1962; Antonopoulos, 1980a; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986].

AS62:  $i = 3$ ; CP82, PC, PZ: 41.3° N, 19.7° E, I = IX, M = 6.5; S89, 90:  $i_{\max} = 3$ , P.

#### 1303 or 1304, August (December) 8, morning. HA.

Eastern part of the Mediterranean Sea. A catastrophic earthquake. Many castles on the Island of Crete collapsed. The town of Rhodes on the island of the same name was destroyed almost completely. Akko suffered in Palestine, Damascus, Zefat (Safad — *ref.*) — in Syria (now in Israel), one half of the latter was destroyed. All buildings without exception in Cairo were damaged; many houses and mosques collapsed. The cities of Coronea, Methone and



others on the Peloponnesus Peninsula suffered seriously. It was felt very weakly in Constantinople and, possibly, in Venice.

On the Island of Crete, the sea rushed toward *Candia (Heracleon - ref.)* with such a force that many buildings were broken down and many people were killed. Shortly after, the sea receded, and the harbour became dry. In *Akko*, the sea receded far off, more than one mile, uncovering the bottom, on which there happened to be many lost goods, and then flooded the coast with force. The sea retreated drying up the bottom for hundreds of yards in many harbours of *Syria, Lebanon, Palestine*. In *Alexandria*, the sea level rose, and it threw up a French ship onto the coast, together with many fish and sea animals and fragments of the city walls. The level of *the Nile* varied widely; ships sailing in the middle of the river and lying at anchor were thrown up onto the banks 15 m inland. The tsunami was observed on the *Island of Rhodes*, on the *south - eastern shore of Peloponnesus*, in the Adriatic Sea [Ambraseys, 1962, 1965a; Ann. Bibl., 1964, Nos. 51, 870; Antonopoulos, 1980a; Caputo and Fanta, 1982, 1984; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986].

AS62: *Egypt*,  $i = 5 - (3?)$ ; *Syria*,  $i = 4$ ; the *Island of Crete*,  $i = 4$  [?]; *Peloponnesus* and the *Island of Rhodes*,  $i = 3$ ; the Adriatic Sea,  $i = 3$  [?].  
CF82: The *shore of the Adriatic Sea*,  $i = 3 - 4$ . CP82, PC, PZ:  $36.3^\circ \text{N}$ ,  $27.3^\circ \text{E}$ ,  $I = \text{XI}$ ,  $M = 8.0$ . PZ97:  $36.1^\circ \text{N}$ ,  $29.0^\circ \text{E}$ ,  $M = 8$ ; S89, 90:  $i_{\text{max}} = 4$ , L.

### 1321. GV.

Adriatic Sea, Gulf of Venice. According to contradictory data, the earthquake occurred in Venice, damage was done. The city was flooded (without any reason given) [Mallet, 1850-1858; Montandon, 1953; Caputo and Fanta, 1984].

CF82, 84:  $45^\circ 25' \text{N}$ ,  $12^\circ 20' \text{E}$ ,  $I = \text{VIII}$ ,  $i = 3 - 4$ .

### 1329, June 28 (possibly 23). CA.

Calabrian Arc, Island of Sicily, the eastern coast. Etna began to erupt approximately at  $23^{\text{h}}$ . Extremely strong shocks caused destruction or damage in settlements. On the shore opposite *Mascali*, a number of boats pulled up on the shore were carried away into the sea, possibly because of its sudden receding [Mongitore, 1743; Baratta, 1901; Ann. Bibl., 1964, Nos. 76, 991; Caputo and Fanta, 1984].

CF82, 84:  $37^\circ 50' \text{N}$ ,  $15^\circ \text{E}$ ,  $I = \text{VIII}$ ,  $i = 3 - 4$ ; S89, 90:  $i_{\text{max}} = 3$ , P.

### 1332 (1331), February 12. SM.

Zone of the Sea of Marmara, *Constantinople*. An earthquake accompanied by huge sea waves took place. According to a description by Nicephoros Gregoras, "sea waves higher than mountains flooded the eastern

walls of Byzantium and forced them from the earth; waves went under the city gate and opened it; they flooded and overturned houses inside the city walls". According to Antonopoulos, this description is not necessarily of a tsunami, but one of storms in Constantinople [Perrey, 1850; Mihailovič, 1933; Ambraseys, 1962; Antonopoulos, 1979, 1980a, 1990].

AS62:  $i = 3$ ; PZ97: year 1331,  $40.9^\circ \text{N}$ ,  $28.9^\circ \text{E}$ ,  $M = 6.8$ ,  $I = \text{VIII}$ ; S89, 90:  $i_{\text{max}} = 3+$ , P.

### 1343, November 25. WI.

Tyrrhenian Sea, Italy, Bay of Naples. Underground shocks in Naples caused significant damage, according to some data, and lives were lost. Ships in the sea port were destroyed [Magnati, 1946; Caputo and Fanta, 1982, 1984; Bedosti and Caputo, 1987].

CF82:  $i = 4$ ; S89, 90:  $i_{\text{max}} = 4$ , P.

### 1344 (possibly 1331, 1332, 1334, 1342, 1343), February 12 (October 14, 18). SM.

Zone of the Sea of Marmara, Strait of Bosphorus. An earthquake with its focus on the western shore. Destructions in Constantinople. The earthquake was felt in Kherstonisos and Lysimachia, on the shore of the Gulf of Saros.

Huge sea waves caused significant damage on *the western coast of the Sea of Marmara*. They flooded the shore of *Thrace* at a great distance, for a mile in some places. The water went under the fortress gate in *Constantinople*, knocking it down and flooding the houses inside the fortress. Several ships that were in the harbour or had been sailing along the coast were taken up by a wave and smashed against the sea shore. Many people, reserves of food and goods were lost. Receding back to usual limits, the sea left a lot of mud and dead fish on the dry land; some sources mentioned waves on the shore of Syria [Perrey, 1850; Dück, 1904; Lambros, 1914; Heck, 1947; Montandon, 1953; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 278, 813; Antonopoulos, 1980a; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986; Papazachos and Papazachou, 1997].

AS62:  $i = 4$ ; CP82, PC:  $40.8^\circ \text{N}$ ,  $28.8^\circ \text{E}$ ,  $I = \text{X}$ ,  $M = 6.9$ ; PZ97: year 1343, October 18,  $40.8^\circ \text{N}$ ,  $28.3^\circ \text{E}$ ,  $M = 7.5$ ,  $I = \text{VIII}$ ; S89, 90:  $i_{\text{max}} = 4$ , L/R.

### 1348 (1342, 1343, 1345), January 25, about 23<sup>h</sup>. GV.

Adriatic Sea, Gulf of Venice. A destructive earthquake occurred in Gorizia, Friuli, Treviso, Belluno. It extended up to Verona, Vicenza and Lombardy, and was felt in Pisa and in Dalmatia. In *Venice*, the bottom of the Canal Grande became exposed. Tsunami? [Baratta, 1901; Caputo and Fanta, 1982, 1984].



CF82, 84: 46° 36' N, 13° 50' E, I = XI, i = 3 - 4; S89, 90:  $i_{\max} = 3$ , P.

### 1365, January 2. AF.

Alboran Sea, Algeria. The earthquake destroyed the town of Algiers almost completely; most of the town fell down, and so many people were killed that the Berber tribes were able to occupy it. The earthquake was accompanied by approximately one hundred shocks during the night, further shocks causing no damage were felt in the town over the next year. The sea waves originated after the earthquake and flooded part of the town [*Algiers*] up to a significant height. People were drowned [Ambraseys and Vogt, 1988; Yelles Chaouche, 1991].

### 1389, March 20. AS.

Aegean Sea, Island of Chios and Asia Minor. A destructive earthquake occurred and embraced a large area. The greater part of the fortress Chios was destroyed. The earthquake was felt in Asia Minor, in particular, in Izmir.

The tsunami wave ran against the eastern half of the *Island of Chios* and caused great damage flooding half of the market square in the town of Chios. Strengthening of the wave was noted when it passed through the narrow strait between the island and Asia Minor. The wave caused destruction in *Izmir* and in the small fortress of *New Phocaea* (Yeni Foça) [Lambros, 1914; Heck, 1947; Galanopoulos, 1954, 1960b, 1961; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 378, 813, 1343; Antonopoulos, 1980a; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986].

GP60,61: 38 1/4° N, 26 1/4° E, I = X; AS62: i = 3; CP82, PC, PZ: 38.4° N, 26.3° E, I = IX, M = 6.8; S89, 90:  $i_{\max} = 3$ , P.

### 1402, June. WG.

Gulf of Corinth. Tsunami on the *western shore of the Gulf of Corinth* [Papazachos and Papazachou, 1997]

PZ97: 38.11° N, 22.41° E, M = 7.0,  $i_{\max} = 5$ .

### 1403 (1402), November 16. AM.

Aegean Sea, Asia Minor, the south - eastern shore, (and the Near East [?]). The earthquake caused significant damage; mountains collapsed. Near the shore of Syria and Palestine, the sea receded by more than one mile, and then returned to its usual limits with a great rush [Perrey, 1850; Willis, 1928; Sieberg, 1932a; Heck, 1947; Kallner - Amiran, 1951, 1952; Ambraseys, 1962; Ann. Bibl., 1964, No. 735; Antonopoulos, 1980a].

AS62: i = 3; S89, 90:  $i_{\max} = 3$ , P.

### 1456 (possibly 1450, 1457), December 4, between 20<sup>h</sup> and 21<sup>h</sup>. WI.

Tyrrhenian Sea, Italy, Bay of Naples. A catastrophic earthquake embracing mostly the mountainous regions of the Apennines Chain continued for approximately 6 min. About 25,000 people were killed. The characteristics of the consequences for different regions are the following: Acquaviva was razed to the ground, Apice was destroyed completely, between 500 and 2,400 people were killed; Ariano was destroyed almost completely, between 600 and 2,200 citizens were killed; 2,000 people were killed in Barberio; Biocari was wiped out, Isernia was heavily destroyed, there were about 1,200 victims; Campobasso was destroyed completely, there were very many victims; Casalduni was wiped out, there were a very great number of victims; Lafino\* was destroyed completely, over 1,000 people were killed; Cerreto Sannita was razed to the ground, over 400 people were killed; Acerenza was razed to the ground, 1,200 inhabitants were killed.

In the *Bay of Naples*, the sea was so rough that people on the coast "felt as if they were being attacked by thousands of devils", and people on ships and galleys felt as if they were doomed [Baratta, 1901; Ann. Bibl., 1964, No. 76; Caputo and Fatta, 1984; Bedosti and Caputo, 1987]. Most likely, it was a seaquake.

CF82, 84: 41° 18' N, 14° 42' E, I = XI, i = 3 - 4; S89, 90:  $i_{\max} = 4$ , V/P.

### 1481, May 3, night (also March 15, May 5, 12, October 3, December 18). HA.

Hellenic Arc, Island of Rhodes. The strong earthquake caused destruction in the town of *Rhodes*; many people were killed.

Numerous aftershocks were felt till the second half of 1482. Then, the sea rose over 3 m (from other data 1.8 m) and gushed onto the shore. Mooring lines of a big ship lying in the harbour were torn; a ship ran on a reef and was lost with all its crew when the water receded. The damage done by the tsunami waves was greater than the damage caused by the earthquake [Schmidt, 1881; Sieberg, 1932a,b; Ambraseys, 1962; Galanopoulos, 1960a, 1961; Ann. Bibl., 1964, No. 210; Antonopoulos, 1980a; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986].

GP60a: 36° N, 28° E, I = IX, i = 3; AS62, AP80, 90, PC, PZ: 38.2° N, 28.5° E, I = X, M = 7.1; S89, 90:  $i_{\max} = 3$ , P/L.

### 1494, July 1, 16<sup>h</sup>. HA.

Hellenic Arc, Island of Crete. The strong earthquake shook the island. Much damage was done in *Heracleon*, dwelling houses and the bell towers of churches were damaged. In the harbour, great waves tore ships off their anchors and knocked them together with such a force that it seemed that they flew apart



in bits. Water changed its colour many times [Ambraseys, 1962; Ann. Bibl., 1964, No. 185; Antonopoulos, 1980a; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986].

AS62:  $i = 3$ ; PC:  $35 \frac{1}{2}^{\circ}$  N,  $25 \frac{1}{2}^{\circ}$  E,  $i = 2$ ; PZ97:  $34.9^{\circ}$  N,  $24.2^{\circ}$  E,  $M = 7.2$ ,  $i = 3+$ ; S89, 90:  $i_{\max} = 2+$ , P.

#### 1508, May 29. HA.

Hellenic Arc, Island of Crete. An earthquake occurred which was, possibly accompanied by tsunami waves observed on the north - eastern and southern coasts of the island [Ambraseys, 1962; Papadopoulos and Chalkis, 1984].

AS62:  $i = 3$  on the *northern shore of Crete*,  $i = 3-$  on the *southern shore of Crete*; CP82, PC:  $35^{\circ}$  N,  $25 \frac{1}{2}^{\circ}$  E,  $I = XI$ ,  $M = 7.1$ ; S89, 90:  $i_{\max} = 3$ , P.

#### 1509, September 14. SM.

Sea of Marmara with the Straits of Bosphorus and Dardanelles. A destructive earthquake, which was stronger on the European shore than on the opposite coast, took place. Istanbul, Edirne, Gallipoli (Geilbolu, now), Çorum and other cities were damaged. Buildings, towers and the coast walls in Istanbul were razed to the ground, the sultan's castle shook with such a force that 5 towers, that had been erected at great expense and where jewellery was kept, collapsed. 1,700 houses collapsed in the city, 13,000 inhabitants were killed. The old aqueduct was destroyed. The coastal region of Galata was especially severely damaged. Underground shocks continued for 40 days and nights.

The sea in the *Bay of the Golden Horn* rose and rushed onto the coast. Waves rolled over the city walls. Many streets and suburbs of *Istanbul* were flooded [Knolles, 1603; Grablowitz, 1903; Dück, 1904; Mihailovič, 1933; Heck, 1947; Montandon, 1953; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 278, 446, 777; Papadopoulos and Chalkis, 1984; Papazachos *et al.*, 1986].

AS62:  $i = 3$ ; CF82, PC, PZ:  $40.8^{\circ}$  N,  $28.1^{\circ}$  E,  $I = X$ ,  $M = 7.7$ ; S89, 90:  $i_{\max} = 3-$ , L.

#### 1511, March 26. GV.

Adriatic Sea, Gulf of Venice. Very strong underground shocks occurred in the regions of Friuli and Veneto at short time intervals between  $20^{\text{h}}$  and  $20^{\text{h}}30^{\text{m}}$ ; each of them lasted approximately 10 s and was accompanied by a loud underground rumble. Nothing but debris remained of the castle and an old extension of the church of S. Giovanni in Udine. The earthquake caused destruction in Cividale del Friuli, Madonna del Lanto\*, Faedis, Venzone, Tarcento, Tolmino and many other places. Rock falls occurred in the mountains near Gemona, and the River Livenza stopped flowing for a moment. Some old sources of water in the pleistocistal area dried up, and new sources appeared.

The earthquake was felt in Venice, Padua, Treviso, and in other places. The macroseismic epicentre was possibly located between Gemona (del Friuli) and Tolmino. 4 - 5 shocks more were felt at night, but they were weaker and shorter than the former.

Rollers appeared in the sea. They grew with such a roar that the citizens of Trieste, frightened by this phenomenon, were forced to leave their dwellings and to hide on the hill near the castle. In the Lagoon of Venice the water rose in canals up to the windows of the buildings [Baratta, 1901, 1936; Radics, 1902; Caloi *et al.*, 1970; Ann. Bibl., 1964, Nos. 76, 1282; Caputo and Faita, 1982, 1984]. In the later catalogue the co-ordinates of the earthquake epicentre are given as  $46^{\circ}15'$  N and  $13^{\circ}20'$  E; the earthquake intensity as  $I = X$ ,  $i = 5 - 6$ . In Caputo and Faita [1982]  $i = 6$  [?].

In Guidoboni and Tinti [1989] with a reference to Ribaric [1979], it was mentioned that the earthquake was felt in Istria, its intensity was  $I = IX - X$ ; it was not possible to find any information on the tsunami in the region of Trieste during the recent comprehensive study of the earthquake [Gentile *et al.*, 1984]. In addition to this, with reference to a source of the 16th century, data were given on the fact that during the earthquake in *Venice* the water went away far from the coast, and some fairly deep canals dried up. At the same time, the authors of the paper, on the basis of the absence of destruction and victims in Venice, believed that the estimate of the tsunami intensity should be reduced.

S89, 90:  $i_{\max} = 2 - 3$ , P.

#### 1534. NE.

Levantian Sea, Near East. The destructive earthquake occurred in Palestine. The clock tower of the cemetery church in Jerusalem was damaged among other things. A landslide partitioned the Jordan River bed. There was a report from *Jaffa* (Tel Aviv) on a tsunami wave [Sieberg, 1932a; Ambraseys, 1962].

AS62:  $i = 3$ ; S89, 90:  $i_{\max} = 3$ , Q/P.

#### 1538, September 26. Wl.

Tyrrhenian Sea, Bay of Naples. Strong underground shocks began in Pozzuoli toward the west of Naples in 1538 and damaged everything. On September 26 - 27, the earth was shaken continuously, and there were especially strong shocks, which also embraced all the shore of Calabria. The sea in *Pozzuoli* receded from the coast to a distance up to 200 yards. Fish were left on the dry bottom, which was gathered by citizens with hand carts. A new volcanic cone - Monte - Nuove - had been growing for 24 hours and started to erupt at the Phlegrean Fields near Pozzuoli, at the site where the therms of Tripergola were located, between Lake Avernus and the Mt Barbaro\*



**1594. WI.**

Tyrrhenian Sea, Bay of Naples. Underground shocks in Naples and Pozzuoli. The sea receded 200 yards from the coast [Mallet, 1850-1858; Baratta, 1901; Ann. Bibl., 1964, No. 76; Caputo and Fatta, 1984; Bedosti and Caputo, 1987].

CF82, 84: 40°45' N, 14°10' E, I = VII, i = 4 - 5; S89, 90:  $i_{\max} = 4 - 5$ , P.

[Mongitore, 1743; Baratta, 1901, 1931; Ann. Bibl., 1964, Nos. 76, 991; Caputo and Fatta, 1984; Bedosti and Caputo, 1987].

CF82, 84: 40°50' N, 14°10' E, I = VIII, i = 3 - 4; S89, 90:  $i_{\max} = 3 - 4$ , P.

**1546, January 14. NE.**

Levantine Sea, Near East. The strong earthquake occurred in Lebanon and Palestine. There was severe destruction in Nablus and Ramah. Reports on the earthquake came from Jerusalem, Jaffa, Tripolis (Tarābulus esh Sham), Damascus, Famagusta (the Island of Cyprus). The sea bottom and the Jordan River bed dried up. After the storming sea had returned and rolled onto the coast, over 12,000 inhabitants of *Gaza* and *Jaffa* were drowned. Sea waves were observed on the *Island of Cyprus* and on the *shore of Asia Minor* [Perrey, 1850; Technener, 1861; Schmidt, 1891; Willis, 1928; Sieberg, 1932a; Heck, 1947; Kallner - Amiran, 1951, 1952; Ambraseys, 1962; Ann. Bibl., 1964, Nos. 139, 311, 1601].

AS62: i = 4; S89, 90:  $i_{\max} = 3+$ , P/L.

**1562, October 20. CA.**

Calabrian Arc, Calabria, Reggio di Calabria. In October, the inhabitants of Cape Calamizzi near Reggio di Calabria heard a dull underground roar. During the whole day of October 20 the roar and heaving of the earth grew. Finally, at about 23<sup>h</sup> one could see that the cape began to submerge, and then vanished completely, and the sea appeared at its place. As this took place, the inhabitants of *Reggio* were gazing with fear at a scene: along the whole shore trees were being torn up by their roots, buildings were swaying and collapsing, and the ground was sinking, together with the gardens occupying an area of more than one mile, and the open sea was appearing in its place [Mercalli, 1906; Caputo and Fatta, 1984].

S89, 90:  $i_{\max} = 4$ , P/L.

**1564, July 20 (27), 23<sup>h</sup>. LS.**

Ligurian Sea, Italy, France. An extremely strong earthquake occurred with its focus apparently in the Maritime Alps, possibly in the valley of the River La Vésubie. It embraced Nice, Provence, Villefranche, San Remo, Porto Maurizio and so on. Aftershocks were felt for 50 days and nights.

The sea near *Nice* and *Villefranche* receded (became lower by "one spear") and its bottom was uncovered; many fish were left there including also some unknown kinds (deep - sea fish [?]). A beach and several shops were flooded in *Antibes* before the water went away from the seaport [Baratta, 1901, 1936; Caputo and Fatta, 1984].

CF82, 84: 44° N, 7°17' E, I = IX, i = 4; S89, 90:  $i_{\max} = 4 - 5$ , P.

## MAIN PARAMETERS OF TSUNAMIS IN THE MEDITERRANEAN SEA\*

Year	Cause of tsunami	Coordinates of earthquake or volcano, deg.		Magnitude, M	Site of manifestation of tsunami	Max. intensity of tsunami $i_{max}$	Reliability of data
		N	E				
<b>The Sea of Marmara (SM)</b>							
120	E	40.7	29.1	7.2		2	P
447	E?	40.2	28.0	7.3		4	L/R
542	-	40.3	27.8	6.8		4	L/R
558?	-	40.9	28.8	7.0		-	P
740	E	40.7	29.3	7.3		3	L
975?	?	-	-	-		3	P
1039	E?	38.4	27.3	6.8		-	Q
1265	E	40.7	27.4	6.6		2	P
1332	E	40.9	28.9	6.8		3+	P
1344	E	40.8	28.8	6.9		4	L/R
1509	E	40.8	28.1	7.7		3-	L
1646	E	-	-	-		3	P
1766	E	40.8	29.0	6.5		2	P
1829	E	41.1	24.3	7.3		2	P
1857	E	40.2	29.0	-		-	Q
1878	E	40.8	29.0	6.7		3	Q/P
1894	E	40.6	28.7	6.7		3	P
1912	E	40.6	27.2	7.6		-	P
1999	E	40.7	29.8	7.4		-	P
<b>North Greece (NG)</b>							
-479	E	39.7	23.3	6.7	Chalkidiki Peninsula	3	L
1902	E	40.8	23.4	6.6	Thessaloniki	2	L
1928	E	40.8	26.8	6.2	Gulf of Strimon	2	P
1932	E	40.5	23.9	7.0	Chalkidiki Peninsula	3	R
1978	E	40.8	23.2	6.5	Gulf of Strimon	2-	P
<b>East Greece (EG)</b>							
-426	E?	38.9	22.7	7.1	Gulf of Euboea	4	L
426	E	-	-	-	Gulf of Euboea	4-	L
552	E+L	38.4	22.3	7.1	Gulf of Euboea	4-	P
1853	E	38.3	23.4	7.0	Gulf of Euboea	3+	P
1859	?	-	-	-	Piraeus	2-	Q
1894	E+L	38.7	23.1	7.0	Gulf of Euboea	4	R
1928	E+L	38.0	23.0	5.0	Chalkida	3	L
1956	E	39.3	23.1	5.6	Volos	3	L

\* Symbols are listed after the table.



Year	Cause of tsunami	Coordinates of earthquake or volcano, deg.		Magnitude, M	Site of manifestation of tsunami	Max. intensity of tsunami $i_{max}$	Reliability of data
		N	E				
<b>Asia Minor (AM)</b>							
1300	?	-	-	-	Troy	5?	P
1403	E?	-	-	-	South-Eastern shore	3	P
1489	E	-	-	-	Antalya	3	P
1667	E	38.4	27.1	6.6	Izmir	2	P
1688	E	38.4	26.9	7.0	Izmir	2	P
1846	E	-	-	-	Izmir	3?	P
1851	E	36.5	28.7	7.2	Fethiye	3	L
1851	E?	-	-	-	Fethiye	3	L
1852	?	-	-	-	Izmir	2-3	P
1852	E	-	-	-	Izmir	3	P
1928	E	38.1	27.4	6.5	Izmir	2	L
1961	?	36.7	28.5	6.5	Izmir	2?	L
<b>Aegean Sea, islands (AS)</b>							
1380	V+E	36.4	25.4	-	Island of Thira	10	R
1330	E	40.0	25.0	7.0	Island of Limnos	-	Q
62	V+E	36.5	25.4	6.7	Island of Thira	3	P
554	E	37.0	27.7	7.0	Island of Kos	4	L
1389	E	38.4	26.3	6.8	Island of Chios	3	P
1650	V+L	36.4	25.4	7.0	Island of Thira	7	R
1672	E	36.5	25.5	-	Island of Thira	-	Q
1672	E	40.0	26.0	6.5	Island of Tenedos	-	Q
1738	E	36.8	24.4	6.5	Island of Milos	3	P
1856	E	38.4	26.2	6.6	Island of Chios	3+	P
1859	E	40.0	25.9	6.8	Island of Imroz	3	P
1866	E	38.3	26.3	6.8	Island of Chios	3	P
1866	E	36.4	25.3	6.0	Island of Thira	4	L
1867	E	39.2	26.4	7.0	Island of Lesvos	2	P
1881	E	38.2	26.1	6.5	Island of Chios	2+	P
1893	E	40.5	25.5	6.8	Island of Samothraki	3+	L
1933	E	36.7	27.2	6.4	Island of Kos	2	P
1949	E	38.6	26.3	6.7	Island of Chios	2	L
1956	E	36.7	25.8	7.5	Island of Amorgos	6	R
1956	E	36.6	25.7	6.9	Island of Folegandros	5	P
1959	?	-	-	-	Aegean Sea	3	P
1961	?	-	-	-	Aegean Sea	3	P
1968	E+L	39.5	24.8	6.7	Island of Limnos	2	L
1983	E	40.1	24.8	-	Island of Limnos	2+	P
1991	?	37.7	26.3	-	Aegean Sea	2	L
1991	?	37.1	26.8	-	Aegean Sea	3	R
<b>Hellenic Arc, islands (HA)</b>							
220	E	36.5	28.2	7.2	Island of Rhodes	3	P
142	E	36.7	28.0	7.0	Island of Rhodes	4	L

Year	Cause of tsunami	Coordinates of earthquake or volcano, deg.		Magnitude, M	Site of manifestation of tsunami	Max. intensity of tsunami $i_{max}$	Reliability of data
		N	E				
262	E	-	-	-	Island of Rhodes	4	Q
365	E	35.3	25.7	8.0	Island of Crete	4	R
1303	E	36.3	27.3	8.0	Island of Rhodes	4	L
1481	E	36.2	28.5	7.1	Island of Rhodes	3	P/L
1494	E	35.5	25.5	7.2	Island of Crete	2+	P
1508	E	35.0	25.5	7.1	Island of Crete	3	P
1601	E	35.5	25.5	-	Island of Crete	-	Q/P
1609	E	36.4	28.4	7.2	Island of Rhodes	4	P
1612	E	35.5	25.5	6.7	Island of Crete	5-	P
1629	E	35.5	25.0	7.0	Island of Crete	3?	P
1741	E	36.2	28.5	7.3	Island of Rhodes	4	P
1843	E?	36.3	27.6	6.5	Island of Chalki	4	P
1851	E	-	-	-	Island of Chalki	2	P
1856	E	35.5	26.0	8.3	Island of Crete	3+	P
1863	E	36.5	28.0	7.8	Island of Rhodes	-	Q
1866	E	36.0	24.0	6.0	Island of Kythira	4	L
1870	E	-	-	-	Port of Alexandria	3	L
1948	E	35.5	27.2	7.1	Island of Karpathos	4	R
1979	E?	34.6	24.1	5.8	Island of Crete	2	-
<b>Island of Cyprus (IC)</b>							
-23	E	-	-	-	Island of Cyprus	4	P/L
76	E	-	-	-	Island of Cyprus	4	Q
342	E	-	-	-	Island of Cyprus	3	Q
1202	E	34.3	33.0	6.6	Island of Cyprus	4	P/L
1953	E	34.8	32.5	6.5	Island of Cyprus	2-3	L
<b>Near East (NE)</b>							
-760	?	-	-	-	Israel - Lebanon	3	P
-590	E	-	-	6.8	Sür	4	P
-525	E	-	-	7.5	Lebanon	2-3	P
-138	E?	-	-	7.0	Akko - Sür	3	P
348	E	-	-	-	Beirut	3	P/L
362	E?	-	-	-	Shore of the Dead Sea	3	P/L
551	E	-	-	7.8	Tripolis	3	P/L
746	E	-	-	-	From Egypt to Syria	3	P/L
859	E	-	-	-	Samandagi	3	P
881	E?	-	-	6.5	Akko	2-3	Q
1032	E	-	-	6.9	Gaza	3	P
1034	E	-	-	6.2	Akko	4-	P
1068	E	-	-	-	Israel	4	L
1114	E	36.5	36.0	7.0	Samandagi	3	P
1202	E	-	-	-	Syria	5	P/L
1534	E	-	-	-	Israel	3	Q/P
1546	E	-	-	-	Gaza - Jaffa	3+	P/L



Year	Cause of tsunami	Coordinates of earthquake or volcano, deg.		Magnitude, M	Site of manifestation of tsunami	Max. intensity of tsunami $i_{max}$	Reliability of data
		N	E				
1752	E	-	-	7.0	Tripolis	3?	P
1759	E	-	-	-	Akko	4-	P/L
1822	E	36.0	36.0	7.1	Beirut	3	P
<b>West Greece (WG)</b>							
-373	E?	38.3	22.1	7.3	Gulf of Corinth	5	P
1402	E	38.2	22.7	7.0	Gulf of Corinth	5	P
1622	E	37.6	21.0	6.0	Island of Zakynthos	-	Q/P
1633	E	37.6	21.0	6.9	Island of Zakynthos	3-	P
1636	E	38.1	20.3	7.2	Island of Kefallonia	3	P
1723	E	38.5	20.5	-	Island of Levkas	3?	P
1732	E	39.5	20.0	-	Island of Kerkyra (Corfu)	2-	P
1748	E	38.3	22.1	6.8	Gulf of Corinth	3	P
1791	E?	37.8	21.0	7.0	Ionian Sea	3	P
1804	E	38.3	21.8	6.7	Gulf of Patras	3	P
1817	E	38.3	22.1	6.8	Gulf of Corinth	3+	P
1820	E	38.8	20.8	6.6	Island of Levkas	-	-
1820	E	37.7	21.1	6.9	Island of Zakynthos	3+	P
1821	E	37.8	21.3	6.5	Island of Zakynthos	4	P
1825	E?	38.8	20.7	6.8	Island of Levkas	3?	P
1835	?	-	-	-	Island of Zakynthos	2	P
1861	E+L	38.2	22.2	7.3	Gulf of Corinth	4	P/L
1862	E	38.3	22.3	-	South Peloponnesus	2-3	P
1867	E	38.6	20.9	7.4	Island of Levkas	2	P
1867	E	36.4	22.2	7.1	South Peloponnesus	4	L/R
1869	E	38.8	20.7	6.9	Island of Levkas	3	P
1870	E	38.4	22.5	7.0	Gulf of Corinth	4	P
1873	L?	38.0	22.3	-	Island of Zakynthos	-	-
1881	?	-	-	-	Gulf of Corinth	-	-
1883	E	39.5	20.0	-	Island of Kerkyra (Corfu)	3	P
1886	E	37.1	21.4	7.5	South Peloponnesus	3	L
1887	E	38.3	22.8	-	Gulf of Corinth	3	P
1888	E	38.2	22.1	6.1	Galaxidi	2	R
1898	E	37.8	21.0	-	Island of Zakynthos	2+	P
1899	E	37.2	21.6	6.6	South Peloponnesus	3	P/L
1914	E	38.8	20.6	6.3	Island of Levkas	4	P
1915	E	38.5	20.7	6.7	Ionian Sea	3+	P
1947	E+L	36.9	22.0	7.0	South Peloponnesus	2+	L
1948	E	38.7	20.5	6.5	Island of Levkas	4	L
1953	E+L	38.3	20.8	7.2	Island of Ithaca	6	P
1963	L	-	-	-	Gulf of Corinth	5	L
1965	E	38.4	22.3	6.3	Gulf of Corinth	2	P
1981	E	38.2	23.0	6.7	Gulf of Corinth	2	R
1984	E	38.3	21.9	5.5	Sergoula	3	R

Year	Cause of tsunami	Coordinates of earthquake or volcano, deg.		Magnitude, M	Site of manifestation of tsunami	Max. intensity of tsunami $i_{max}$	Reliability of data
		N	E				
1995	E	38.6	22.2	6.4	Gulf of Corinth	3	R
1996	E	38.4	22.1	-	Gulf of Corinth	4	R
<b>Albania (AL)</b>							
-57	E	41.5	19.4	6.6	Durrës	3	P
1273	E	41.3	19.7	6.5	Durrës	3	P
1833	E	40.4	19.9	6.4	Vlorë	4	P
1851	E	40.7	19.7	6.6	Vlorë	3	P
1866	E	40.4	19.5	6.5	Vlorë	4	P
1920	E	40.3	20.0	6.3	Vlorë	4	P
<b>Montenegro, Croatia, Dalmatia (DL)</b>							
1667	E	42.6	18.1	7.7	Dubrovnik	3-4	P
1750	E	46.0	12.7	-	Rijeka	3-4	P
1802	E	45.3	14.4	-	Bakar	3-4	P/L
1823	E	-	-	-	Dubrovnik	4-	P
1838	E	45.3	14.5	-	Rijeka	3	Q/P
1843	E	42.6	18.1	-	Dubrovnik	4	P
1844	E	-	-	-	Dubrovnik	3	P
1844	E	43.4	16.7	-	Dubrovnik	2	P
1845	E	-	-	-	Dubrovnik	3	Q
1853	E	-	-	-	Baošič	3	Q/P
1870	E	-	-	-	Island of Vis	3	P/L
1937	E	43.2	16.4	5.2	Island of Hvar	-	Q/P?
1978	?	-	-	-	Vela-Luka	5	R
1979	E	42.0	19.0	7.0	Boka Kotorska*	1	R
<b>Gulf of Venice (GV)</b>							
792	E	45.5	11.0	-	-	2-3	Q
1106	E	45.5	12.3	-	-	3	W
1321	E	45.4	12.3	-	-	3	P
1348	E	46.6	13.8	-	-	3	P
1511	E	46.2	13.3	-	-	2-3	P
<b>East Italy (EI)</b>							
1331	E	-	-	-	Cesena	3	Q/P
1624	E	44.6	11.8	-	Delta of the Po	3	P
1627	E	41.8	15.3	6.3	Gargano Peninsula	5	L/R
1672	E	44.0	12.8	-	Rimini	3	L
1756	E	-	-	-	Gargano Peninsula	4	Q/P
1813	E	43.7	13.6	-	Ancona	3	Q/P
1826	E	43.8	13.0	-	Senigallia	-	P
1875	E	44.2	12.4	-	Rimini, Senigallia	4	P
1889	E	42.1	15.5	-	Ancona	2?	Q/P



Year	Cause of tsunami	Coordinates of earthquake or volcano, deg.		Magnitude, M	Site of manifestation of tsunami	Max. intensity of tsunami $I_{max}$	Reliability of data
		N	E				
<b>Calabrian Arc (CA)</b>							
177	E	38.0	15.0	-	Island of Sicily	6	PP
362	E	38.0	15.5	-	Island of Sicily	4-5	L
963	E	-	-	-	Island of Sicily	5-6	L/R
1169	E	37.5	15.3	-	Island of Sicily	4-5	P
1329	E	37.8	15.0	-	Island of Sicily	3	P/L
1562	E	-	-	-	Reggio di Calabria	4	P
1613	E	-	-	-	Messina	3-4	P
1638	E	39.0	16.3	-	Calabria	4-5	P
1649	E	38.3	15.7	-	Strait of Messina	5	P
1693	E	37.2	15.0	-	Island of Sicily	4	P
1699	E	-	-	-	Catania	3-4	P
1726	E	38.2	13.4	-	Palermo	3	P
1727	E	37.5	13.0	-	Sciaccia	3	Q/P
1783	E	38.4	15.8	-	Strait of Messina	5	R
1783	E+L	38.4	15.8	-	Scilla	6	R
1783	E	38.6	16.2	-	Strait of Messina	2-3	Q/P
1783	E	38.8	16.3	-	Strait of Messina	3	P
1783	E	38.8	16.5	-	Strait of Messina	4	L
1784	E	38.2	15.5	-	Roccella	5	L
1784	?	38.2	15.7	-	Scilla	3	P
1817	E	37.5	13.0	-	Sciaccia	3	P
1818	E	37.6	15.0	-	Catania	3	L
1823	E	38.3	14.8	-	Palermo	4-5	Q/P
1831	E	37.1	12.5	-	Sciaccia	1	P
1832	E	39.0	17.0	-	Cutro	3	P
1836	E	39.6	16.6	-	Rossano	3-4	L
1894	E	38.2	15.9	-	Strait of Messina	3	P
1903	E	-	-	-	Palermo	2	Q
1905	E	38.8	16.1	-	Island of Sicily	4	L/R
1907	E	38.1	16.1	-	Calabria	3	L
1908	E	38.2	15.6	7.0	Strait of Messina	6	R
1916	V	38.8	15.2	-	Island of Stromboli	4	R
1919	V	37.6	15.2	-	Island of Stromboli	4-5	L
1926	E	38.8	14.7	6.0	Lipari Islands	3	L
1930	V	38.8	15.2	-	Island of Stromboli	3	Q/P
1939	V	38.5	14.7	-	Island of Filicudi	2	P
1940	E	38.1	13.5	-	Island of Sicily	3	P
1941	E	38.3	12.2	-	Trapani	2	L
1954	V	38.8	15.2	-	Island of Stromboli	3-4	L
<b>West Italy (WI)</b>							
<b>Tsunami of seismic origin</b>							
79	E	40.8	-	-	Bay of Naples	4	L
407	E	-	-	-	Island of Ichia	4	Q/P

Year	Cause of tsunami	Coordinates of earthquake or volcano, deg.		Magnitude, M	Site of manifestation of tsunami	Max. intensity of tsunami $I_{max}$	Reliability of data
		N	E				
1343	E	-	-	-	Bay of Naples	4	P
1456	E	41.3	14.7	-	Bay of Naples	4	Q/P
1538	E	40.8	14.2	-	Pozzuoli	3-4	P
1594	E	40.7	14.2	-	Pozzuoli	4-5	P
1631	E	40.8	14.4	-	Bay of Naples	5	L
1682	E	-	-	-	Bay of Naples	3	L
1707	E	-	-	-	Bay of Naples	3	L
1714	E	-	-	-	Naples	3	P
1723	E	-	-	-	Bay of Naples	3	P
1760	E	-	-	-	Bay of Naples	3	Q/P
1805	E	41.4	14.5	-	Bay of Naples	2	P
1870	E	-	-	-	Tyrrhenian Sea	3-4	Q
1895	E	41.7	12.2	-	Tyrrhenian Sea	2-3	Q/P
<b>Oscillations of the sea level of unknown origin (from the south to the north)</b>							
1112	?	40.7	14.5	-	Bay of Naples	3-4	P
1690	V	-	-	-	Bay of Naples	3	P
1698	?	40.7	14.5	-	Bay of Naples	3	P
1730	?	-	-	-	Bay of Naples	2-3	P
1804	?	-	-	-	Bay of Naples	2-3	P
1813	?	40.0	14.0	-	Bay of Naples	2-3	P/L
1847	?	-	-	-	Bay of Naples	2	P
1895	?	-	-	-	Anzio	3-4	Q/P
258	?	42.0	12.5	-	Estuary of the Tiber	4	P
1703	?	42.4	13.3	-	Estuary of the Tiber	2	P
1806	?	41.7	12.7	-	Nettuno	2	Q/P
<b>Ligurian Sea (LS)</b>							
<b>Tsunami of seismic origin</b>							
1564	E	44.0	7.3	-	San Remo - Nice	4-5	P
1646	E	43.5	10.1	-	Livorno	3	P
1703	E	44.2	8.8	-	Genoa	3	P
1742	E	43.5	10.2	-	Livorno	3	P
1751	E	44.2	9.2	-	Genoa - San Remo	3	P
1808	E	44.8	7.3	-	Marseille	P/L	P/L
1809	E	44.8	7.2	-	Gulf of La Spezia	P	P
1818	E	43.8	8.0	-	Genoa - Antibes	P/L	P/L
1818	E	44.8	10.4	-	Genoa	2-3	P
1819	E	43.7	8.0	-	Genoa	3	P
1828	E	44.8	9.2	-	Genoa	3	P
1831	E	43.8	7.8	-	San Remo	3	P
1846	E	43.3	10.7	-	Livorno	3	P/L
1851	E	-	-	-	Livorno	2-3	Q/P
1887	E	43.7	8.1	-	Savona - Antibes	3	L/R
1888	E	-	-	-	San Remo	3	P



Year	Cause of tsunami	Coordinates of earthquake or volcano, deg.		Magnitude, M		Site of manifestation of tsunami	Max. intensity of tsunami $i_{max}$	Reliability of data
		N	E	E	M			
1896	E	43.7	8.1	-	-	Savona	2?	Q/P
1914	E	43.5	10.2	-	-	Livorno	2	Q/P
<b>Oscillations of the sea level of unknown origin (from the south-east to the north-west)</b>								
1846	?	-	-	-	-	Livorno	4	L
1847	?	-	-	-	-	Livorno	3	P
1850	?	-	-	-	-	Livorno	3	P
1852	?	-	-	-	-	Livorno	3	P
1303	?	-	-	-	-	Genoa	4	P
1816	?	-	-	-	-	Genoa	3	Q/P
1820	?	-	-	-	-	Genoa	3	P
1871	?	-	-	-	-	San Remo	3	Q/P
1880	?	-	-	-	-	Porto Maurizio	3	Q/P
1854	?	43.7	7.8	-	-	Nice	-	Q
1855	?	-	-	-	-	Nice	3	P
1876	?	-	-	-	-	Nice	3-4	L
1885	?	-	-	-	-	Nice	4	L/R
1979	?	-	-	-	-	Nice	6	R
1812	?	-	-	-	-	Marseille	3-4	L
1849	?	-	-	-	-	Marseille	3	P
1924	?	-	-	-	-	Marseille	3	P
<b>Spain (SP)</b>								
1790	E	-	-	-	-	Cartagena	3-4	P/L
1860	E	-	-	-	-	Torreveja	2-3	P
<b>Africa (AF)</b>								
1755	E	Lisbon	Earthquake	-	-	Tangier, Oran	6	R
1773	?	-	-	-	-	Tangier, Algeria	5	L
1790	E	-	-	-	-	Oran	3-4	P/L
1802	E	36.5	2.9	-	-	Algeria	2	L
1856	E	37.1	5.7	-	-	Algeria	4	L
1891	E	36.5	1.8	-	-	Algeria	-	P
1894	?	-	-	-	-	Bizerte	3	P
1905	?	-	-	-	-	Bizerte	3	P
1954	E	36.3	1.5	6.7	-	Orleansville, Algeria	2	R
1980	E	36.2	1.4	-	-	El Asnam, Algeria	2	R

### Notes

- A sign “ - ” before the year in the column “Year” implies that the phenomenon took place in the era B.C.
- Causes of tsunami:
  - E - *earthquake*;
  - V - *volcanic eruption*;
  - L - *landslide*;
  - ? - *cause not found*.
- Signs + and - in the column “Max. intensity of tsunami” imply “slightly more” and “slightly less”, respectively.
- Reliability was estimated in accordance with a 5-grade scale:
  - R - *reliable*: an event was recorded at least by one gauge or there exist many reliable visual observations;
  - L - *likely*: few reliable observations;
  - P - *possible*: it is difficult to evaluate whether the tsunami or some other event (seiches, sea-quake, wind surge, and so on...) was observed
  - Q - *questionable*: probably some other event, different from tsunami, took place, but the possibility of tsunami shouldn't be utterly excluded;
  - W - *wrong*: erroneous indication of tsunami.



APPENDIX 2

LIST OF TSUNAMIGENIC EVENTS IN THE MEDITERRANEAN SEA\*  
(V. K. Gusiakov, A. V. Osipova, O. N. Solovieva)

Year	Mon	Day	Hr	Mn	Sc	Zone	Lat	Long	Dep	Ms	Mt	I	H <sub>max</sub>	N	C	V	R
-1380**	-	-	-	-	-	AS	36.40	25.40	-	-	-	10.0	-	-	VT	4	S
-1300	-	-	-	-	-	AM	-	-	-	-	-	5.0	-	1	U	2	S
-760	-	-	-	-	-	NE	-	-	-	-	-	3.0	-	1	U	2	S
-590	-	-	-	-	-	NE	36.70	22.60	-	6.8	-	4.0	-	1	T	2	S
-525	-	-	-	-	-	NE	39.40	22.30	-	7.5	-	3.0	-	1	T	2	S
-479	-	-	-	-	-	NG	39.70	23.30	-	6.7	-	3.0	-	1	T	2	S
-426	-	-	-	-	-	EG	38.90	22.70	-	7.1	-	4.0	-	3	T?	3	S
-373	-	-	-	-	-	WG	38.30	22.10	-	7.3	-	5.0	-	1	T	2	S
-330	-	-	-	-	-	AS	40.00	25.00	-	7.0	-	-	-	-	T	1	S
-220	-	-	-	-	-	HA	36.50	28.20	-	7.2	-	3.0	-	-	T	2	S
-198	-	-	-	-	-	East Med	-	-	-	-	-	-	-	-	T	1	S
-138	-	-	-	-	-	NE	44.10	10.00	-	7.0	-	3.0	-	2	T	2	S
-57	-	-	-	-	-	AL	41.30	19.50	-	6.6	-	3.0	-	1	T	2	S
62	-	-	-	-	-	AS	36.50	25.40	-	6.7	-	3.0	-	1	V	3	S
77	6	20	-	-	-	IC	37.90	22.90	-	6.3	-	4.0	-	3	T	1	S
79	8	24	7	-	-	WI	40.80	14.40	-	-	-	4.0	-	1	T	3	S
120	-	-	-	-	-	SM	40.70	29.10	-	7.2	-	2.0	-	-	T	3	PZ
148	-	-	-	-	-	HA	36.70	28.00	-	7.0	-	4.0	-	4	T	3	S
177	-	-	-	-	-	CA	38.00	15.00	-	-	-	6.0	-	-	T	2	S

\* Symbols are listed after the table.

\*\* Different authors give the date of this event between 1700 B.C. and 1380 B.C.



Year	Mon	Day	Hr	Mn	Sc	Zone	Lat	Long	Dep	Ms	Mt	I	H <sub>max</sub>	N	C	V	R
258	-	-	-	-	-	WI	42.00	12.50	-	-	-	4.0	-	1	U	2	S
262	-	-	-	-	-	HA	41.90	12.50	-	3.6	-	4.0	-	1	T	2	S
342	7	-	-	-	-	IC	41.30	19.50	-	-	-	-	-	-	T	1	S
348	-	-	-	-	-	NE	41.90	12.50	-	4.1	-	3.0	-	2	T	2	S
362	-	-	-	-	-	CA	38.00	15.50	-	-	-	5.0	-	-	T	2	S
362	-	-	-	-	-	NE	-	-	-	-	-	3.0	-	-	-	1	S
365	7	21	-	-	-	HA	35.30	25.70	70	8.0	-	4.0	-	9	T	4	S
407	4	-	-	-	-	WI	-	-	-	-	-	4.0	-	1	T	2	S
426	-	-	-	-	-	EG	-	-	-	-	-	4.0	-	-	T	3	S
447	11	8	-	-	-	SM	40.20	28.00	-	7.3	-	4.0	-	1	T	3	S
543	9	6	-	-	-	SM	40.30	27.80	-	6.8	-	4.0	-	4	T	3	S
551	7	7	-	-	-	EG	38.40	22.30	-	7.1	-	4.0	-	4	TL	2	S
551	7	9	-	-	-	NE	40.80	29.90	-	7.8	-	3.0	-	3	T	2	S
554	8	15	-	-	-	AS	37.00	27.70	-	7.0	-	4.0	-	3	T	3	S
558	12	14	-	-	-	SM	40.90	28.80	-	7.0	-	-	-	-	T	2	S
740	10	26	-	-	-	SM	40.70	29.30	-	7.3	-	3.0	-	2	T	3	S
746	1	18	-	-	-	NE	45.40	12.25	-	4.9	-	3.0	-	-	T	2	S
792	4	30	-	-	-	GV	45.50	11.00	-	-	-	3.0	-	-	T	1	S
803	12	19	-	-	-	NE	36.95	35.58	-	-	-	3.0	-	-	T	2	S
859	-	-	-	-	-	NE	36.08	36.25	-	-	-	3.0	-	1	T	2	S
881-82	-	-	-	-	-	NE, AF	-	-	-	-	-	3.0	-	3	-	2	S
963	7	22	-	-	-	CA	-	-	-	-	-	5.0	-	-	T	3	S
975	10	26	-	-	-	SM	41.04	28.98	-	-	-	3.0	-	2	U	2	S
1032	3	6	-	-	-	NE	-	-	-	6.9	-	3.0	-	-	T	2	S
1034	1	4	-	-	-	NE	32.80	35.53	-	6.2	-	4.0	-	2	T	2	S
1039	2	2	-	-	-	SM	38.40	27.30	-	6.8	-	-	-	-	T	1	S
1050	-	-	-	-	-	AS	-	-	-	-	-	-	-	-	V	3	S
1065	9	23	-	-	-	SM	-	-	-	-	-	-	-	-	T	3	S

Year	Mon	Day	Hr	Mn	Sc	Zone	Lat	Long	Dep	Ms	Mt	I	H <sub>max</sub>	N	C	V	R
1068	3	18	-	-	-	NE	31.92	34.85	-	-	-	4.0	-	4	T	3	S
1106	3	-	-	-	-	GV	45.50	12.30	-	-	-	3.0	-	1	T	0	S
1112	6	20	-	-	-	WI	40.00	14.00	-	-	-	4.0	-	1	U	2	S
1114	3	12	-	-	-	CA	36.50	36.00	-	7.0	-	3.0	-	-	T	2	S
1169	2	4	-	-	-	CA	37.50	15.30	-	7.0	-	4.0	-	1	T	3	S
1169	2	11	-	-	-	CA	-	-	-	-	-	-	-	-	T	3	S
1172	-	-	-	-	-	CA	-	-	-	-	-	-	-	-	T	3	S
1202	5	22	-	-	-	NE	34.30	33.00	-	6.6	-	4.0	-	2	T	3	S
1265	8	11	-	-	-	SM	40.70	27.40	-	6.6	-	2.0	-	-	T	2	PZ
1273	3	-	-	-	-	AL	41.30	19.70	-	6.5	-	3.0	-	1	T	2	S
1303	7	23	-	-	-	LS	30.05	31.25	-	-	-	4.0	-	-	U	2	S
1303	8	8	-	-	-	HA	36.10	29.00	-	8.0	-	4.0	-	5	T	3	PC
1321	-	-	-	-	-	GV	45.40	12.30	-	-	-	3.0	-	1	T	2	S
1329	6	28	-	-	-	CA	37.80	15.00	-	-	-	3.0	-	1	T	2	S
1331	3	13	-	-	-	EI	44.17	12.25	-	-	-	3.0	-	1	T	1	S
1332	2	12	-	-	-	SM	-	-	-	-	-	3.0	-	1	T	2	S
1343	11	25	-	-	-	WI	-	-	-	-	-	4.0	-	1	T	2	S
1344	2	12	-	-	-	SM	40.80	28.80	-	-	-	5.0	-	2	T	4	S
1348	1	25	-	-	-	GV	46.60	13.80	-	6.9	-	3.0	-	1	T	2	S
1365	1	2	-	-	-	AF	-	-	-	-	-	-	-	-	T	3	S
1389	3	20	-	-	-	AS	38.40	26.30	-	6.8	-	3.0	-	4	T	2	S
1402	6	-	-	-	-	WG	38.11	22.41	-	7.0	-	5.0	-	1	T	2	PZ
1403	11	16	-	-	-	AM	-	-	-	-	-	3.0	-	2	TV	2	S
1456	12	4	-	-	-	WI	41.30	14.70	-	-	-	4.0	-	1	T	2	S
1481	5	3	-	-	-	HA	36.20	28.50	-	7.1	-	3.0	1.80	1	T	2	S
1481	10	3	-	-	-	AS	38.20	28.50	-	7.1	-	3.0	-	-	T	4	PC
1494	7	1	-	-	-	HA	35.50	25.50	-	7.2	-	3.0	-	1	T	2	S
1508	5	29	-	-	-	HA	35.00	25.50	-	7.1	-	3.0	-	2	T	2	S



## List of Notations:

- SM** - the Sea of Marmara, the Bosphorus and Dardanelles Straits; **AL** - the coast of Albania;  
**NG** - the Aegean coast of northern Greece; - the coast of Montenegro and of Croatia;  
**EG** - the coast of eastern Greece; **GV** - the Gulf of Venice;  
**AM** - the Mediterranean coast of Asia Minor; **EI** - the eastern (Adriatic and Ionian) coast of Italy;  
**AS** - the Aegean Sea; **CA** - the Calabrian Island Arc, *i.e.* the Calabria district within continental Italy and the Island of Sicily;  
**HA** - the Hellenic Island Arc; **WI** - the western coast of Italy, washed by the Tyrrhenian Sea  
**IC** - the Island of Cyprus; **LS** - the Ligurian Sea;  
**NE** - the coast of the Near East; **SP** - the coast of Spain;  
**WG** - the coast of western Greece; **AF** - the coast of northern Africa.

Note: Sign '-' in all columns means that this parameter is not available

#### EVENT DATE (in GMT):

year - year  
 mo - month (from 0 to 12)  
 day - day (from 1 to 31)  
 hr - hour (from 0 to 23)  
 min - minute (from 0 to 59)  
 sec - second (from 0.0 to 59.9)

#### SOURCE LOCATION:

lat - latitude in ( ' ' for south latitude )  
 long - longitude ( ' ' for west longitude)  
 dep - source depth (in km)

#### MAGNITUDES:

Ms - surface-wave magnitude  
 Mt - Abe's tsunami magnitude [Abe, 1973]

#### PARAMETERS OF TSUNAMI:

I - tsunami intensity on Sieberg - Ambraseys-scale  
 [Ambraseys, 1965a], and Soloviev [1972]  
 H<sub>max</sub> - maximum run-up height above mean sea level (in m)  
 N - number of available run-up measurements

#### C - cause of the tsunami:

L = *landslide* (subaerial or submarine)  
 M = *meteorological*  
 A = *astronomical* tide  
 T = *tectonic* (earthquake)  
 V = *volcanic* (volcanic eruption)  
 U = *unknown*

#### V - validity of the event:

4 = *definite* tsunami (probability approximately 1.0)  
 3 = *probable* tsunami (probability approximately 0.75)  
 2 = *questionable* tsunami (probability approximately 0.50)  
 1 = *very doubtful* tsunami (probability approximately 0.25)  
 0 = *false* entry (probability close to 0.00)

#### R - main reference for the event

S = Soloviev, *et al.*, 1997  
 PC = Papadopoulos and Chalkis, 1984  
 TN = IITC Tsunami Newsletter, 1977-1997  
 PZ = Papazachos and Papazachou, 1997