

**Data from investigation on seismic Sea waves events  
in the Eastern Mediterranean from 1900 to 1980 A.D.**

Part 6

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1. INTRODUCTION

Tsunamis from 1900 to 1980 A.D. in the Eastern Mediterranean Sea between 31-44 N and 18-36 E excluding the Black Sea and the Italian coasts of the Adriatic Sea is the object of the present paper.

2. DESCRIPTION OF EVENTS

1. 1902 July 5. Salonika ( $m=ii$  —).  
( $G C: 40\frac{3}{4}$  N —  $23\frac{1}{4}$  E,  $I=IX$ ,  $M=?$ ,  $d=n$ ).  
Ref: 15.

Information has been obtained from Vid. Huserl (1902). A. Galanopoulos (1960, p. 26) mentions earthquake but no tsunami.

2. 1908 December 28. *Lybian Sea. 90 miles north of Alexandria (m=v), Egyptian coasts (m=ii).*  
 (G C:  $38^{\circ}$  N —  $15^{\circ}\frac{1}{2}$  E, I = XI, M = 4.6 d = 10).  
 Ref: 16.

The earthquake data have been obtained from V. Karnik (1969).

3. 1914 November 27. *Ionian Islands, Leukas (S. Maura) (H = 3,5 m.) (m=iv+).*  
 (G C:  $38^{\frac{3}{4}}$  N —  $20^{\frac{1}{2}}$  E, I = X, M =  $6^{\frac{1}{4}}$ , d = n).  
 Ref: 8, 9.

The earthquake data have been obtained from V. Karnik (1969), A. Galanopoulos (1960, p. 46) mentions earthquake but no tsunami.

4. 1915 August 7. *Ionian Islands. Between Cephalonia and Leukas (S. Maura) (m=iii+).*  
 (G C:  $38^{\frac{1}{2}}$  N —  $20^{\frac{1}{2}}$  E, I = IX, M = 4.9, d = n).  
 Ref: 9, 11, 12.

The earthquake data have been obtained from V. Karnik (1969).

5. 1920 December 18. *Albanian coasts. Valona (m=iv), Saseno (m=v—).*  
 (G C:  $40^{\frac{1}{2}}$  N —  $19^{\frac{1}{2}}$  E, I = IX, M = 5.6, d = n).  
 Ref: 17, 18, 19, 20, 21.

The earthquake data have been obtained from V. Karnik (1969).

6. 1928 March 31. *Asia Minor, Smyrna (m=ii).*  
 (G C:  $38,1$  N —  $27,1$  E, I = IX, M = 4.9, d = n).  
 Ref: 3.

The earthquake data have been obtained from V. Karnik (1969).

7. 1928 April 23-25. Grecian Archipelago; Piraeus. Chalkis. Nauplion, Alexandroupolis ( $H=0,60m.$ ) ( $m=ii$ ). Crete, Chania, Karystos ( $H=2,00m.$ ) ( $m=iii+$ ).  
(G C: 42,4 N — 25,7 E,  $I = VI$ ,  $M = 4.6$ ,  $d = n$ ).  
Ref: 4, 6, 13, 14, 17a, 22.

A. Galanopoulos (1960, p. 26) mentions earthquake but no tsunami.

8. 1928 May 3. Eastern Greece. Strumonic Gulf ( $m=ii$ ).  
(G C: 40,8 N — 26,8 E,  $I = VII$ ,  $M = 4.3$ ,  $d = n$ ).  
Ref: 4.

The earthquake data have been obtained from V. Karnik (1969).

9. 1932 September 26. Gulf of Hierissos. Chalcidice ( $m=ii+$ ).  
(G C:  $40\frac{1}{2}$  N —  $23\frac{3}{4}$  E,  $I = X$ ,  $M = 6.9$ ,  $d = n$ ).  
Ref: 5.

Information has been obtained from Belousek F. (1933).  
A. Galanopoulos (1960, p. 54) mentions earthquake but no tsunami. Earthquake data have been obtained from V. Karnik (1969).

10. 1947 October 6. South Peloponnesus. Methone in Messenia ( $m=ii+$ ).  
(G C: 36,9 N — 22 E,  $I = IX$ ,  $M = 6.9$ ,  $d = 28$ ).  
Ref: 7, 12.

The earthquake data have been obtained from V. Karnik (1969).

11. 1948 February 9. Dodecanese. Island of Karpathos.  
( $L=1000$  m) ( $m=iv$ ).  
(G C:  $35\frac{1}{2}$  N — 27 E,  $I = IX$ ,  $M = 7.1$ ,  $d = 40$ ).  
Ref: 9, 11, 12.

The earthquake data have been obtained from V. Karnik (1969).

12. 1948 April 22. *Ionian Islands. Leukas S. Maura* ( $H=1.00$  m)  
( $m=iv$  —).  
( $G C: 38\frac{1}{2}$  N —  $20\frac{1}{4}$  E,  $I = X$ ,  $M = 6.4$ ,  $d = n$ ).  
Ref.: 9, 11, 12.

The earthquake data have been obtained from V. Karnik (1969).

13. 1949 February 9. *Dodecanese. Island of Karpathos.*

After an earthquake on Karpathos, the sea advanced 1 km in land and the water washed away extensive areas of cultivated land (Galanopoulos A, 1961).

14. 1956. July 9. *Grecian Archipelago. Amorgos* ( $H=30m$ ), *Astipalaea* ( $H=20m$ ), *Pholegandros* ( $H=10m$ ) *Patmos* ( $H=4m$ ), *Kalimnos* ( $H=3,5m$ ), *Crete* ( $H=3,5m$ ), *Tinos* ( $H=2,7$ ). ( $v\div o$   $m=iii$ ).  
( $G C: 36.9$  N —  $26$  E,  $I = IX$ ,  $M = 7.8$ ,  $d = 20?$ ).  
Ref: 1, 9, 10, 11.

Ambraseys N. (1960) « The seismic sea-wave of July 1956 in the Greek Archipelago », Journ. Geoph. Research, vol. 65, Nr. 4, p. 1257: the earthquake of July 9th 1956 was followed by a severe seismic sea-wave which originated from  $36^{\circ} 48'$  North,  $25^{\circ} 12'$  East. Most probably the wave was produced by a series of landslides on the steep banks of the submarine trench of Amorgos. The amplitude of the wave near its source was 30m, and the agitation of the sea at the central area lasted several days.

Effect of the waves on islands of the Archipelago, N.N. Ambraseys, 1960. In Kalimnos and in the town of Kalimnos the wave was felt most strongly, and the damage inflicted there was rather severe. In the town of Pothea the sea retired first and then rose with a great swell flooding the shore and the entire town. The height of the wave was 2,5 m on land and its impulse was so severe that residential blocks of buildings on the harbour as well as light ship building installations 200 m inland were badly damaged. Over thirty fishing boats and one large sailing ship were tossed on land and crushed. Three times the sea receded and ad-

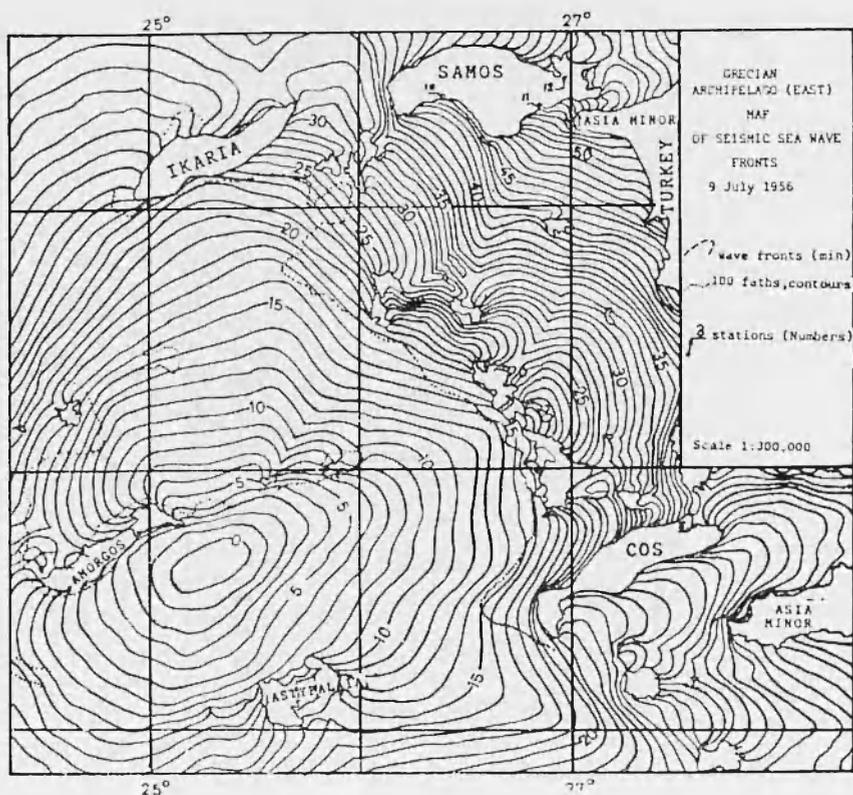


The cathedral's clock stopped at the first shock. Pothasa, Kalymnos. (N. N. AMIBRASEYS, 1960), [Event n. 14].

vanced in the first hour, carrying debris and furniture one mile inland. A person was seized and carried by the wave  $3/4$  of a mile inland; three other persons were taken by the waves and subsequently drowned. Extensive areas of cultivated land at various parts of the island were washed away.

At Porto-Scala in the island of Astipalaia, the first wave was 16 feet high on land and surged 800 m into the town. A large number of fishing boats were crashed on shore and debris was carried over 1000 m inland. In other parts of the island hundreds of acres of cultivated land were washed away. Two persons were injured and a number of houses damaged. One house collapsed.

At the town of Katapola in Amorgos island, the wave was 2,5 m high and caused considerable damage to harbour works



Greek archipelago (east). Map of seismic sea wave fronts, July 9, 1956. (N. N. AMBRASEYS, 1950), [Event n. 14].

and houses near the sea front. Four large sailing ships were thrown on the quay and four others were wrecked on shore. The pavement of the quay settled and the quay proper was damaged. The beach near the town and the land behind it were littered with trunks and limbs of trees, and cultivated land further inland was washed up. At the southeast coast of the island, waves up to 30 m in height crashed against the rocky cliffs of the coast. This part of the island is sparsely populated, and due to the rocky topography of the coast villages are perched high up on the rocks. No casualties were reported.

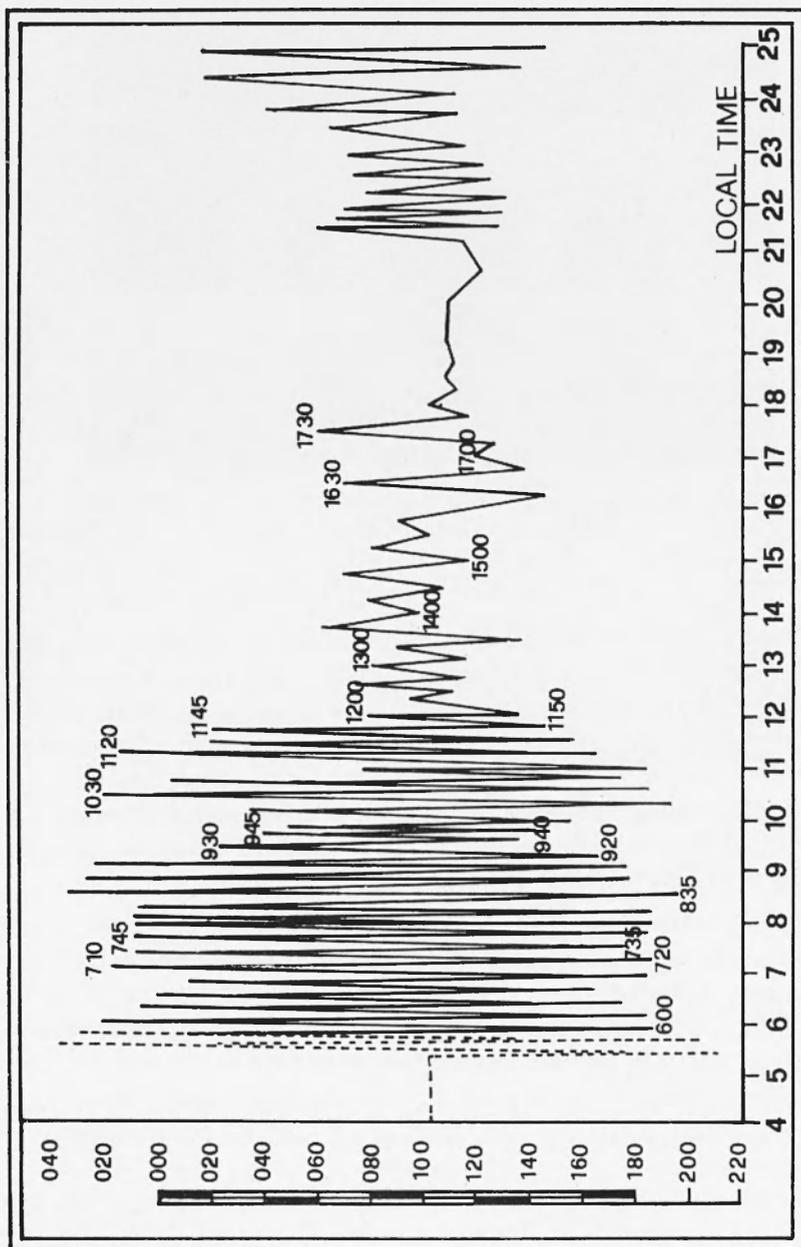


Scala, Patmos. Houses near the coast, flooded by the tsunami. (N. N. AMBRASEYS, 1950), [Event n. 14].

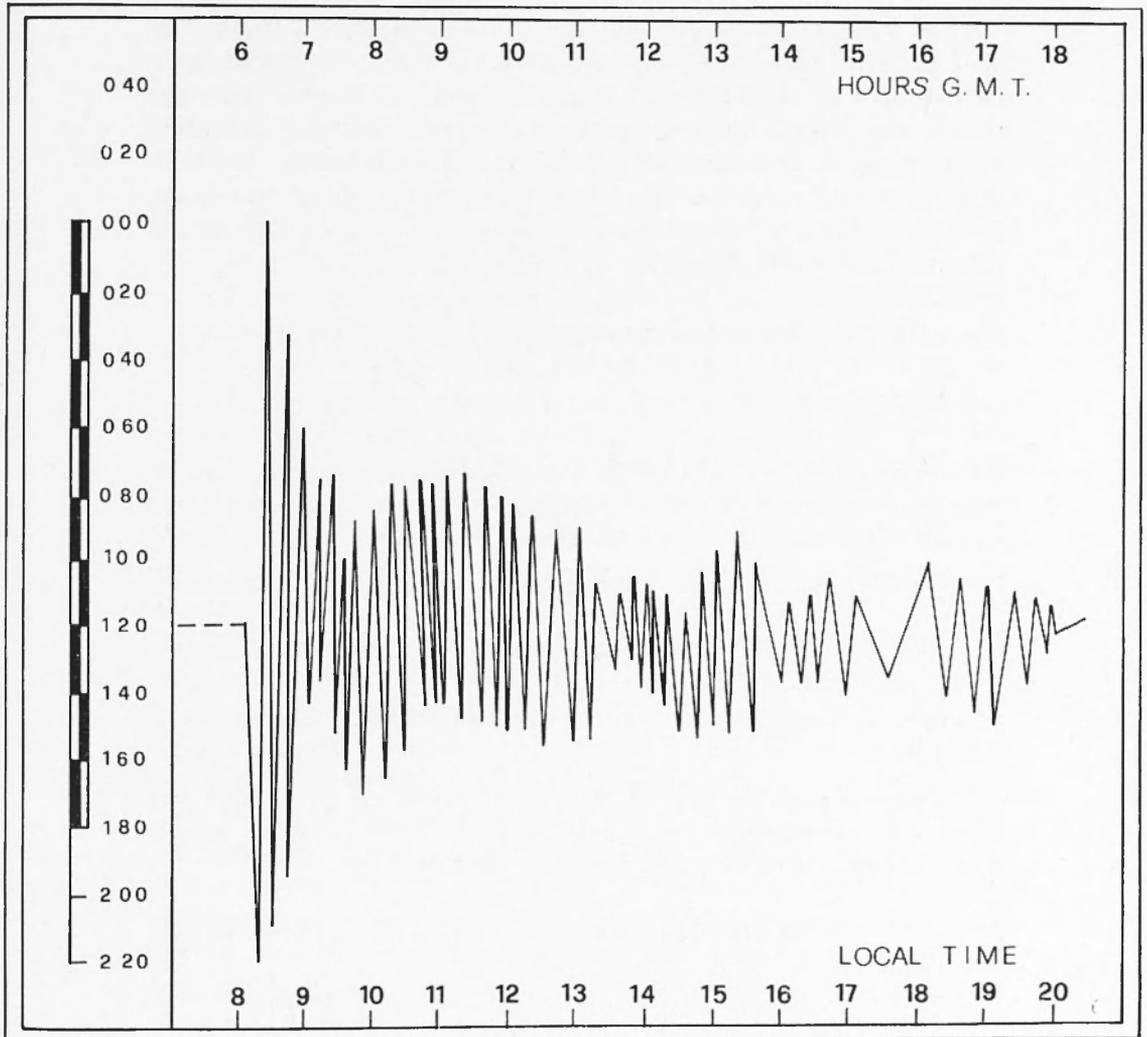
In the island of Antiparos the sea overflowed the shores and also the town of Kastro which stands on a ridge near the northern end of the island. Little damage was inflicted on buildings near the coast, but the quay was washed away, left with the top concrete slabs unsupported, leaning out at 45 degrees. Other parts of the pier settled considerably. A motorboat was taken by the waves and crashed on the rocks 30 m inland, while a score of fishing boats were taken offshore.

In the island of Lipso the sea advanced 1.400 m and a number of houses were damaged. In Sokora a large number of grazing cattle was taken by the wave and drowned. In the harbour of Lipso the wharf and quay were demolished, and harbour facilities were severely damaged. One house collapsed.

Near Laki of Leros island, the first movement was a retreat of the sea. Although the height of the waves was only 1.20 m a number of houses around the harbour were damaged and goods stored on the wharfs were taken away by the waves. Ten fishing boats were taken by the waves and destroyed. Many fishing villages on the island were flooded.



Sea-level fluctuations, Laki station, Lerós (N. N. AM BRASEYS, 1960), [Event n. 14].



Sea-level fluctuations, Souda station, Crete (N.N. AMBRASEYS, 1960), [Event n. 14].

In the town of Oiniki in Karpathos island, the wave was so severe that it demolished the break-water and anchorage of the harbour. The height of the wave there was over 6 m and flooded many villages inflicting severe damage to houses and drowning thirty cattle.

On the southwest promontory of the island of Rhodes, the islet of Prasonisos which was connected with the island by a narrow belt of land 300 m long, was detached shortly after the shock, the stretch of land connecting it with Rhodes subsiding more than 10 m underwater. It is not clear whether this subsidence was the result of the seismic shock. It appears, however, that the isthmus of Prasonisos subsided due to spreading of the soft material from which it was composed.

15. 1956 November 2. *Magnessia. Volos* ( $H=1.20m$ ) ( $m=ii+$ ).  
( $G C: 39\frac{1}{2} N - 23 E, I=VII, M=5\frac{3}{4}, d=n$ ).  
Ref: 11, 12a.

16. 1959\* February 23. *North and West Coasts of the Grecian Archipelago. Salonica* ( $H=1.00m$ ) *Salamis* ( $H=0,30m$ ), *Leros* ( $H=0,30m$ ), *Crete* ( $H=0,60m$ ).

No earthquake shock was recorded. Most probably a seiche.

17. 1961 May 23. *Asia Minor. Sea of Marmara, Smyrna* ( $m=ii?$ ).  
( $I=VII, M=6\frac{1}{2}, d=n$ ).  
Ref: *Bulletin of the Seismological Institute, Athens* (May, 1961).

The water of the gulf of Smyrna changed in colour and was filled with seaweed. A light wave was observed by some people living along the shore and familiar with the sea.

18. 1961\* June 6. *Grecian Archipelago. Crete* ( $H=1,00m$ ) ( $m=ii$ ), *Volos* ( $H=0,30m$ ), *Leros* ( $H=0,30m$ ).  
Ref: *Bulletin of the Seismological Institute, Athens*.

Probably strong seiche.

19. 1963 February 7. *Gulf of Corinth from Aeghion to Psathopyrgos*.  
Ref: *Annales Geologiques des pays helleniques, Athenes* 1964.

P. Comninakis, N. Delibasis and A. Galanopoulos, « A Tsunami Generated by an Earth Slump Set in Motion Without Shock »:  
On February 7, 1963, at 21: 28 (local time) three high waves

ravaged the southern coasts of the Gulf of Corinth from Aeghion to Psathopyrgos and the opposite coasts of central Greece from Monastiraki to Douvia. A subterranean rumble was heard the first 3 to 6-meter high wave struck, but no shock was felt. From Selianitika to Labiri, each about 3 kilometers distant from the mouth of the Erineos river, fishing boats were crushed on the rocks, fish were found strewn on fields, small houses of very poor construction were destroyed, and barrels, bedsteads and kitchen utensils littered the shoreline. The same occurred on the northern coast of the Gulf from Marathia to Trizonia. Two people were drowned and 12 were injured.

The waves were particularly severe on the cape Salmenikos, on the western side of the river, where a coastal strip of about 55,000 square meters slumped 5 to 44 meters under the sea. The slumped mass has been estimated at 57,000 cubic meters. Another slump took place in the bed of the river. The slumped material from the river bed was estimated at 26,000 cubic meters. On the western side of the river the waters entered about 500 meters inland. Reed, lemon and orange trees were uprooted and vineyards on both sides of the river covering an area of about 150,000 square meters were destroyed.

Taking the predominant period of the observed tsunami  $T_m = 2$  min and applying Iida's formulae, it was found the magnitude of the tsunami-associating shock  $M = 2.2$ , the average vertical displacement of the coastal strip  $\alpha_m = 10$  cm, and the diameter of the equivalent tsunami-source, assumed to be a circular depression,  $L = 0.25$  km. The findings are consistent with the observed area of the slumped strip (55,000 square metres) and the magnitude of the associating shock assumed to have been produced by a collapse of 57,000 cubic metres of loose material with a density  $\rho = 2$  gr/cm<sup>3</sup> and an average throw of 10 cm. The conclusion is that sudden subsidence of the coastal strip could have produced the tsunami.

The weather in the Eastern Mediterranean on February 7, 1963, and the extremely local character of the 1963 waves preclude a meteorological agent in starting the tsunami.

It is believed that a series of 7 local earthquakes having occurred near Patras on February 2, 1963, might have given rise to

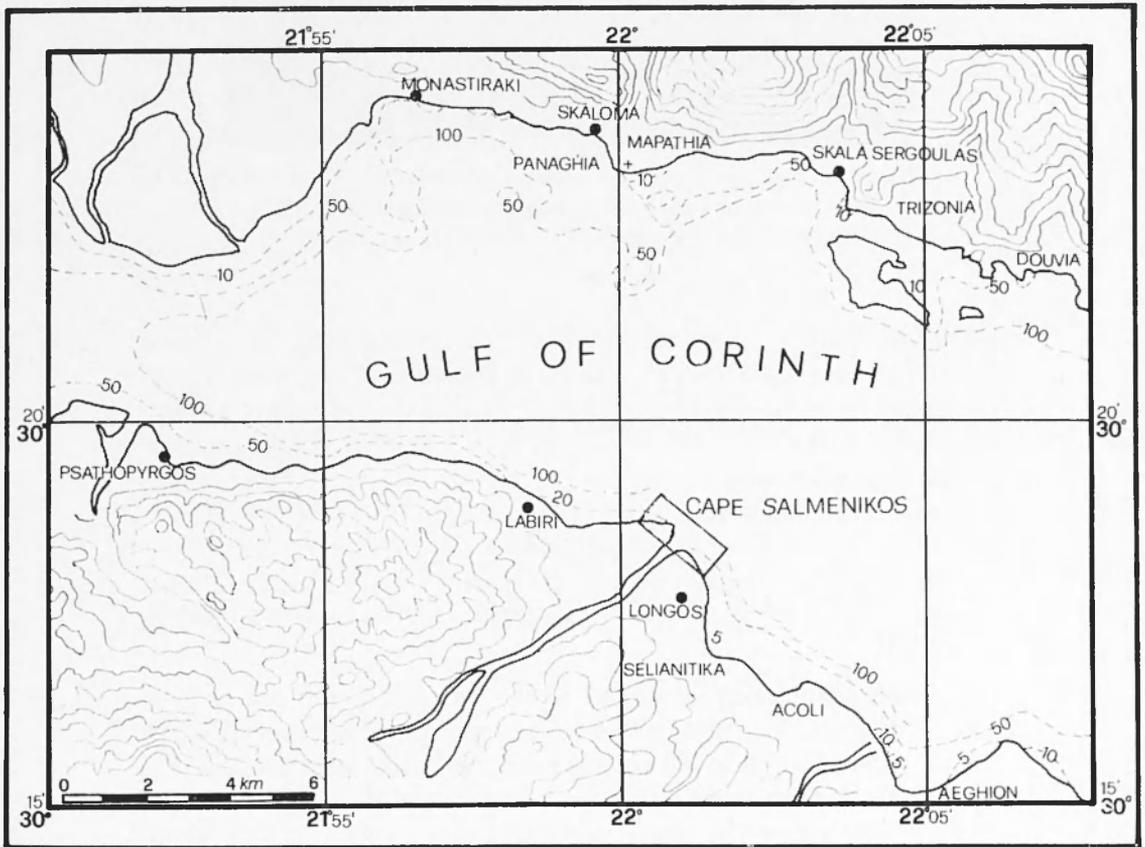


Failure of the front and baek wall of a brick house in the shore of Selianitica on February 7, 1963 [Event n. 19]. (P. COMNINAKIS, N. DELIBASIS and A. GALANOPOULOS, 1964)



Sea-weeds of a vine-branch 2,20 m high left in the region "Bouka" carried by the sea waves of 7th February 1963. Note the complete destruction of the vineyard [Event n. 19]. (P. COMNINAKIS, N. DELIBASIS and A. GALANOPOULOS, 1964)

a creep of the loose material which had been deposited in the shore area of the Erineos mouth region. Rainfalls in western Greece, the heaviest in seventy years, have accelerated this process and resulted in occurrence of an earth slump in the general river mouth region on February 7, 1963. Large landslides in western Greece, one of which has led to almost complete destruction of the village « Mikro Chorio » on January 13, 1963, favour the idea that abundant deposition of material at the upper edge of



A map of the Gulf of Corinth showing the area affected by the sea waves of the 7th February 1963, [Event n. 19]. (P. COMINAKIS, N. DELIBASIS and A. GALANOPOULUS. 1964)



Small bridge at a country coastal road found in the sea upon flooding of coast by seawaters, (Event n. 19).  
(Photograph, courtesy of N. N. AMBRASEYS)

the slope bank in the shore area of the river mouth must have been the main agent which caused a decrease of the stability of the slope so as to make it collapsed. Evidently the slumping was strong enough to set off sea waves, which caused severe damage to the nearest coasts.

20. 1965 July 6. Gulf of Corinth. Itea Bay.

(G C: 38.4 N — 22.3 E, I=VIII, M=6.3, d=n).

Ref: *Bulletin of the Seismological Institute, Athens* (May, 1965).

A subsidence was observed in the bottom of the sea of Eratini. In the south edge of the Gulf of Corinth, of a band of earth about 100 m long and 10 m large, as well as a light fluctuation of the tide in Itea bay.

On the bottom of the gulf of Galaxidi some crevices 30 m long and 5 m large. It was said that someone, who was sleeping on the beach, was drown because of the sliding of the earth band into the sea.

21. 1968 February 19. Islands St. Eustratios, Lemnos ( $m=ii$ ), Lesvos, Euboea.  
(G C: 39.5 N — 24.8 E,  $I=IX$ ,  $M=6.7$ ,  $d=n$ ).  
Ref: *Bulletin of the Seismological Institute, Athens* (February, 1968).

Island St. Eustratios, earth slumping in the region of St. Nicolas.

At the western coast of the island St. Eustratios a small tsunami set up observed in the southwestern side of Lemnos island. In the harbour of Myrina the tsunami built up to 1.20 m height. In the low region of Moudros and Kaspakas sea waters entered 20 m and 4 m inland respectively.

22. 1978 June 20. Salonica, Strymonic Gulf. Most probably a strong seiche. ( $m=ii$  —).  
(G C: 40,75 N — 23,26 E,  $M=6.5$   $d=16$ ).  
Ref: *Seismological Institute Bulletin, Athens*.

23. 1979 May 15. South Coasts of Crete. Most probably a strong seiche ( $m=ii$  —).  
(G C: 34,62 N — 24,08 E,  $M=5.8$   $d=58$ ).  
Ref: *Seismological Institute Bulletin, Athens. Apogevmatini* (16-5-79).

The epicenter of the earthquake was in the sea about 80 km far from the south coast of the island.

Many small craft in the area run a great risk as result of the seismic sea waves.

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