NEOGENE FLUVIOLACUSTRINE SYSTEMS IN THE NORTHERN PERI-AEGEAN REGION

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Abstract: The complex fluviolacustrine systems in the northern Peri-Aegean Region were set on in Middle Miocene time, and fully developed in Late Miocene, Pliocene and Quaternary times. Their onset and evolution are closely related to the complex rifting along the Vardar/Axios and Strouma/Strymon fault belts.

Key words: Neogene dynamics; fluviolacustrine systems; Peri-Aegean

Pre-Miocene history

Complex fluviolacustrine systems existed in Late Eocene and Early Oligocene times South of the newly-formed Stara-planina (Balkan) mountain range, and were draining towards two (Piyanets and East-Rhodope) large marine gulfs. During the Late Oligocene marine regression, a system of river-connected lakes formed in connection to the Pannonian Paratethys, and was dried out and closed during a compression phase in earliest Neogene time. The principal planation surface (peneplain) on the Balkan Peninsula has been formed during the following relative tectonic quiescence. The low-mountain relief had been drained by small rivers that left no recognizable sediments.

Middle Miocene onset and evolution; First sedimentation cycle

First evidence about the onset of peri-Aegean fluviolacustrine systems comes from the late Middle Miocene (Karpatian? - Badenian – Sarmatian: Palamarev et al., 1999; Vatsev, 1999). The start of the neotectonic stage is marked by beginning Late Badenian – Early Sarmatian disintegration of the peneplain. Several horsts (the Pirin horst included) renewed their uplift.

The first sedimentation cycle recognized throughout the Strouma/Strymon fluviolacustrine system occurred in Badenian and Sarmatian times (Nedjalkov et al., 1988) within a river plain and local lakes. The lakes formed mostly in the Sarmatian, and often produced lignite coal seams (Kyustendil, Serres) and locally (Simitli) diatomites or diatom-bearing marls. The Vardar/Axios fluviolacustrine system (Psilovicos & Syrides, 1984) and parts (Rhodope, Razlog graben) of the Mesta/Nestos system have been also set on.

Second cycle: Maeotian and early Pontian

All three fluviolacustrine systems developed considerably (Fig. 1). Well-sorted thick alluvial deposits were related to meandering channels within the plain. A marine ingression flooded most of the Serres graben in Maeotian and early Pontian time. The northern threshold of the ingression in the whole peri-Aegean region has been the major Middle-Mesta fault at the southern slope of the Belasitsa/Kerkini Mountain and its continuations West and East. This fault has been a major and long-living branch of the North-Anatolian Fault Zone (NAFZ), with considerable normal faulting and right-lateral strike-slip displacements throughout Neogene and Quaternary times. Interaction of proluvial and alluvial sedimentation of the Palaeo-Strouma with the lacustrine sedimentation occurred within the Kyustendil graben. All along the Blagoevgrad, Simitli and Sandanski grabens, river channels within the plain and some small lakes were influenced by seasonal abundant flood of the border fans. The smooth relief and tropical to subtropical climate favoured the breeding of big mammals (Koufos et al., 1995; Spassov, 2001). The widening of the system in Maeotian time was certainly not only a result of its maturation but also of the gradual extension due to normal faulting in the graben boards. Gorges have been gradually incised through transversal horsts resulting from activation of cross or oblique faults.

The Mesta/Nestos fluviolacustrine system has been also enlarged. After initial alluvial and proluvial sedimentation related to the onset of Palaeo-Mesta in the Razlog and Gotse Delchev areas, lakes have been formed and evolved in Maeotian to Middle Pontian times with prolonged deposition of diatomites in the Gotse Delchev graben (Vatsev, 1999; Temniskova-Topalova & Ognjanova-Rumenova, 1997). These lakes have been probably related in Pontian times through the Drama basin and Palaeo-Angitis to the Serres basin and the Aegean Sea (Zagorchev et al., 2002).

The Pirin horst continued to be a low barrier between the two fluviolacustrine systems as witnessed by the presence of well-rounded marble fragments in the Badenian? – Sarmatian Katountsi Formation and the Maeotian Sandanski Formation (Sandanski graben), and in the conglomerate (Maeotian or Early Pontian) beneath the diatom calcareous clays near Amphipolis in the Serres graben. The evolution of the Ilindentsi and Katountsi proluvial fans with a steady influx of marble pebbles derived from the Pirin horst may be followed virtually at the same emplacements from Badenian? – Sarmatian through Maeotian and Pontian to Pliocene and Pleistocene times.

Third cycle: Late(?) Pontian to Early(?) Pliocene

The Pontian evolution of the fluviolacustrine systems exhibits a dramatic change in mid-Pontian time. It is marked by the massive influx of very coarse terrigenous material from the horsts into

the adjacent grabens, and is particularly important at the example of the Pirin horst. The latter has undergone an intense high-velocity uplift, with the partial destruction of the Maeotian oroplain, and formation of a rim of proluvial – alluvial fans within the surrounding grabens: the Kalimantsi Formation in the Sandanski graben, and the Nevrokop Formation, in the Gotse Delchev graben. The mass presence (for the first time) of pebbles from the Palaeogene granites proves the unroofing of their plutons in Pontian time (Zagorchev, 1992).

Fourth cycle: Pliocene

The palaeobotanical data (Palamarev et al., 1999) point at climate changes in Pliocene time: from tropical through subtropical and semi-arid to arid, and finally, to a moderate climate. The new bed of Palaeo-Strouma between the Simitli and Sandanski grabens was formed over the Late Cretaceous granites, and the gorge was widened and filled in by the second conglomerate-sandstone member of the Kalimantsi Formation that covered directly the weathered surface of the granite. The main connections between the different widened areas of the fluviolacustrine systems were already established almost in their present state. Intense horst uplift in late Pontian and Pliocene times led to deposition of thick proluvial-alluvial fans. The lower course of the very wide and mature Vardar/Axios fluviolacustrine system has been rich in lake and swamp basins often inherited since Miocene times. Probably first linked to the Vardar/Axios system, the rivers of the Mygdonia (Limni Volvi) graben with its Miocene-set lakes evolved with the development of a local watershed, and directed their course as an independent small system towards the Strymon gulf. The sea coast changed its outline. The most important neotectonic movements occurred in latest Pliocene times. They resulted in considerable block rotations and tilting of the grabens against the highest-amplitude faults (Zagorchev, 1992). Later (Pleistocene) sediments cover with unconformable depositional contact both the tilted pre-Quaternary sections and the graben-bounding normal faults.

Fifth cycle: Pleistocene and Holocene

Substantial new elements were introduced in the fluviolacustrine systems of the Peri-Aegean (Choleev & Baltakov, 1989; Psilovicos & Vavliakis, 1989) in Pleistocene times. The horst uplift was accompanied by climatic changes due to the coming ice ages. The highest mountains were covered by glaciers during three glacials (Mindel, Riss and Wurm). The glaciers almost melted during the interglacials, leaving glacial and fluvio-glacial deposits, typical circuses, and deeply incised V-shaped and U-shaped valleys in the mountains. Moraines often dammed the valleys with formation of relict lakes during the interglacials and in the post-glacial time (Holocene). Big lakes (Doyran, Boutkovo/Kerkini, Mygdonia, Drama, Volax and Bistonis) existed in the peri-

Aegean coastal plain South of the Middle-Mesta fault zone. Glaciation in the high mountains (Velchev, 1995) induced the formation of glacial and fluvioglacial deposits in the river valleys, and produced typical features of the relief. Mesta/Nestos emancipated from the Strouma/Strymon fluviolacustrine system with formation of a new gorge through the young horst of Lekanis Mountain, and formed the present impressive delta partially at the expense of the Prinos-Kavala basin.

Conclusions

The evolution of the Neogene - Quaternary fluviolacustrine systems in the northern peri-Aegean Region allows for several important conclusions:

1) The neotectonic stage began after prolonged quiescence and planation that formed the principal peneplain. Normal faulting was the dominant mechanism, with repeated offsets along faults of the major fault belts, and evolution of the fluviolacustrine systems within the grabens with deposition of 1500 (Simitli, Sandanski) – 3500 m (Serres) thick proluvial, alluvial and lacustrine sediments. The fluviolacustrine systems (Palaeo-Strouma and Palaeo-Mesta) have been separated by the constantly uplifting Pirin horst, and the Peri-Aegean coastal plain has been limited to the North by the Middle-Mesta normal fault.

2) The evolution of the fluviolacustrine systems in Neogene times is clearly divided into three stages, and namely, (i) onset: Badenian – Sarmatian; (ii) mature stage: Maeotian – Pontian (partially); (iii) activation of the block disintegration in Pontian and Pliocene times: increased normal faulting with unroofing of the Palaeogene granite plutons in the highest horsts (Pirin), and cyclic deposition of coarse sediments within the graben fluviolacustrine systems. There are no proofs for the existence of detachment faults nor for exhumation of metamorphic core complexes.

3) The high-amplitude displacements and block tilting in latest Pliocene times led to a partial re-distribution of the drainage network, formation of new connecting gorges, and (due to Pleistocene glaciation in the high mountains) deposition of glacial and fluvioglacial sediments.

References

Choleev, I., & Baltackov, G., 1989: Basic features of Late Cenozoic evolution of the Mesta valley system in Bulgaria. *Geographica Rhodopica*, 1, 14-17.

Georgakopoulos, A., 2000: Lithology and stratigraphy of the Neogene Prinos-Kavala basin, Northern Greece. *Geological Society of Greece, Special Publication No 9*, 79-84.

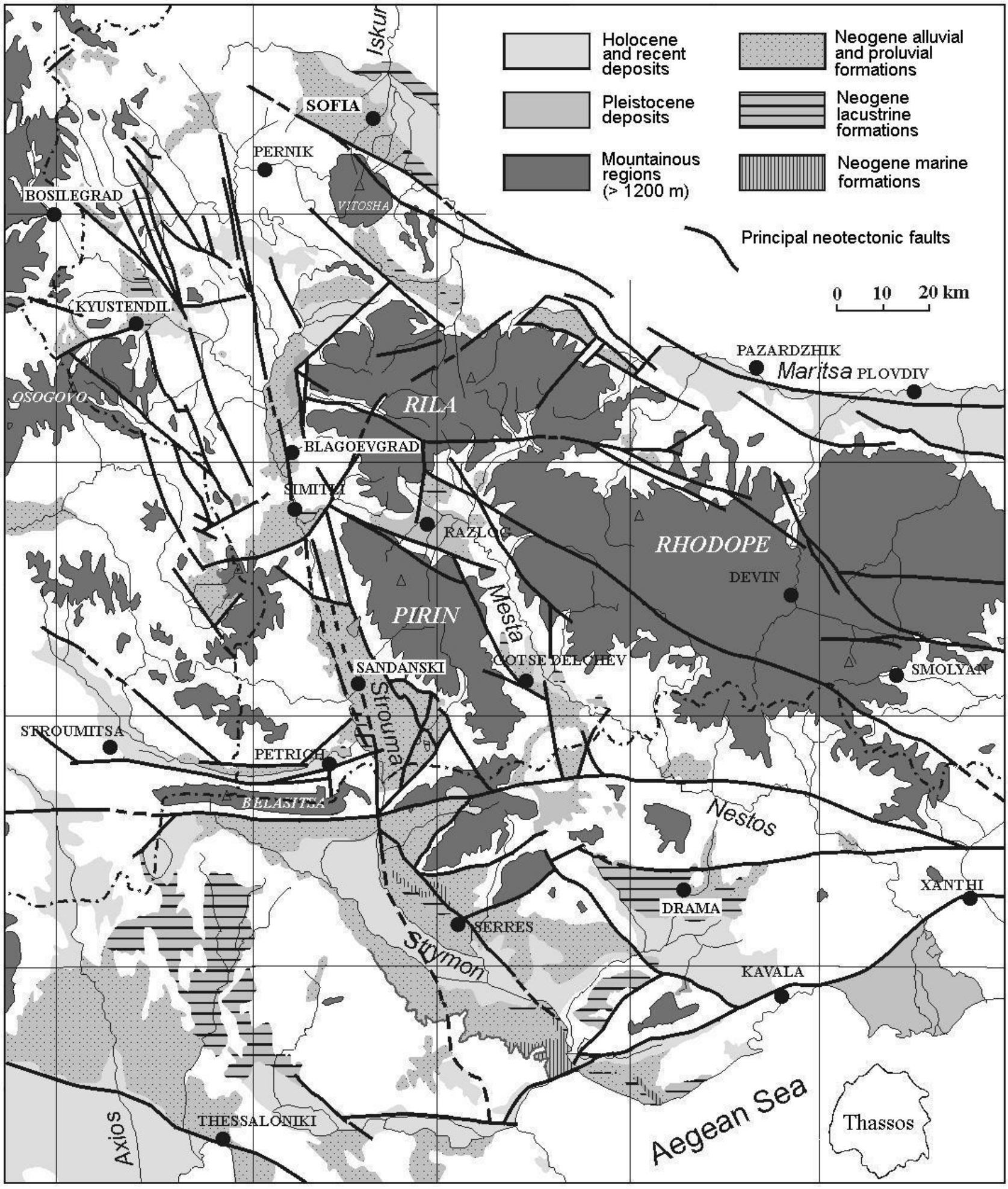
Karistineos, N. K., & Georgiades-Dikeoulia, E., 1986: The marine transgression in the Serres basin. *Annales geologiques des pays helleniques,* 33; 321-332.

Koufos, G. D., Syrides, G. E., Kostopoulos, D.S., & Koliadimou, K.K., 1995: Preliminary results about the stratigraphy and the palaeoenvironment of Mygdonia basin, Macedonia, Greece. *Geobios,* M.S. 18, 243-249.

Nedjalkov, P., Kojumdgieva, E., & Bozhkov, I., 1988: Sedimentary cycles in the Neogene grabens along the

Struma valley. *Geologica Balcanica,* 18, 2, 61-66.
Palamarev, D., Ivanov, D., & Bozukov, V., 1999: Palaeoflorenkomplexe im Zentralbalkanischen Raum und ihre Entwicklungsgeschichte von den Wende Oligozaen/Miozaen bis ins Villafranchium. *Flora Tertiaria Mediterranea*, VI, 5, 1-95.
Psilovicos, A., & Syrides, G., 1984. Neogene and Quaternary palaeoenvironments in the Northern Aegean area. Annales Geologiques des Pays Helleniques, 32; 105-114.
Psilovicos, A., & Vavliakis, E., 1989. Contribution to the evolution of the river Nestos valley in the Greek Rhodopes. *Geographica Rhodopica*, 1; 26-33.
Spassov, N., 2001: The Turolian Megafauna of West Bulgaria and the character of the Late Miocene "Pikermian biome". *Bolletino della Societa Paleontologica Italiana* (in press).
Syrides, G., 2000: Neogene marine cycles in Strymon basin, Macedonia, Greece. *Geological Society of Greece, Special Publication No 9*; 217-225.
Temniskova-Topalova, D. & Ognyanova-Rumenova, N. 1997: Description, comparison and biostratigraphy of the non-marine Neogene diatom floras from Southern Bulgaria. *Geologica Balcanica*, 27, 1-2; 57-81.
Vatsev, M., 1999: New data about the stratigraphy of the Neogene rocks from the Southwestern Rhodopes. *Review of the Bulgarian Geological Society,* 60, 1-3, 127-137 (in Bulgarian).
Velchev, A., 1995. Pleistocene glaciation of the Bulgarian mountains*. Annuaire Universite de Sofia, livre 2 – Geographie*, 87, 53-65.
Zagorchev, I., 1992: Neotectonic development of the Struma (Kraistid) Lineament, southwest Bulgaria and northern Greece. *Geological Magazine,* 129, 2, 197-222.
Zagorchev, I., Stoykova, K., Ognyanova, N. & Dimadis, L. 2002 (this volume). Pontian lacustrine regimes and marine ingression in the Strymon area, Northern Greece.

Fig. 1. Sketch map for the peri-Aegean fluviolacustrine systems in Neogene and Quaternary times


Holocene and recent deposits
Pleistocene deposits
Mountainous regions (> 1200 m)
Neogene alluvial and proluvial formations
Neogene lacustrine formations
Neogene marine formations
Principal neotectonic faults
0 10 20 km
Iskur
SOFIA
PERNIK
BOSILEGRAD
VITOSHA
KYUSTENDIL
OSOGOVO
RILA
BLAGOEVGRAD
SIMITLI
RAZLOG
PAZARDZHIK
Maritsa
PLOVDIV
RHODOPE
DEVIN
PIRIN
Mesta
GOTSE DELCHEV
SANDANSKI
SMOLYAN
Strouma
STROUMITSA
PETRICH
BELASITSA
Nestos
XANTHI
DRAMA
SERRES
Strymon
KAVALA
Aegean Sea
Thassos
Axios
THESSALONIKI