Geological Aspects of the Mediterranean Sea

The Prehistory of the Mediterranean region begins with the *Tethys Sea*, a large body of water between the African and the Eurasian continents. At its maximum size it extended from north of Arabia to the east of the Himalayas (Figs. 1 and 2).

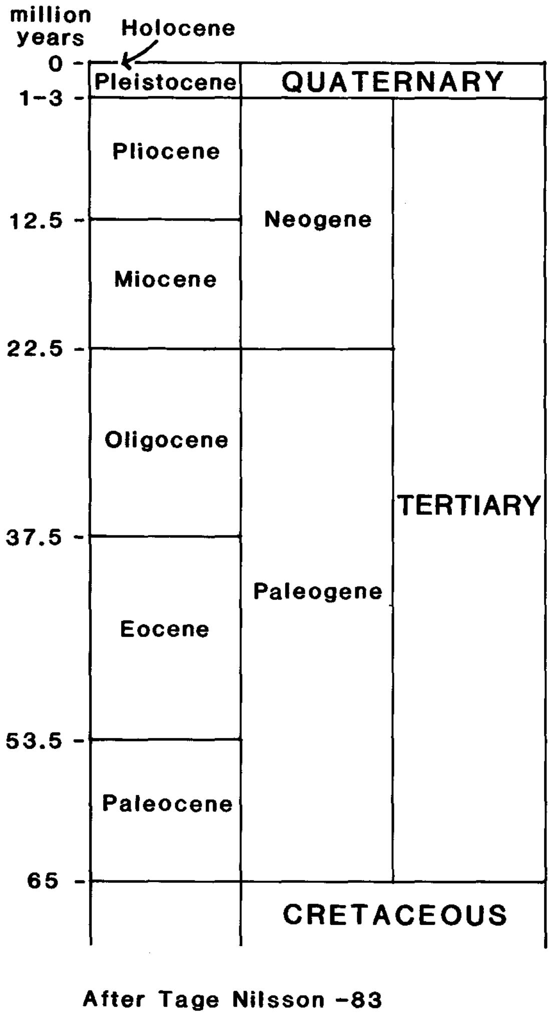

Fig. 1. Chronostratigraphical units and absolute chronology of the Cenozoic Era. The Tethys Sea existed from late Cretaceous to Miocene time.

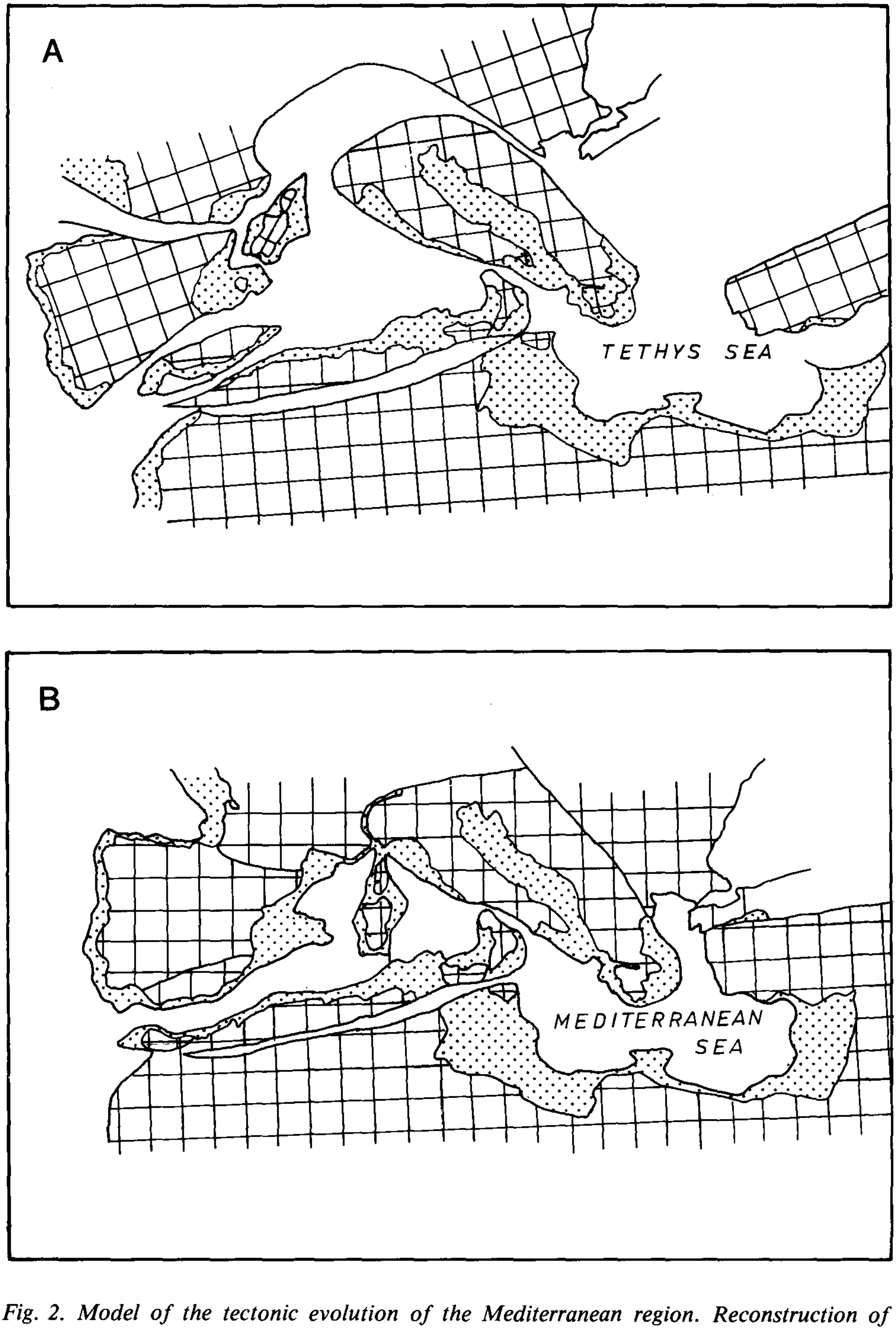

Fig. 2. Model of the tectonic evolution of the Mediterranean region. Reconstruction of microcontinents. After K.J. Hsu, 1977. A. The Tethys Sea in late Cretaceous time. B. The Mediterranean Sea in Tertiary (Miocene) time. From Kennett 1982.

Huge masses of sediments accumulated on the bottom of the Tethys Sea during nearly 200 million years. The southern continent, now Africa, broke up and moved northward against Eurasia, (Fig. 3) gradually diminishing and closing the Tethys Sea, until it became the recent Mediterranean Sea.

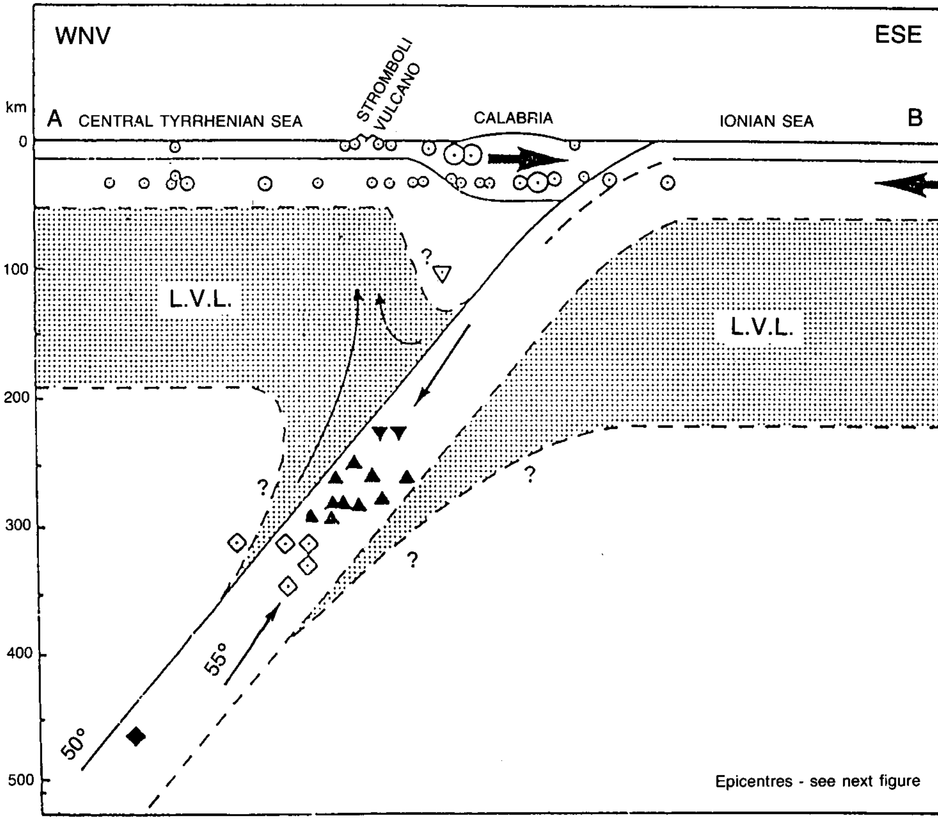

Fig. 3. Seismic profile through southern Tyrrhenian and Ionian Sea, a plate tectonic interpretation. L.V.L. = Low Velocity Layer. Simplified after Ritsema, 1971. From Pichler, 1981.

The tectonic movements buckled the thick accumulations of sea bottom sediments creating the mountain chain which extends from the Atlas range through the Mediterranean region, the western Alps, the Caucasus and the Himalayas.

Accordingly the Mediterranean Sea of today is a product of a near collision between Africa and Eurasia, reflected by modern tectonic movements, volcanism and earthquakes (Fig. 4). The trapped basin is relatively small, complex and deep. In some areas the depth exceeds 4.000 m.

A physiographic subdivision of the Mediterranean can be recognized :

1. *The Balearic Basin*, marked by a flat bottom plain.
2. *The Tyrrhenian and Aegean Seas*, exhibiting dormant or active volcanism.
3. *The eastern Mediterranean province*, dominated by an arcuate submarine ridge and confined volcanic activity. This province is influenced by compressional forces and the sea ultimately faces destruction.

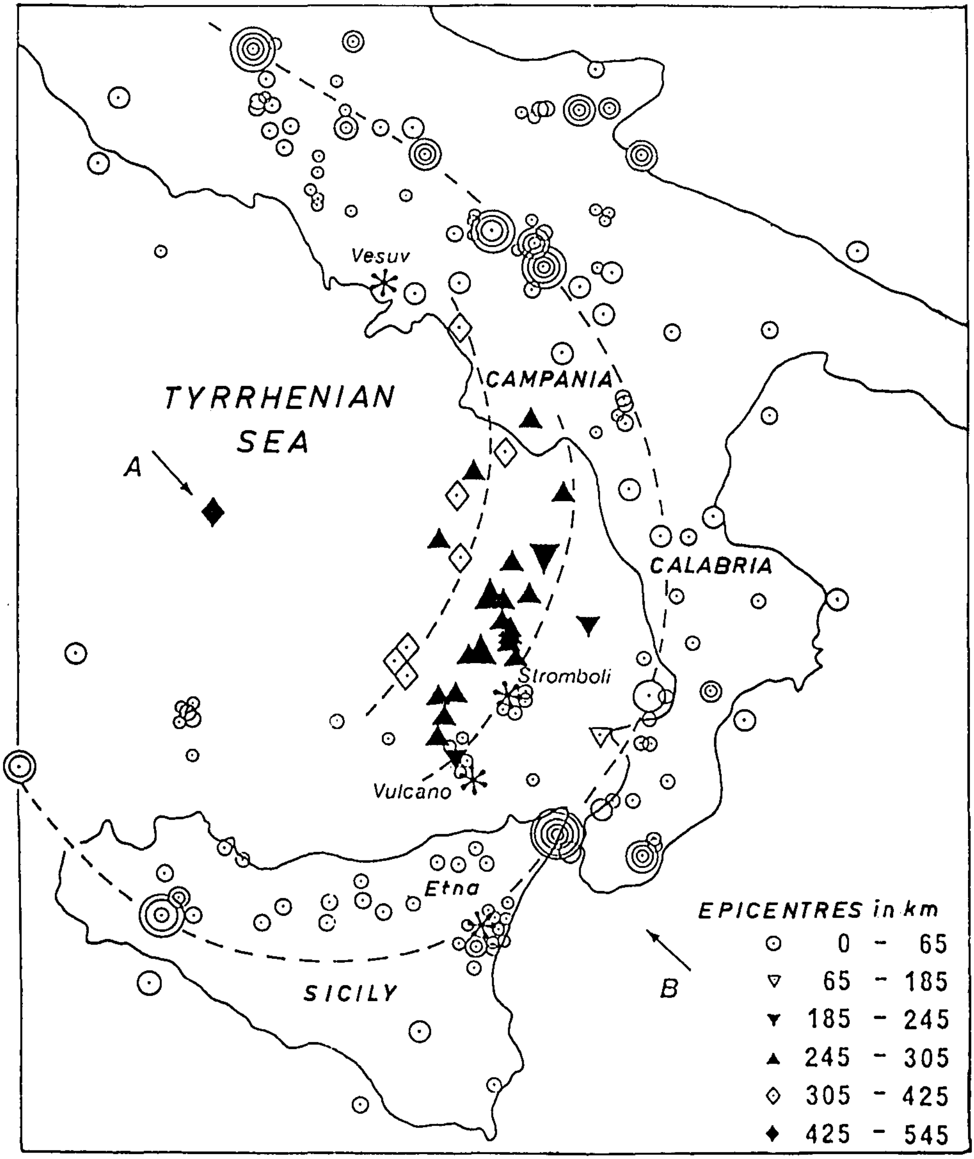

Fig. 4. Seismicity in earthquake belts along the Tyrrhenian Sea. Number and size of shallow earthquakes. A-B = seismic profile in figure 2. After Blot, 1971. From Pichler, 1981.

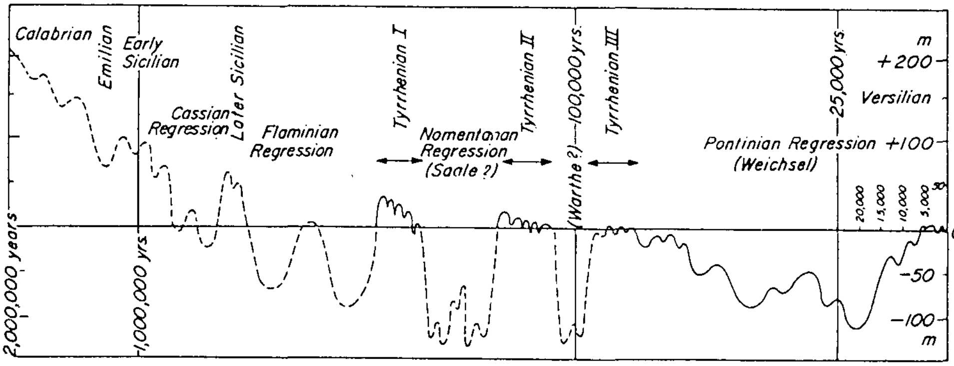

Fig. 5. Hypothetical trace of Quaternary sea-level oscillations in the mediterranean region. Time scale prior to 25.000 yrs B.P. is logarithmic. From K.G. Eriksson, 1961.

The evidence from recent geophysical studies of the Mediterranean region — deep-sea drilling and mapping of plate tectonic movements — shows a picture of a constantly changing mosaic of small and large plates, producing ridges, trenches, backarc basins and island arcs.

In the Miocene (Tertiary time), about 20 M.a. ago, the Mediterranean Sea began to assume the shape of today, in the same enlarging the Tyrrhenian Sea.

The topography of the surrounding mountains testifies insignificant Pleistocene glaciations. Isostatic sea level fluctuations are related to shifts in the local load and varying sedimentation rate, in the same time consequences of comprehensive climatic changes.

The predominance of young folded mountains in the Mediterranean area makes the study of eustatic sea level fluctuations a bit hazardous. In many districts recent crustal movements and volcanism are complicating factors. In spite of the negative evidence many scientists are of the opinion that it is possible to recognize a sequence of glacial-eustatic stages (Fig. 5). Research along the north-eastern part of the Tyrrhenian coastal region has clarified the Quaternary history of those districts of the borderland. The results indicate a relation between the glaciations in the Alps and the changes in the level of the sea and shows a correlation of the volcanic development with the Quaternary chronology (Fig. 6).

Several drilling cores from the bottom of the Mediterranean Sea have been investigated. More than 25 widely distributed volcanic ash (tephra) layers have been recorded. In small and medium explosive eruptions the volcanic cloud will rise up to the tropopause. The tephra distribution will mainly be dependent on the actual wind direction in the troposphere. In powerful explosive eruptions, however, the ash cloud may reach an altitude of 30 km or more, and the most finegrained particles can be carried all around the globe by prevailing winds in the stratosphere.

Estimated age (years BP)	NORTH-WEST EUROPE General division			BRITAIN	ALPS	CENTRAL ITALY Glaciations	Marine stages: MEDITERRANEAN	Marine stages: NW. EUROPE	Mammalian faunas: ITALY	Mammalian faunas: FRANCE	Mammalian faunas: HUNGARY	Mammalian faunas: CENTRAL EUROPE	Human races	Cultural stages	
0	HOLOCENE			Holocene			transgr. (« Nizza »)	Flandrian	modern fauna				Modern man	Meso-and Neolithic and younger	
10.000; 35.000	PLEISTOCENE	Late	Weichsel	Weichselian (Devensian)	Würm	Pontinian	regression	regression	younger faunas	younger faunas	younger faunas	numerous sites	classical Neanderthalers	Upper; « Middle »	Palaeolithic
75-110.000			Eem	Ipswichian	R.W.		Tyrrhenian	Eem Sea				Ehringsdorf Taubach. etc	pre-Neanderthalers and presapiens types	Lower	
? 125.000			Saale	Wolstonian	Riss	Nomentana	regression	regression				Steinheim etc.			
		Middle	Holstein	Hoxnian	M.R		?	Holstein Sea							
			Elster	Anglian	Mindel	? Flaminia	Roman Regression	regression						?	
400.000; 700.000			Cromer Complex	Cromerian Beestonian Pastonian	?	?	Crotonian	?	Cromerian		Biharian	Mosbachian (Mauer. Mosbach. Süssenborn)	Heidelberg man	? ? « Early »	
			Menapian	—	?	? ? Cassia	Sicilian								
900.000		Early	Waal	—				?	Valdarno Superiore	Villafranchian, Late: Senèze etc.	Villanyan	Erpfingen Tegelen			
			Eburonian	Baventian	?	?									
1.7 million			Tiglian	Antian Thurnian Ludhamian			Emilian	regression		Villafranchian, Middle: St. Vallier Roccaneyra Pardines					
			Praetiglian	? Waltonian	?	Acquatraversa	Calabrian	« Icenian » « Amstelian »		Villafranchian, Early: Étouaires		Zwarte fauna			
2-2.5 million	PLIOCENE		Reuverian	Coralline Crag			Piacentian-Astian	older marine deposits	Valdarne inferiore ?	? La Vialette					

Fig. 6. Correlation chart for the European Quaternary. From T. Nilsson, 1983.

Tephrochronology as a dating method is developing into a scientific tool of extraordinary accuracy. The major elements in tephras exhibit broad chemical similarities if they have the same silica content. Important for identification, correlation and for dating of geological events are the trace elements of the tephra, as for instance cerium (Ce), rubidium (Rb) and lanthanum (La).

Tephra or volcanic wind-borne material is also found in many other environments, e.g. in freshwater deposits, in eolian and fluvial sediments, in peat and in icecovers and recent glaciers. In the Mediterranean area in a near future it might be possible to construct a firm time table, based on tephrochronology and closely linked to archaeological dating — in the same time calibrating and rectifying other dating methods of volcanic ash (fission track, K-Ar radiometric dating).

Eolian dust, very small windborne particles of terrigenous minerals, mostly quartz, observed in drilling cores from the bottom of the western Mediterranean Sea indicate severe climatic conditions when accumulated in widespread layers.

Another type of microstratified sediments is repeated sequences of volcanic glass together with « coaly rods », interpreted as being ash of burnt grass. During the transition from Late Glacial to Postglacial time (Pleistocene-Holocene boundary) for instance, the climatic conditions seem to have been very unstable to judge from the abrupt changes between quite different sediment types and the relatively high frequency of beds of microstratified wind-borne material.

Advanced studies of *volcanic glass, obsidian*, has revealed a new method of dating, measuring *the hydration rate of the glass*. It seems to be useful for geological as well as for archaeological research. Thus it will be possible to date events ranging in age from a few hundred to several million years.

For accurate definitions of the *working vocabulary* of the earth sciences see BATES, R.L. and JACKSON, J.A. (*ed.*), *Dictionary of Geological Terms*, New York, 1984.

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