Mineralogy of Quaternary sand-size sediments from the Sea of Crete : Implication for provenance variability in active continental margins

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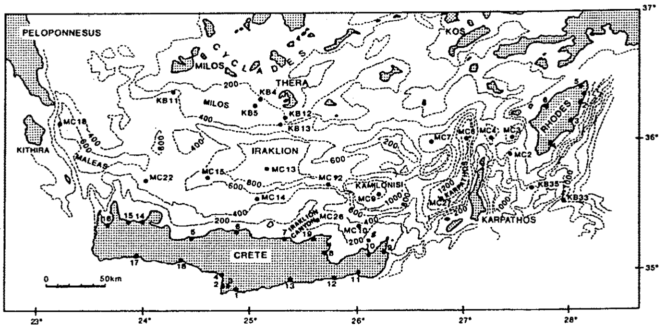
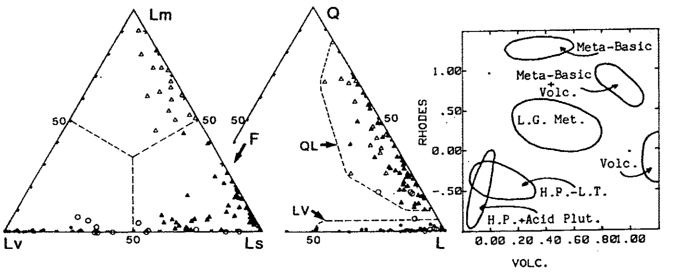
This study concerns 88 gravity core samples taken from 22 sampling points in the Sea of Crete (Bartole et al., 1983) and 25 samples collected along the coasts of Crete and Rhodes during the cruises R/V Noroit (1980) and R/V Bannock (1981). A mineralogical point-counting of both light and heavy minerals containing the sand-size fraction of these samples has been performed in order to infer the provenance of Quaternary turbidite sediments from the Sea of Crete.

Light mineral analysis shows that sands from the Sea of Crete can be subdivided into two different groups (Valloni and Mezzadri, 1984): (1) Lithovolcanic sands (LV), characterized by plagioclase and volcanic rock fragments (mostly wind-blown ash); and (2) Quartzolithic sands (QL) composed mainly of quartz and various types of metamorphic and sedimentary rock fragments (Saccani, 1987). LV sands are confined to the central and the northern part of the basin, closer to the volcanic arc of the Cyclades. QL sands occur in the southern part of the basin, closer to the Peloponnesus-Crete-Rhodes ridge (outer ridge). QL sands ca be further subdivided, on the basis of lithic grains, into two sub-groups: Lithometamorphic-dominated sands (Lm), in which metamorphic rock fragments are predominant; and Lithosedimentary-dominated sands (Ls), in which sedimentary rock fragments are prevalent. Lm and Ls sands occur in different portions of the basin depending on the composition of the closer source-area forming rocks.





Q-mode factor analysis of **heavy mineral** data shows that 5 heavy mineral associations occur in the Southern Aegean area:

(1) High pressure metamorphic assemblage (*Garnet - Epidote - Chloritoid - Glaucophane*) characterizing the western part of the basin behind the southern coasts of Peloponnesus (North Maleas basin). Provenance of these minerals is referred to the schists with Glaucophane outcropping in the Peloponnesus.

(2) High pressure metamorphic - acid igneous assemblage (*Green Hornblende - Apatite - Zircon - Sphene - Epidote - Glaucophane*) which is found in the branch of the basin behind the northwestern coasts of Crete (South Maleas basin). Provenance is inferred to be from the terrains of the phillite series outcropping in Northwestern Crete.

(3) Volcanic assemblage (*Hyperstene - Augite*) affecting the northern and central part of the basin (Milos, Iraklion, Kamilonisi and Karpathos basins). Provenance is from the volcanic arc of the Cyclades.

(4) Low grade metamorphic assemblage (*Epidote - Garnet -Amphiboles*) characterizing the sediments from Crete and from its northern slope and deriving from the metasedimentary terrains of Crete.

(5) Meta-basic assemblage (*Tremolite -Actinolite - Epidote - Spinel*) affecting the sediments from Rhodes, its slope and from the branch of the basin close to the Karpathos-Rhodes part of the outer ridge (Karpathos basin).

In conclusion, the two opposite margins of the Sea of Crete furnish to the basin quite distinct mineral assemblages. The different mineral associations descibed above are confined in individual sub-basins separated from each other by structural higs and plateaux (Bartole et al., 1983). Only in the eastern part of the basin volcanic-derived and metamorphic-derived sediments alternate vertically, depending on the prevalence of volcanic over tectonic processes.

An important issue which rises from these data is that, during Quatenary, compositionally differing sedimentary sequences developed within the same plate tectonic setting. Moreover, Recicled-Orogen-derived sands with stable mineral associations abundantly occur in a volcanic plate tectonic setting. Thus, this study is a great help in understanding sedimentation processes in modern and ancient sedimentary basins, especially along active continental margins.

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The prePliocene carbonate deposits at Leg 107 ODP - site 652 (Central Tyrrhenian Sea) : sedimentary and deagenetic frameworks

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The prePliocene sediments recovered at ODP site 652 (central Tyrrhenian) consist of a barren 533 m-thick calcareous -dolomitic mudstones and siltstones sequence intercalated with thin layers of nodular gypsum/anhydrite ,that have been interpreted to be lacustrine deposits of Messinian age . Upwards , the series passes into a 40 cm-thick transitional interval of varicolored clays and marls and then into Pliocene hemipelagic oozes . Petrography , bulk mineralogy and oxygen and carbon isotopes of the carbonate phases are used to characterize the sedimentary and diagenetic conditions in relation to the geodynamic context .

The prePliocene sequence may be subdivided in two zones based on the mineralogy and stable isotope composition of the carbonate phases :

In the upper zone (192 m -410 m), calcite is dominant and commonly associated with an assemblage of near-stoichiometric and Fe-rich dolomites . The δ values of calcite are rather constant (-4.5 ±0.5 for ^{18}O and -1.0±0.5 for ^{13}C) indicating deposition from a large and well-mixed reservoir of continental waters . The associated near-stroichiometric dolomite is enriched both in ^{18}O and ^{13}C with respect to calcite as expected for cogenetic minerals ; this dolomite formed from the same water as the calcite is thus considered as early diagenetic .

In the lower zone (410 m to the bottom), dolomite becomes dominant relative to calcite and is the only carbonate phase in several intervals . The composition of these dolomites ranges from near stoichiometry to Fe-rich. Calcite present in the lower zone registers a maximum 2°/°° decrease of $\delta^{18}O$ values while $\delta^{13}C$ values are unchanged ; the $\delta^{18}O$ variation is interpreted as the effect of burial diagenesis at a normal geothermal gradient of 3°C/100 m; therefore , the present-day thermal flow was induced after deposition of the late Messinian sequence .The Fe-rich dolomite exhibits low $\delta^{18}O$ values (-6.94 to -2.17) and negative $\delta^{13}C$ values (-2.64 to -0.58) which indicate respectively hotter and more restricted conditions during a late diagenetic event . The $\delta^{18}O$ values show a rather regular upwards decreasing trend by 4.8°/°° at maximum ; this has to be the result of alteration from a geothermal gradient of 9°C/100 m (or more in the case of modified ^{18}O-rich pore waters) , which is obviously post Messinian and related to the thermal subsidence of the basin . Furthermore , the $\delta^{18}O$ evolution with depth of the Fe-rich dolomites indicates that the flow of dolomitization fluids became hotter when ascending progressively through the sediments .