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ENDODYNAMIC DETERMINATION AND REARRANGEMENT OF VALLEY SYSTEMS IN BULGARIA AT THE PLIOCENE-QUATERNARY BOUNDARY

ABSTRACT: ANGELOVA D., *Endodynamic determination and rearrangement of valley systems in Bulgaria at the Pliocene-Quaternary boundary.* (IT ISSN 1724-4757, 2003).

Valleys are an important relief element. Valley systems include genetically and dynamically connected valleys of different taxonomic rank and order. The regional and local endodynamic features are reflected in their plan outlines and configuration. Centers of valley divergence and convergence are formed morphologically. The present work considers these phenomena in Bulgaria at the Pliocene-Quaternary boundary. The Fore-Carpathian basin was entirely annihilated at that time, the Black Sea basin was extensionally opened and the Mediterranean basin was also subjected to changes. Regional erosion bases were changed. The formation and orientation of almost all the big rivers was influenced by the linear tectonic structures. The main watershed at the Balkans (in the Bulgarian territory) was stable with small exceptions, its line being broken by tectonic deformations. The space between the valley systems was more dynamic. As a result the position of the secondary and tertiary watersheds was changed. New centers of valley divergence and convergence were created. Many new data about the geodynamics of the Bulgarian territory are presented.

KEY WORDS: Valley systems, Regional and local tectonics, Erosion bases, Plio-Quaternary, Bulgaria.

INTRODUCTION

The valley systems are an important element of the relief development in Bulgaria. They include genetically and dynamically related valleys of different taxonomic rank and order. Their morphological features are characterized by great diversity and complexity. Their plan outlines and configuration reflect the regional and local endodynamic specificity (fig. 1).

The problems about the history of the valley system development and their morphology are one of the most well studied and debatable ones in Bulgarian geomorphology. They have been summarized in the works of Angelova & and references therein, Kostadinova (1995), Angelova & *alii* (2001) and others. These problems have been treated in all regional geomorphologic and specialized geological investigations. The present work considers the endodynamic predetermination and the rearrangements of the valley systems in the Bulgarian territory during the time of one of the most dynamic boundaries, the Pliocene-Quaternary. The work has been performed on the basis of basin analysis and the participation of the author in terrain geological and geomorphologic mapping of Bulgaria in the course of 30 years. No such investigation has been carried out so far.

REGIONAL FACTORS AND BASIC REARRANGEMENTS IN THE RIVER SYSTEMS

The Pliocene-Quaternary boundary was one of the most dynamic ones in the territory of the Balkan Peninsula. The basins serving as regional erosion bases were rearranged at that time. The Fore-Carpathian basin was entirely annihilated and the Black Sea basin was extensionally opened. Changes took place in the Mediterranean basin too. The situation of Bulgaria determines its importance as major morpho-hydrological node for decoding the geodynamic development in the space between Europe, Africa and Asia. The reconstruction of the river network in Bulgaria during the Late Pliocene (i.e. before its rearrangement, the setting and formation of the contemporary river-valley network) is shown in figure 2.

It is seen that the most important hydrological node, in which joined the major watersheds on the Balkan Peninsula during this period, was situated here. The tectonic activation during the Wallachian tectonic phase included all the structural units. The energy of the tectonic movements contributed to the formation of the main orographic lines. Radical changes in the main and secondary watershed

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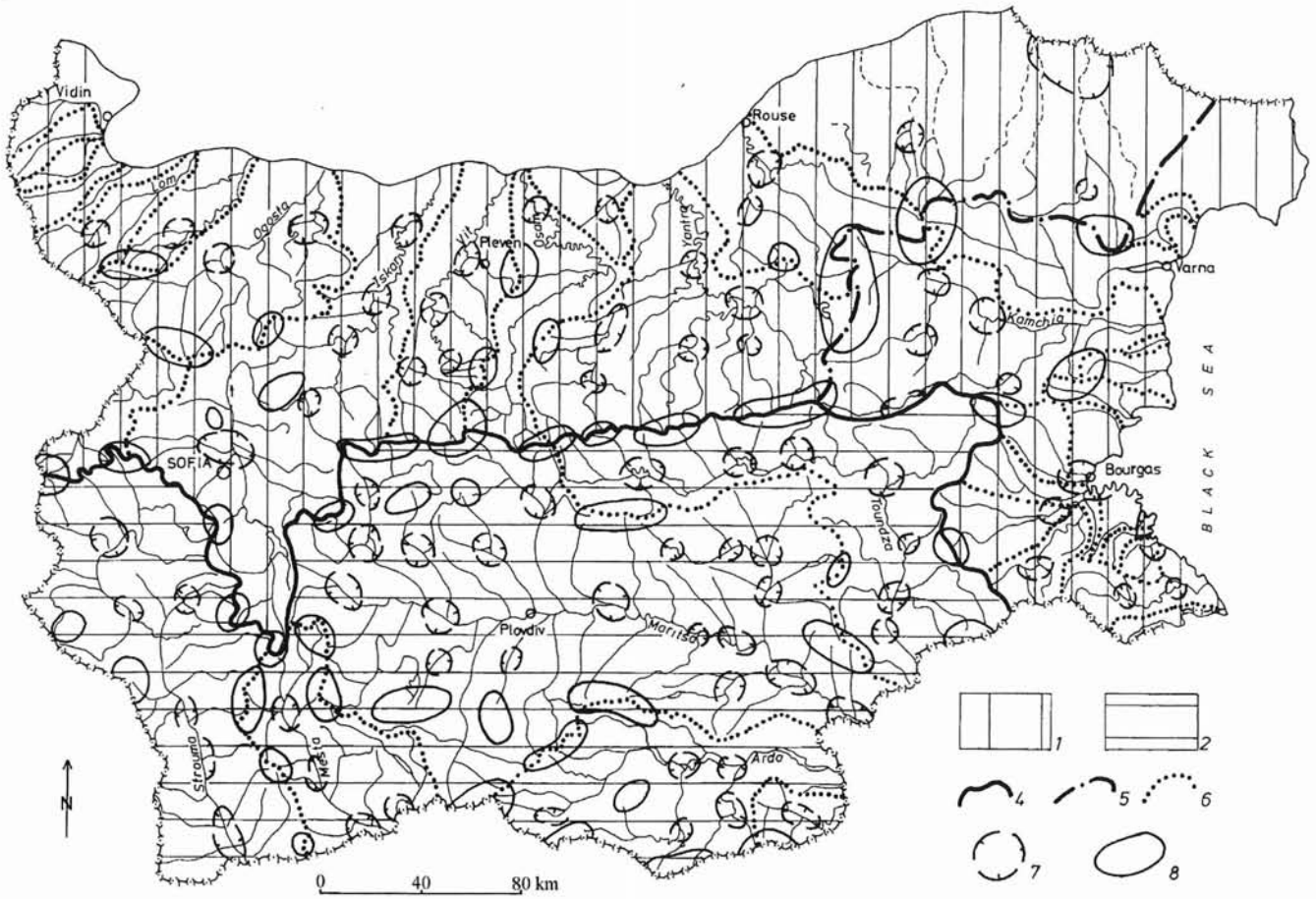

FIG. 1 - Map of the actual river valley systems in Bulgaria: 1 - river systems affiliated to the Black Sea basin; 2 - river systems affiliated to the Aegean basin; 3 - main watershed; 4 - secondary watershed; 5 - watersheds between the single valley systems; 6 - centers of convergence; 7 - centers of divergence.

ridges took place on the Balkan Peninsula. The Fore-Carpathian and the Panonian basins were closed due to collision and the Black Sea basin was opened as a result of post-collision extension. The geological-structural features of the Bulgarian territory determined the formation of indifferent and structural valleys. Their direction depended on the direction of their spreading. In this way, longitudinal, transverse, diagonal, orthogonal (consequent, subsequent, resequent and obsequent), radial beam valleys. New centers of divergence and convergence were formed (fig. 2). They served as benchmarks during the investigation and development of the map and the understanding of the evolution and development of the valley systems during the Late Neogene and the Quaternary. The regions with the origins of the primary valleys were important centers of valley divergence during the Plio-Pleistocene, the major watersheds between the basins passing through their territory. The major morpho-hydrological center on the Balkans was considered to occupy the hilly-mount space to the east of the Sofia City, which was residual from the initial surface of the river-valley system development.

The centers of valley convergence were formed in the basins of the main valleys and were the basic formation units of the single valley systems or were the places of gravitation of different valley systems (fig. 2).

The valley systems of the rivers Strouma, Mesta, Maritsa and Arda preserved their affiliation to the Mediterranean basin during the Late Neogene and the Quaternary (figs. 1, 2, 3).

The Strouma River has its source in the Vitosha Mountain. Its run-off was to the south through the Radomir kettle during the Pliocene. The remnants of this old river valley are well preserved between the Kosmatitsa and Petrus Peaks. Considerable vertical tectonic deformations occurred in its upper reach at the Pliocene-Quaternary boundary and the mountain block structures of the Vitosha, Golo Bardo and Verila Mts. were formed. These tectonic movements were realized along the faults with S-N, E-W and NE-SW direction and caused the global changes in the run-off direction of the Strouma River to north and west towards the Pernik kettle, where a new center of divergence was formed together with the paleorivers (Ange-

lova & Matova, 1993) (fig. 3). The impulse tectonic event diverged a part of the river water in a zone of strong tectonic processing and the formation of the galleries of the longest water cave in Bulgaria - the «Douhlata» cave had been started (Benderev & Angelova, 2000). Rearrangements in the Strouma River watershed are observed in its NW end, where considerable parts of the paleowatersheds were reoriented by bifurcation and pyratery, thus setting the contemporary configuration of the Breznishka, Konska and other rivers. The gorge sections were formed too (Tchoumatchenko, 1966; Vaptsarov, 1975; Konstantinov & Kanev, 1986; Kostadinova, 1995).

The Pliocene-Quaternary boundary was a new stage in the final shaping of the contemporary Maritsa River valley system (Angelova & *alii*, 1993). The main direction of the river during the Pliocene was to SE and it was clearly predetermined in structural and tectonic aspect (fig. 2). The character and development of the fault structures during the Plio-Pleistocene were the reason for the twice repeated shifting to the N of the main river artery and for the cutting of the old valleys and the contemporary system formation. Fragments of the oldest riverbed are preserved along the contemporary watersheds of the Maritsa River and its tributaries as the oldest river terrace level. They were covered by younger Quaternary sediments in the Plovdiv lowland as a result of the Pleistocene subsidence of the morphostructure. Deformations are observed along the faults with direction W-E, NW-SE, N-S, SW-NE, NW-SE. The tectonic deformations during the N_2-Q_1 caused the creation of new divergence and convergence centers (figs. 2, 3), breaking of the watershed between the Toundja and Maritsa Rivers, rearrangements and creation of new river valleys (Dragomanov & *alii*, 1989; Angelova & *alii*, 1991a,b; Angelova, 1992). The direction of the Sredna Gora tributaries was SE and N-S and of the Rhodopes tributaries of the Maritsa River - NE, E and S-N (fig. 1). A part of the Toundja River watershed was disconnected and reoriented to the

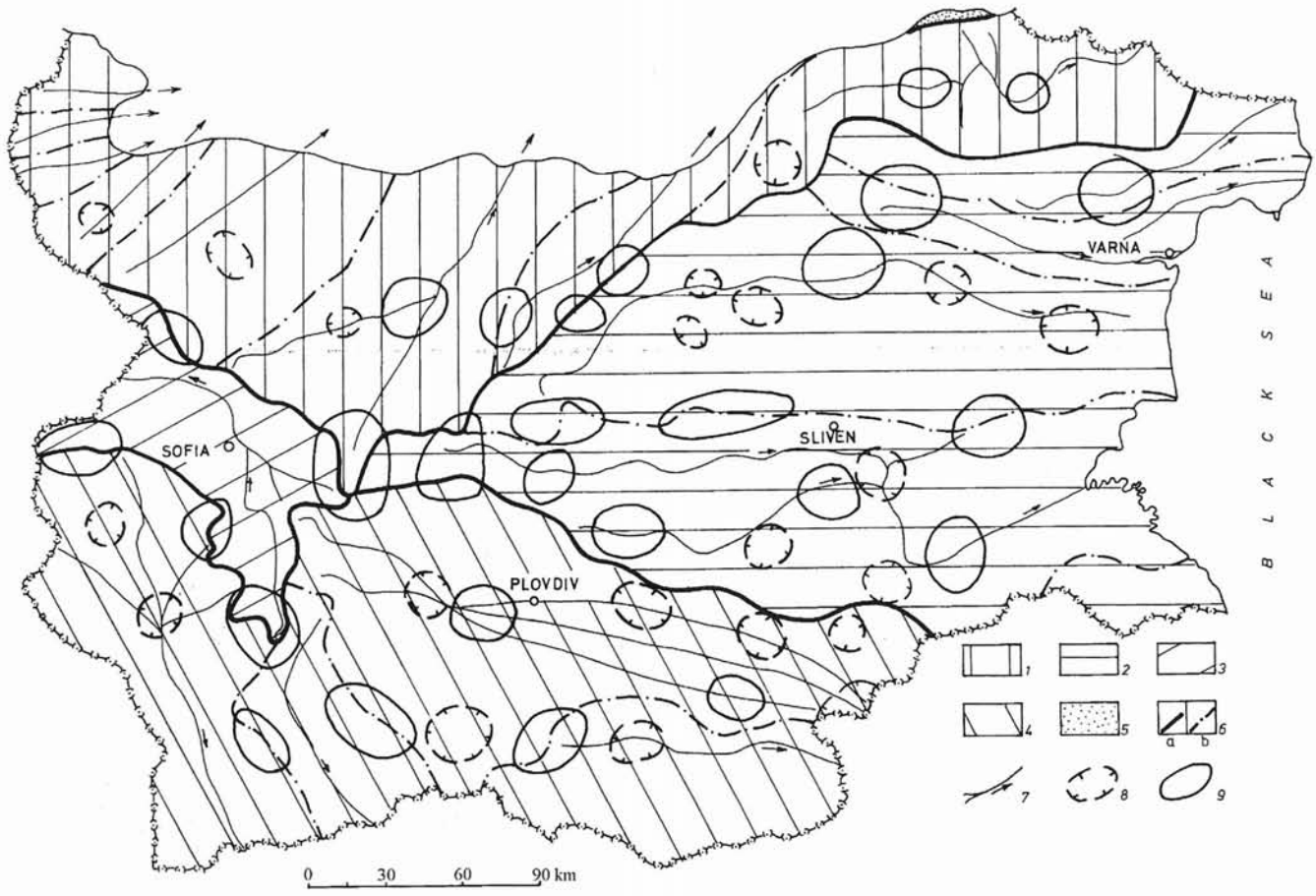

FIG. 2 - Map of the Late Pliocene river basins and centers of rearrangement at the Pliocene-Quaternary boundary: 1 - valley systems affiliated to the Fore-Carpathian basin; 2 - valley systems affiliated to the Black Sea basin; 3 - valley systems affiliated to the Panonian basin; 4 - valley systems affiliated to the Mediterranean basin; 5 - Rousse-Silistra bay of the Dacian basin; 6 - watersheds: a) main and b) secondary; 7 - run-off direction of the Late Pliocene major river artery; 8 - center of convergence; 9 - center of divergence.

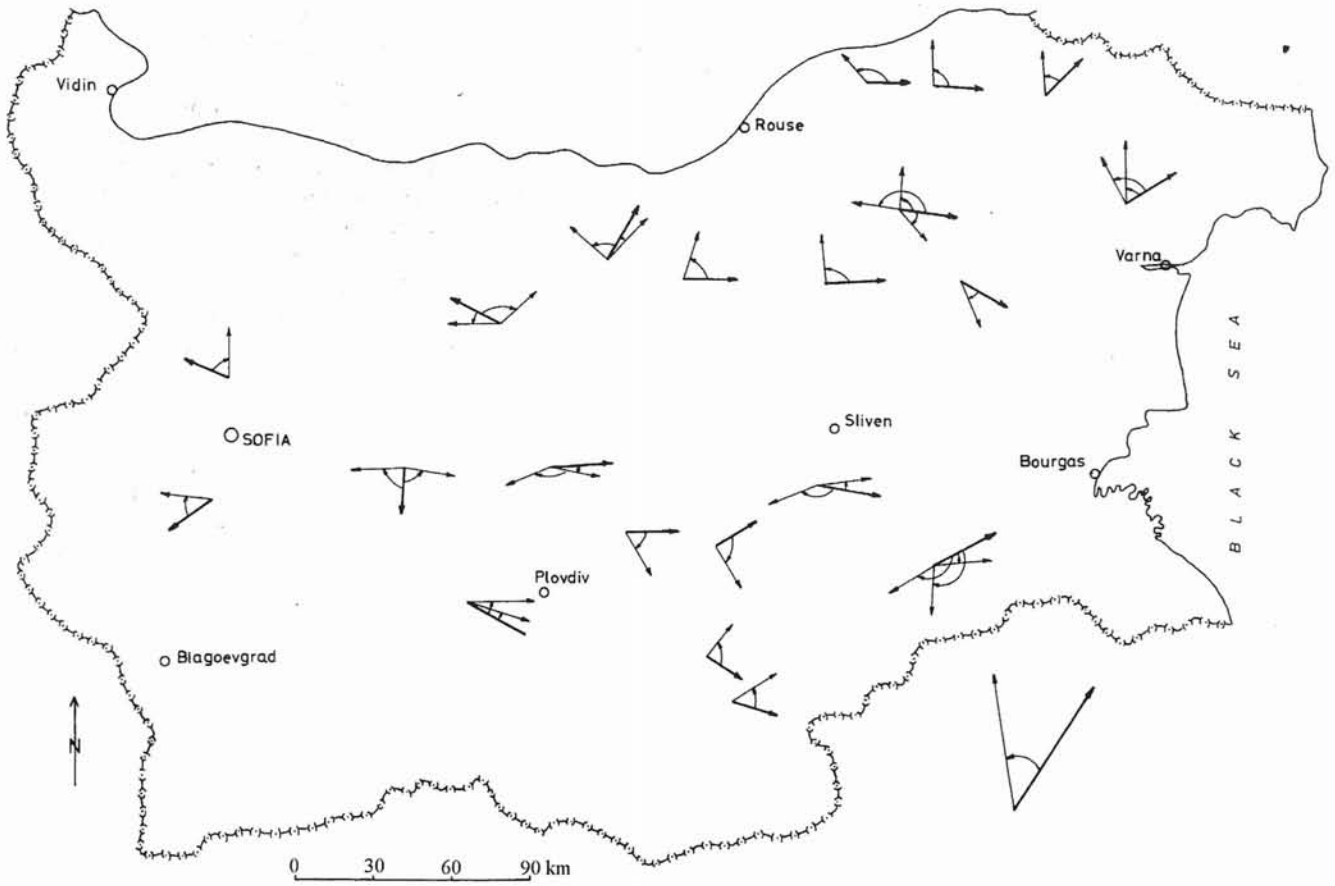

FIG. 3 - Map of the directions of the river system rearrangements: full vector – main directions of the Late Pliocene river systems; light vector – directions of the river system convergence in the centers of divergence.

south along the Sazliika gorge to the Maritsa River watershed (figs. 2, 3).

The subareal plane of the Black Sea basin was very big during the Pliocene (fig. 1). The main valley systems included the entire contemporary valley systems or parts of them, now affiliated to other watersheds. The geodynamic processes that occurred here at the Pliocene-Quaternary boundary were the most vigorous ones. The Quaternary building of the mountain structures in the Central and Eastern Stara Planina Mt., the formation of Bakadzhitsite as an active low-mountain structure (the main watershed between the Black Sea and the Mediterranean basins passes through it nowadays), the tectonic rising of the Strandzha Mt. and the North Bulgarian arc were the reasons for the global rearrangements in the valley systems. The largest Pliocene valley systems of the Kamchia and Toundja Rivers were subjected to serious changes in their evolution (Angelova & *alii*, 2001; Angelova & Malyakov, 2001). The Toundja River comprised one of the biggest watersheds, including the upper and middle course of the contemporary Stryama and Syuyutliika Rivers. It followed then to the E along tectonic lines to the region of the Yambol town, and then taking direction to the S along the Toundja fault zone and continuing along the valleys of the contemporary rivers Popovska and Sredetska. It followed the tectonic lines to mouth in the Black Sea. At the Pliocene-Quaternary boundary, as a result of strongly differentiated tectonic movements along the Stryama gorge and the formation of transverse horst structures between the Stara Planina and Sredna Gora Mts., and between the Bakadzhitsite and the Derven heights, the watershed was disintegrated and separate valley systems were formed - of the Stryama River in the Maritsa River valley system and of the Popovska River in the Toundja River valley system, affiliated to the Mediterranean basin (fig. 3) (Dragomanov & *alii*, 1989, Angelova & *alii*, 1999a,b; Angelova, 1992). The Toundja River made its way to the south along activated faults towards the Mediterranean Sea, the Syuyutliika River and a part of the caught water of the paleo-Toundja River were directed to the south towards the Maritsa River watershed.

The paleo-Kamchia River had a wide riverbed during the Pliocene and had accumulated thick sediments. The watershed system of the Kamchia River had a similar geo-

dynamic development. It included the watersheds of a part of the contemporary Yantra, Rositsa, Vrana and other smaller river systems (Mihailov, 1969; Angelova & *alii*, 2001). The N_2-Q_1 boundary here was very dynamic and rearrangements took place along almost its entire length, a part of the Rositsa River watershed (initial direction NE) being redirected to the N thus forming the Ossam River valley system; another rearrangement took place in the region of the Veliko Turnovo town, where a gorge section occurred thus forming the Yantra River valley system; similar rearrangements were also realized to the E of the Popovo town, where a new valley system of the Roussenski Lom River was formed with run-off direction to the N towards the Quaternary Danube River; the valley system of the Kamchia River was also subjected to significant rearrangements during the Plio-Pleistocene in the region of the towns Shoumen, Preslav and Razgrad, parts of the paleo-valley systems being components of the contemporary valley systems of the Kamchia and Provadiiska Rivers (figs. 1, 2, 3).

The problem about the evolution of the Iskar River gorge in the Stara Planina Mt., where the river cuts through the high orographic ridge of the mountain has been extensively discussed in Bulgarian reference literature. It is the only river during the contemporary stage that crosses transversely the Carpathian-Balkan orographic arc (fig. 1). The erosion-overflow theory (when overflowing river is formed as a result of abundant precipitation, which gradually incises into the rock complexes), the erosion (epigenetic) and the tectonic theories have been launched in reference literature for the gorge formation when a basin (in the present case the Sofia and Lom basins) and mountain chains are present. The antecedent theory (according to which the gorge formation proceeds simultaneously with the mountain formation) is also considered in reference literature. The latter is the accepted theory for the genesis of the Stara Planina Iskar River gorge. Recently it has been unambiguously proved that the Sofia and Lom Neogene basins represented closed lake-river basins (Kamenov & Kojumdgieva, 1983; Kojumdgieva & Popov, 1988; Angelova & Yaneva, 1998) with predominating independent geodynamic development, which had been connected with the Morava basin only in the single stages, i.e. it had been a satellite of the Panonian basin (proved by investigations on the paleoflows in both basins) until the Upper Pliocene (figs. 2, 3). The connection between the two basins - the Sofia and the Lom one (a part of the Fore-Carpathian basin) did not exist, i.e. they were separated by the mighty Stara Planina Mountain chain. As a result of the extensional development of the Sofia graben system at the expense of the surrounding mountain structures, the local erosion basis during the Pliocene was in the region of Kourilo under the foothill steps. The Triassic sediments are almost vertical at this place. The stable against erosion quartzitised sandstones represented a natural barrage for the directed to the north Iskar River. The remains from the accumulative sediments of this Late Pliocene river are preserved at an altitude of 700-715 m, above the villa zone of the Gnilyane quarter and along the road to the Gryuovitsa hamlet. Angular discordance is observed here between the lacustrine-fluvial sediments of the Neogene and the Late Pliocene alluvial sediments. The paleoflows and the slope inclinations are directed to the south mainly towards the interior of the Sofia kettle for the former and to the north-northeast - for the latter sediments. The following tectonic deformations during the Plio-Pleistocene and after it had led to the formation of the present outlook of the gorge, as well as to the formation of a normal fault that broke the barrage in the beginning of the gorge. A depression zone was formed in the region of the Iskar River gorge in the Stara Planina Mountain chain as a result of the Late Neogene extension. It spread both on the summit part and on the northern and southern branches of the main tectonic structures building the Berkovitsa unit. A series of normal faults were formed along the whole length of the Iskar depression in transverse direction to the fold and fault structures, which contributed to the formation of the gorge as a tectonic-erosion type (Angelova, 1999b) and to the control of its direction. This led to a gradual change of the erosion basis to the north and to the rapid incision of the river in stages, to the rising of the mountain structures, to the formation of the present river-valley network. North this way the Iskar River valley system was finally divided between the Danube and the Nishava rivers (fig. 1).

Paleo-Ossam river, another considerable rearrangement in the closing Fore-Carpathian basin, took place in the region of Levski and Gorno Assenovo (Mihailov, 1969; Angelova & *alii*, 2001). It was accompanied by paleoseismic effects. The paleo-Ossam River discharging in the Fore-Carpathian basin near the town of Rousse was broken by strongly differentiated block structures and the valley systems of the contemporary Ossam and Rositsa Rivers were formed (figs. 1, 2, 3).

The other big rivers on Bulgarian territory as Ogosta and Lom in North Bulgaria and Strouma in its middle and lower reach changed cyclically their direction during the N_2-Q_1 stage (those in North Bulgaria to NE and Strouma - to W) depending on the changes of the regional erosion bases and on the activity of fault structures, along which they were oriented (Angelova, 1999a, b, 2000, 2001; Angelova & *alii*, 2001).

CONCLUSIONS

On the basis of the performed basin analysis for the territory of Bulgaria during the Neogene and the Quaternary, the following has been established: the spatial position and configuration of the valley systems; their affiliation and rearrangement at one of the most dynamic boundaries; the energy of the tectonic movements during the Pliocene and the Quaternary; the tectonic control on the development of the valleys and valley systems. The present investigation starts the work on elucidating and understanding of debatable fundamental problems as well as on the solution of practical ones.

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