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Study of Neogene and Quaternary Terrestrial and Marine Sediments from Macedonia and Thrace, Greece

A. Tsirambides

Aristotle University of Thessaloniki, School of Geology, Department of Mineralogy-Petrology-Economic Geology, 54124 Thessaloniki, Greece, ananias@geo.auth.gr

Introduction

The Neogene and Quaternary sediments of Macedonia and Thrace lie unconformably over the folded alpine basement and are of fluvial, lacustrine or marine origin. These sediments are deposited into grabens or other neotectonic basins and are not connected to orogenetic procedures. The Post Alpine formations are widespread and are characterized by a wide lithological and facies variation. The Holocene sedimentation in the eastern Mediterranean is strongly affected by changes in the sea surface level associated with global paleoclimatic changes at the end of the Quaternary (Mountrakis, 2010).

The area of Macedonia and Thrace is a complex of grabens and horsts arranged in a NW-SE trend. Intermountain high level basins with elevation 400-500 m or low level basins with elevation 150-250 m, large coastal basins and plains were filled with Neogene and Quaternary sediments. Red beds are the most characteristic of them. They can be traced in the subsurface of the central parts of the basins. The widespread red beds and the associated rich mammalian fauna offer a good basis for stratigraphic and paleogeographic correlation with other sedimentary deposits in the Mediterranean (Psilovikos et al., 1987).

The coastline of Macedonia and Thrace incorporates the mouths of many small and large rivers. Most of them drain the mainland, except Evros, Nestos, Strymon and Axios that expand their network to neighboring countries. Evros River is the largest supplier of continental clastic material (8.5 × 106 tons/year) in the coastal region of NE Aegean. Similarly, in the Thermaikos Gulf, the rivers Gallikos, Axios, Aliakmon and Pinios discharge (25-30) × 106 tons/year of clastic terrestrial material (Poulos et al., 2000). The total suspended material in the NW Aegean is (484-830) × 103 tons/year (Karageorgis & Anagnostou, 2003).

Results and discussion

The fluvial sediments are climatically uniform in their setting and prograding into the north Aegean Sea. Tidal activity is negligible and the waves play a secondary role compared to the high sediment discharge of the rivers. Sand is the predominant (>60%) constituent of the river mouths (top sets), while the prodelta area consists mainly of silt- and clay-sized (>70%) particles (Poulos & Chronis, 1997).

The extended presence of quartz, feldspars and micas in the discharged material of the Evros is expected because it constitutes the weathering products of the large drainage basin of the river (extended in NE Greece and south Bulgaria), where igneous and metamorphic rocks predominate. The presence, in significant amounts, of zeolites is justified by the extended presence of volcaniclastic sediments in this drainage basin (Tsirambides & Kantiranis, 1998).

Evros is the largest supplier of fine grained Fe-Al-rich continental detritus to the offshore area. The modern sediments of the Alexandroupolis Gulf have adopted their characteristic zonal distribution in response to the coastal topography, the water motion and the quality of the supplied material. Acid and mafic igneous (especially volcanic), as well as metamorphic rocks cover the western and central parts of the Evros river drainage basin; Neogene sediments cover the eastern part and the coastal zone (Perissoratis et al., 1987).

The abundance of illite and smectite in the offshore sediments is mainly due to the weathering of primary Fe-Mg minerals of the drainage basin rocks and their transport and deposition in the Gulf. Especially, the abundance of smectite is enhanced by the high Fe and organic content, which results in a rapid flocculation and settling out of smectite grains. Kaolinite content expresses the strong climatic dependence controlled by the intensity of hydrolysis of continental rocks which occur in the drainage basin. However, the low content of kaolinite may be due to unfavorable climatic and physicochemical conditions, as well as to the detrital origin, rapid transport and deposition of the weathered material in the Gulf. Furthermore, the low percentage of the interstratified illite/smectite, as well as some presence of amphiboles in the clay fraction of the discharged material, confirm the limited reworking and weathering of the primary ferromagnesian minerals because of the high river discharge over short time periods and rapid deposition in the Gulf (Pehlivanoglou et al., 2000).

The most likely source materials for the formation of red beds at the Cedar Hills of Thessaloniki are feldspars, micas, and various Fe-Mg silicates, which are primary constituents of the metamorphic and ultramafic rocks predominating in these hills such as the greenschists (Tsirambides, 2004).

During Holocene, the rivers Gallikos, Axios, Aliakmon and Pinios discharged into the Thermaikos Gulf terrestrial clastic sediments with a mean accumulation rate 2.2 × 106 tons/yr. The maximum thickness of the sediments in the Gulf reaches 25-30 m. The estimated mean sedimentation rate ranges from 5 cm/ka to 15 cm/ka. The main minerals present in decreasing abundance are: quartz, feldspars (plagioclases > K-feldspars), Fe-Mg minerals, micas, and clay minerals. On average, the clay fraction (<2 μm) consists of: 48% illite, 26% smectite, 18% (chlorite + kaolinite), 3% quartz, 3%

feldspars and 2% Fe-Mg minerals. The origin of dolomite and calcite is mostly biogenic. Ordered and randomly interstratified phases of I/S are present. The abundance of smectite is enhanced by the high Fe and organic content of the terrigenous input, as well as by the physicochemical conditions of the seawater, which result in rapid flocculation and settling of smectite flocks. The low content of kaolinite may be due to unfavorable climatic and physicochemical conditions, as well as to the detrital origin, rapid transport and deposition of the weathered material in the Gulf. Furthermore, the presence of amphiboles observed even in the coarse clay fraction (2-0.25 μm) confirms the limited reworking and weathering of the primary ferromagnesian minerals because of the high river discharge over short time periods and rapid deposition in the Gulf. Finally, the significant presence of interstratified illite/smectite confirms the limited reworking and weathering of the primary minerals during their transport and deposition from the drainage basins of the rivers to the Gulf (Lykousis et al., 1981; Lykousis & Chronis, 1989; Karageorgis & Anagnostou, 2001; Pehlivanoglou et al., 2004).

The recent sediments of the Thermaikos Gulf have adopted their characteristic zone distribution in response to the coastal topography, the water circulation, and the prevailing climate in the region. The composition and dispersal of the suspended load of the rivers into the Gulf is controlled by the prevailing seasonal meteorological conditions at their catchment areas and the coastal area. The aggregation and distribution of clay particles in the Gulf is least controlled by the organic content of the terrigenous input because its presence is limited (Poulos et al., 2000).

Conclusions

All terrestrial sediments from Macedonia and Thrace are coarse grained and poorly sorted, with angular to sub-angular grains. These are mainly composed of quartz and feldspars, followed by micas, calcite and Fe-Mg minerals. Among the clay minerals illite predominates over smectite and smectite over vermiculite (+chlorite+kaolinite). In addition, the interstratifications I/S, Ch/V and S/V are present in significant amounts in the clay fraction (<2 μm), signifying the incomplete character of the weathering of the primary minerals. Mixing during transportation, flocculation, differential settling processes and organic matter are the main mechanisms for the distribution of the discharged terrigenous load into the North Aegean Gulfs.

All gulf bottom samples are coarse to fine grained and medium sorted, and their grains are angular to sub-angular. Quartz and feldspars predominate. In addition, biogenic carbonates (calcite+dolomite), micas and various Fe-Mg minerals exist as primary and/or accessory minerals. Among clay minerals, illite predominates over smectite and smectite over kaolinite. Almost in all sediments of the gulf bottoms the interstratified phase I/S is apparent.

The presence of feldspars and Fe-Mg minerals, as well as the high content of clay minerals and the polymodal grain-size distribution with angular to sub-angular grains, signify mineralogical and textural immaturity of all the examined terrestrial and marine sediments, as well as predominance of mild climatic conditions and thus mild weathering processes. The quartz content in these sediments is usually <65%. Therefore, a sedimentation cycle of these materials has not been completed.

References

Karageorgis, A., Anagnostou, Ch., 2001. Particulate matter spatial-temporal distribution and associated surface sediment properties: Thermaikos Gulf and Sporades Basin, NW Aegean Sea. Continental Shelf Research 21, 2141-2153.

Karageorgis, A., Anagnostou, Ch., 2003. Seasonal variation in the distribution of suspended particulate matter in the northwest Aegean Sea. J. Geophysical Research 108, No C8, 3274, doi: 10.1029/2002JC001672.

Lykousis, B., Chronis, G., 1989. Mechanisms of sediment transport and deposition: sediment sequences and accumulation during the Holocene on the Thermaikos Plateau, the continental slope, and basin (Sporades Basin), NW Aegean Sea, Greece. Marine Geology 87, 15-26.

Lykousis, B., Collins, M.B., Ferentinos, G., 1981. Modern sedimentation in the NW Aegean Sea. Marine Geology 43, 111-130.

Mountrakis, D., 2010. Geological and geotectonic evolution of Greece. University Studio Press, Thessaloniki (in Greek).

Pehlivanoglou, K., Tsirambides, A., Trontsios, G., 2000. Origin and Distribution of Clay Minerals in the Alexandroupolis Gulf, Aegean Sea, Greece. Estuarine Coastal & Shelf Science 51, 61-73.

Pehlivanoglou, K., Trontsios, G., Tsirambides, A., 2004. Grain size distribution, clay mineralogy and chemistry of bottom sediments from the outer Thermaikos Gulf, Aegean Sea, Greece. Mediterranean Marine Science 5(1), 43-53.

Perissoratis, C., Moorby, S.A., Papavassiliou, C., Cronan, D.S., Angelopoulos, I., Sakellariadou, F., Mitropoulos, D., 1987. The geology and geochemistry of the surficial sediments off Thraki, Northern Greece. Marine Geology 74, 209-224.

Poulos, S.E., Chronis, G.T., 1997. The importance of the river systems in the evolution of the Greek coastline. Bulletin of Institute of Oceanography Monaco 18, 75-96.

Poulos, S.E., Chronis G.T., Collins, M.B., Lykousis, V., 2000. Thermaikos Gulf Coastal System, NW Aegean Sea: an overview of water/sediment fluxes in relation to air–land–ocean interactions and human activities. J. Marine Systems 25, 47-76.

Psilovikos, A., Koufos, G., Syrides, G., 1987. The problem of red-beds in Northern Greece. Ann. Inst. Geol. Publ. Hung. LXX, 509-516.

Tsirambides, A., 2004. Genesis and physical characteristics of the Neogene red beds from the cedar hills of Thessaloniki, Macedonia, Greece. Bull. Geol. Soc. Greece 36, 708-716.

Tsirambides, A., Kantiranis, N., 1998. Composition and origin of the recent fluvial deposits of Evros (Thrace, Greece). Bull. Geol. Soc. Greece 32(2), 329-337.