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Investigations of the late Quaternary morphotectonic evolution of the Balkan Peninsula East Part

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Abstract: *The East Balkan Peninsula Area was a part from the Tethys Ocean until 72 000 000 years. The pre Maestrichtian geologic-tectonic pattern of cockle of the East Balkan Peninsula Area wasn't built on the Europe Continental Massif. The modern East Balkan Peninsula Relief is forming during the Late Quaternary time. The East Balkan Peninsula Margin coincides with the border between the Bulgarian and Moesian Continental Microplates from the west and the Black Sea Oceanic Microplatte to the east. This border present the Neo Europe West Passive Continental Margin in the area of the last Tethys Oceanic Fragment – it Black Sea Oceanic Gulf.*

Keywords: continental fragment, New Europe, Late Quaternary relief

Introduction

The authors interpret the Quaternary morphotectonic evolution of the Balkan Peninsula East Part in the light of the modern mobile concept of the plate tectonics. This approach reveals some new important peculiarities of the Late Pleistocene-Holocene morphogenesis and pattern of the region. The results of those investigation contrast with the existing geosynclinals fixity model for this questions.

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Investigation object

The investigation concerns the questions about: 1/the pre Paleogene and Paleogene-Early Pleistocene geodynamic evolution of the Balkan Peninsula East Part; 2/the contemporary regional endogenese as a general factor for the modern relief forming; 3/the uncial relationships between the Bulgarian Continental Microplate and the Black Sea Oceanic Miroplate.

Methodological basement of the study

The proposed regional morphological study is based on generally accepted contemporary and already well-grounded scientific mobility Plate tectonics presents for the construction of the upper parts of the Earth's crust from different by size and number oceanic and continental plates [1]. They are found in complex temporal and spatial relationships by the action of endogenous geodynamic processes.

The investigation is conformity with the represented on a Table 1 methodological model.

Table 1. Methodological model of the investigation

SCIENCE	METHODS	ENERGY SOURCES	PROCESSES	*RESULTS*
Morphotectonics	Morphostructural analysis	Astenospaere	Deformation	*Morphostructures*
Geomorphology	Morphosculptural analysis	Solar	Erosion	*Morphosculptures*
			Abrasion	
			Deflation	
			Exaration	

Orohydrographic overview

The eastern part of the Balkan Peninsula spreads the area to the east from the Timok, Southern Morava, Pchinya and Vardar Rivers (Figures 1 and 2). This area includes (from the north to the south) the following west–east in general oriented orographic units: southern part of the Lower Danube Plain (to the south from Lower Danube River), low mountain-hills Fore Balkan Zone, high and middle mountain Stara Planina (Balkan) Zone, Sub Balkan Kettle Range Zone, middle mountain Sredna Gora Zone, hills-low mountain Kraishte Zone, low-land and hills Upper Thracian Zone. middle mountain Bregalnitsa Zone, high mountain Rila-Pirin Mountain Range Zone, high and middle mountain Rhodope Zone, low and middle mountain Sakar-Strandzha Zone, high and middle mountain Belasitsa Zone, low land Western Thracian Zone and lower Thracian Zone (Figure 2).

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The varied, quickly and often space changed relief is one of the most important characteristics of the Balkan Peninsula observed part. It is on effect of the very active Quaternary endogenous processes.

Figure 1. Overview map of the Balkan Peninsula Boundary between the western and eastern part of the Peninsula (interrupted black line). Borders of the Bulgarian Continental Microplate (pointed black line)

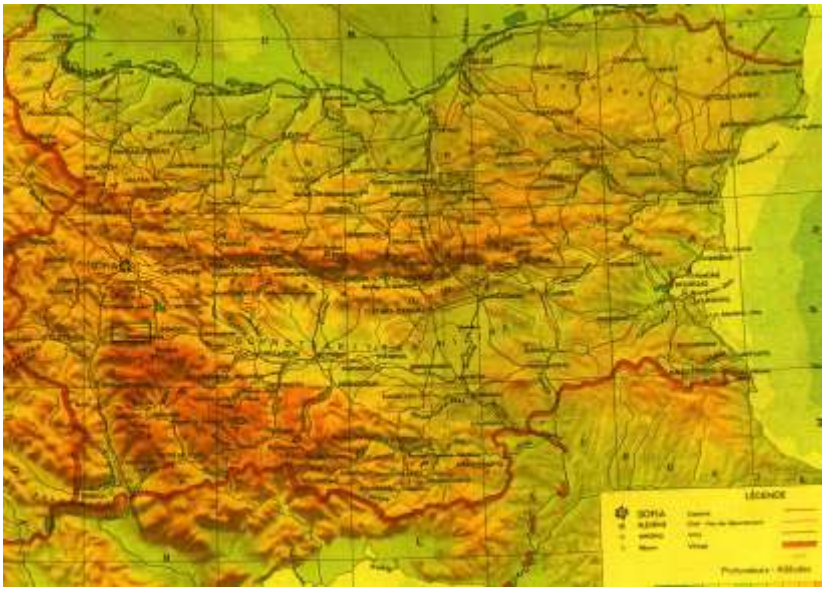

Figure 2. General view of the modern relief of Balkan Peninsula East Part

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Morphotectonic overview

The processes of the East Balkan Peninsula Relief forming are connected with the Tethys Ocean Closing end stadiums and the transcontinental collision between the Gondwana and New Europe Continental Massifs (Figure 3 and Table 2 [2]).

Table 2. Quaternary mosaic morphostructure of the eastern part of Balkan Peninsula

Age	**Geo-tectonic events**	**Neo Europe evolution**	**Relief type**	**Morphoge-nerations**	**Mosaic pattern**
Late Pleistocene - Holocene	Trans-continental collision	Progressive destruction of the post Early Pleistocene Orthoplain Positive and negative morphostructures building	Varied, quicly changeable (mountains, hills, planes, low planes, kettle ect)	Positive and negative morphostructures	Local and regional mosaic pattern origin
Early Pleistocene	Trans-continental collision	Origin and beginning of post Early Pleistocene destruction	Planne or hillyplane relief	Orthoplaines	
Late Oligocene – most Early Pleistocene	Trans-continental collision	Neo Europe origin	Planne or hillyplane relief	Orthoplaines	Microcontinrntal mosaic pattern origin
Maestrichtian–Early Paleocene	End of Tethys Subduction	Grouping and saturation of the continental fragments (terranes) near the Paleo Europe	Planne or hilly plane relief	Relict morphostructures	Microcontinental mosaic pattern origin
Campanian	Tethys Subduction	Moeving the Gondwana continental fragments (terranes) to Paleo Europe	Islands, archipelages		

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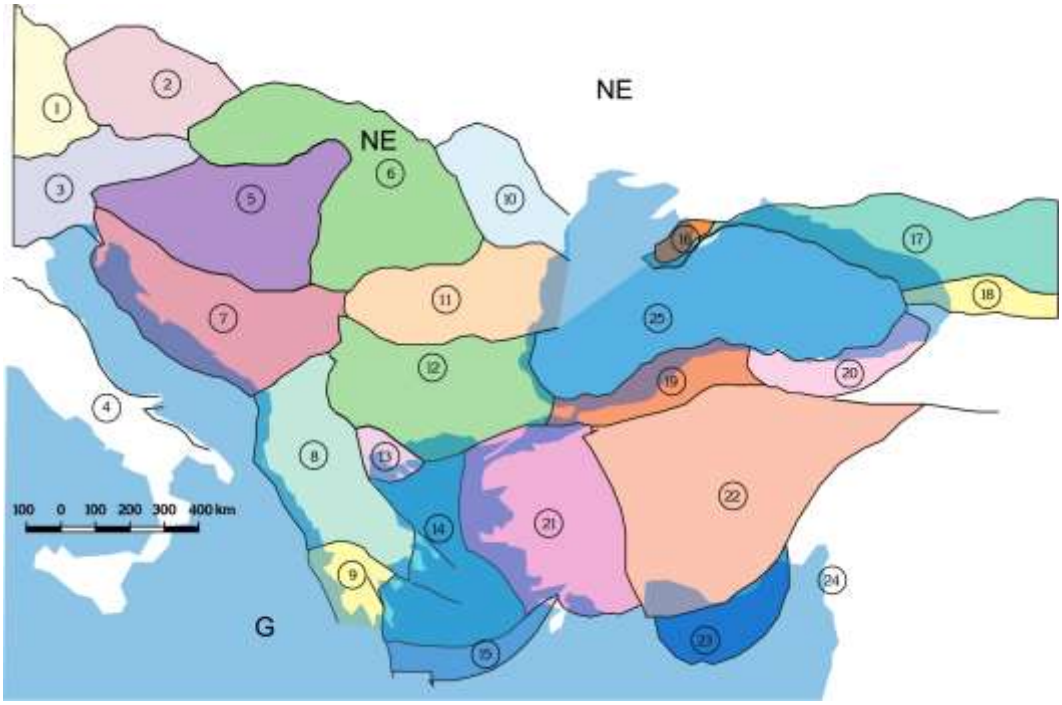

Figure 3. Mosaic tectonic pattern schematic model of the Neo Europe south-eastern part (after *Tzankov, Iliev*, 2015 with modification and addition)

G- Gondwana Continental Macroplate (Continent); E- Europe Continental Macroplate (Continent): PE- Paleo Europe Continental Macroplate , NE – Neo Europe Continental Macroplate.

NE 1-20 - Neo Europe Continental Microplates: 1- Bavarian, 2- Bohemian, 3- Alpean, 4- Apeninian, 5- Moravian, 6-Carpathian, 7-Dinarian, 8- Pindian, 9- Heladian, 10- Scitian, 11- Moesian, 12- Bulgarian, 13- Halkidikian, 14- Aegean, 15- Cretean, 16- West Pontian, 17- East Pontian 18- West Anadolian, 19- East Anadolian, 20- Cyprian; 21- 23 Paleo Europe Continental Microplates: 21- Creamean, 22- Caucasian, 23- Georgian; 24- Arabian Continental Plate, 25 Black Sea Oceanic Microplate

Building time

The modern morphotectonic investigations of the Balkan Peninsula East Part are constituted the relics from four Quaternary morphostructural generations [3]. The Complex Morphostructral Passages building is connected with the third and fourth morphogeneration – the time of the contemporary relief forming. The last one represents a mosaic combination between the new build positive dome like morphounits and the conserved between them negative morphostructures – the relics from the primary post Early Pleistocene Orthoplain. Its morphoforms form the Complex Morphostructral Passages Complex Morphostructral Passages (in sense of [5]). In this sense participle the mentioned compound negative morphostructures in the Balkan Peninsula East Part modern relief forming.

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Regional morphostructure

The contemporary plate tectonic concept of the Earth Crust Pattern and Evolution is based on the already good argument model of the plate-mosaic planetary superficial construction. The modern plate tectonic points of view are unify around the opinion, that the mentioned continental and oceanic crust plates build were grouped (before 550 000 000 yards) in the first rare Lawrasia (to the north) and Gondwana (to the south) large continental massifs (super continents) and the closed between them Tethys Ocean (Figure 4).

Figure 4. Principal model of the Continental Earth Crust Megacontinental Massif Pangea before 250 million years

In the course of the Phanerozoic Evolution have speared some different big continental fragments from the Gondwana Continental Massif Margin: Antarctica, Austral, New Zealand, India, Madagascar, Arabia and numerous more little blocks as islands and archipelagoes in the Mediterranean Area (Figures 5 and 6).

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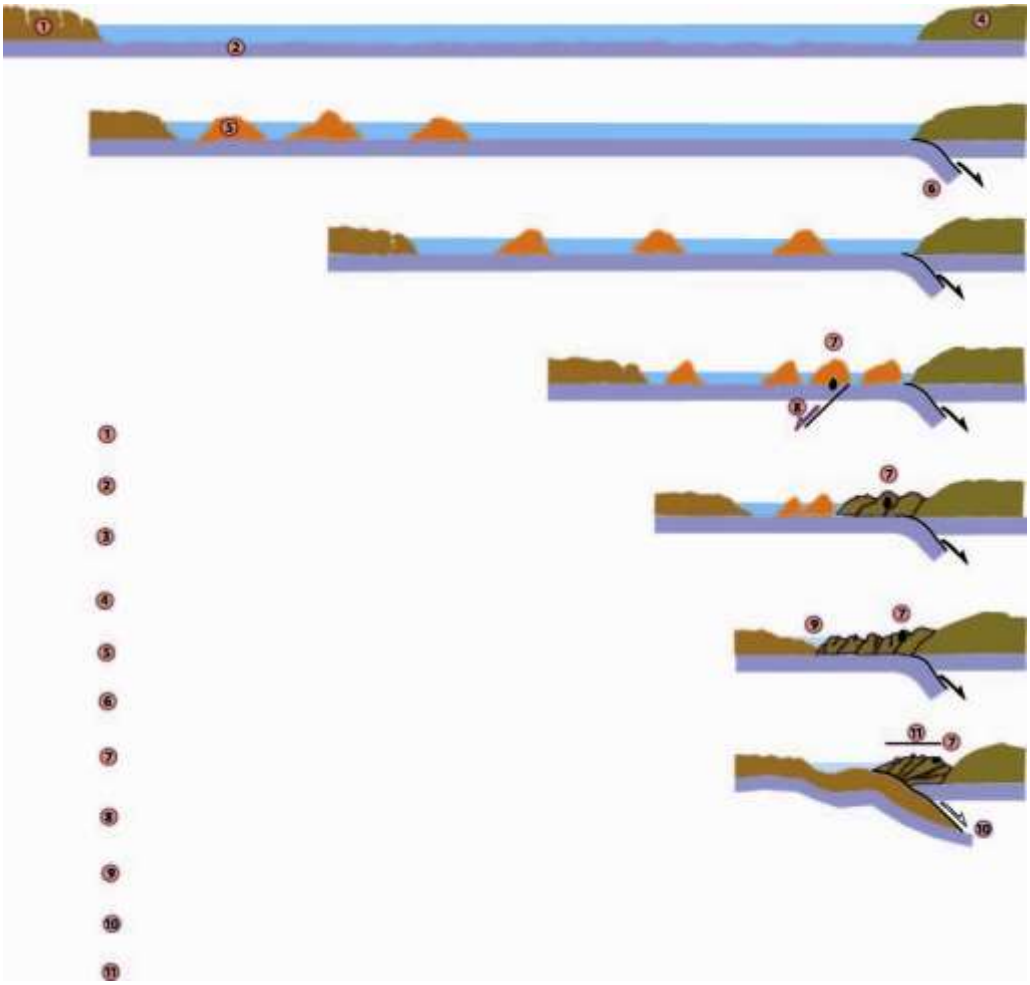

Figure 5. Moments from of the Thethys Ocean Closing [4]

1- Gondwana Continental Massif, 2- Thethys Ocean, 3- Paleo Europe Continental Massif, 4- oceanic crust, 5- islands and archipelagos - fragments from the Gondwana Continental crust in the Thethys Ocean, 6- Phanerozoic Subduction of the Thethys Ocean down the Paleo Europe Continental massif, 7- building the continental aglo;eration of New Europe, 8- events of local subduction in some of islands, 9- closing the Thetys Ocean and forming the Mediterranean Epicontinental Sea, 10- beginning the transcontinental collision between Gondwana and New Europe Continental Massivs, 11 - intensive destruction of the south parts of the New Europe Post Early Pleistocene Orthoplan an high mountains relief building. Mediterranean See (after the Thethys Ocean Cloosing), 8- Gondwana\Neo Europe Transcontinental Collision

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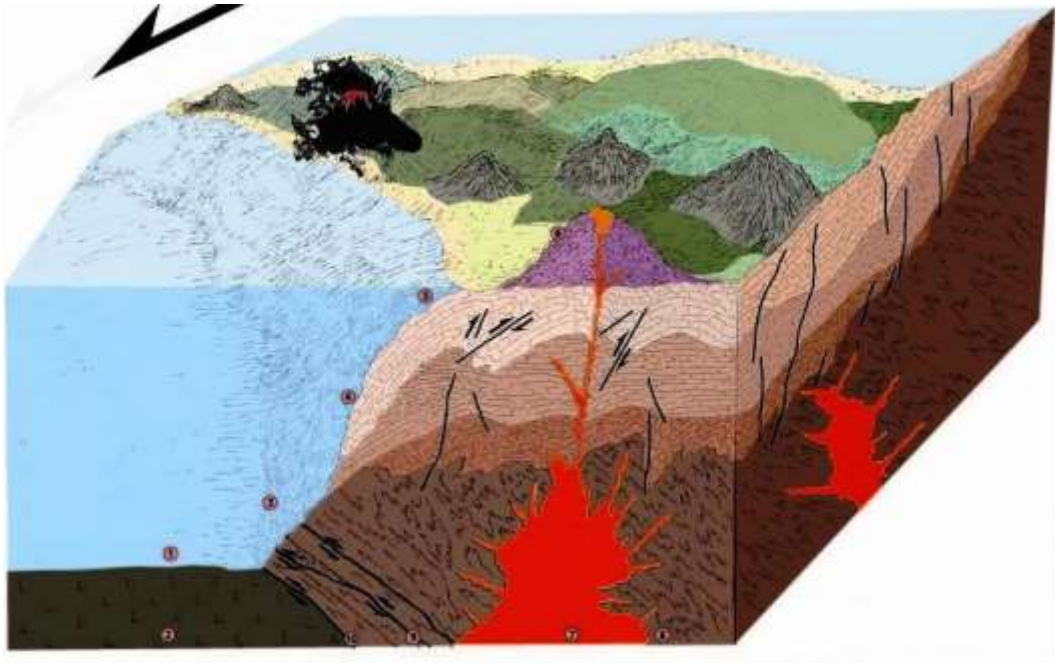

Figure 6. Provisional model (block-diagram) for the) pattern of island (Gondwana Continental Fragment) in the Tethys Ocean part: 1- ocean bottom, 2- oceanic crust, 3- continental foot, 4- continental slope, 5- continental shelf, 6- volcanic cone, 7- intrusive camera, 8- high metamorphic rocks, 9- overthrust, 10- boundary between oceanic and continental Earth crust

The Lawrasia have divided in the same time in Lawrence (contemporary North America) to the west and Eurasia to the east. The west Eurasia part corresponds with the Paleo Europe Continental Massif (the present East Europe). The Gondwana Continental Massif is rotated gradual the reverse to the clock hand and move to the north to Eurasia. It was make the gradual narrow the west part of the Tethys Ocean. This process was bring to the subduction of it north margin under the Paleo Europe South West Border (Figure 4). The Gondwana Continental Fragments (islands, archipelagoes) in the East Mediterranean Area get near and reachs to the Tethys Subduction Zone. They have aglomerated, compacted, sutured between them, and in the end build a new monolith continental massif – Neo Europe – on the Paleo Europe South West and South Borders (Figure 5). The last one is formed after the West Tethys Subduction End and the beginning of the transcontinental collision in the end of Campanian Age (before around 72 000 000 years). The Neo Europe Building Process was realized from the Maestrchtian till the end of Low Oligocene Age (time interval 72 000 000 – 28 000 000 years). The primary Neo Europe Continental Massif Relief was controlled by the block saturation rupture deformations between different continental fragments. The Late Alpidian Tectonic Movements have not so high intensity of the brittle tectonics near the Earth Superficial. The Alpidian Deformations End go after from relative prolong (time interval 28 000 000 – 990 000 years) tectonic „calm“.

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The Relief was lowland and plane. It view correspond with open savannas or forest savannas landscape with isolated mesas, plateaus, erosion hills (buts) and numerous braded rivers (Figure 7).

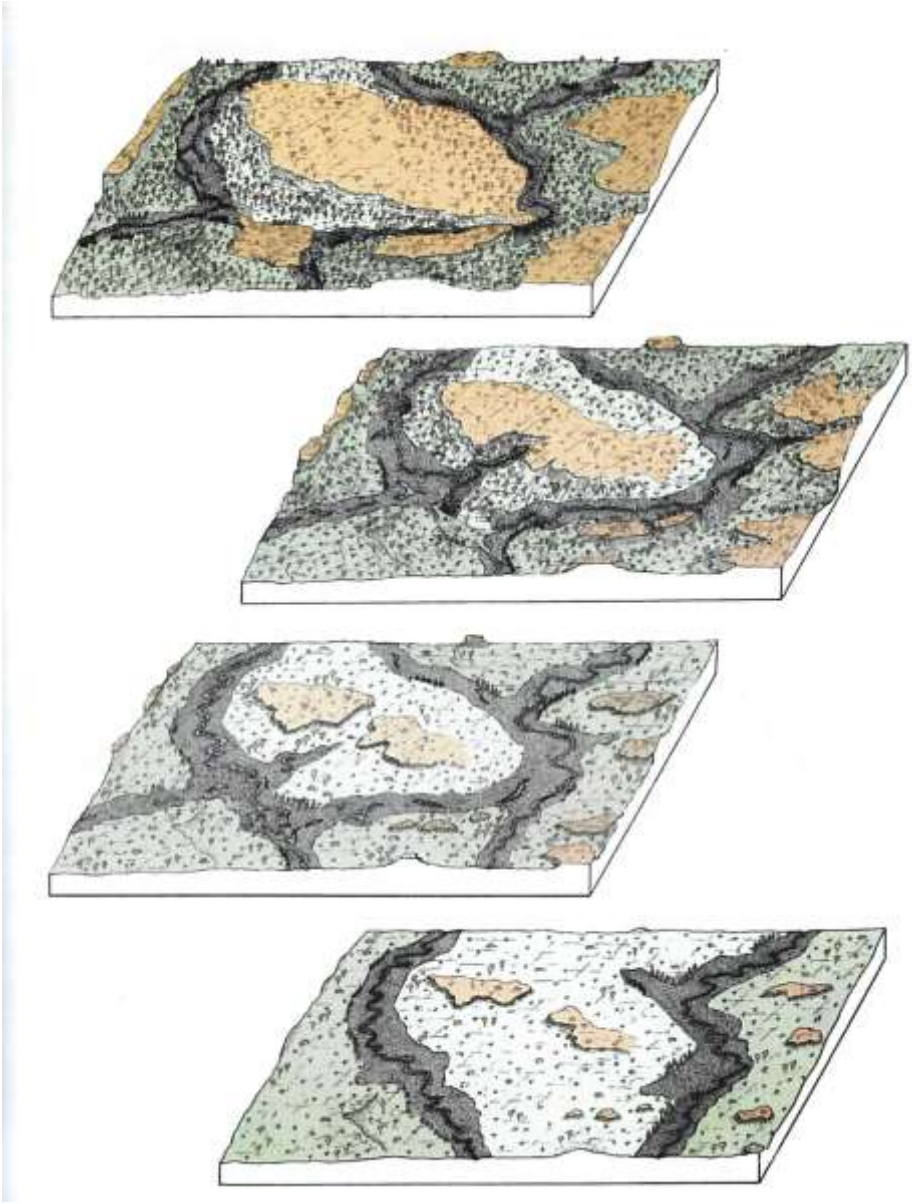

Figure 7. Principal orthoplain model in consecutive moments of it erosion destruction [2]

This substructural character of the Earth Superficial beneficiates the building of the several superdisposed large erosion-accumulative low land-plane of the primary negative morphostructures – orthoplanes 9 (Figure 7). They have formed in superposition from the Upper Oligocene till the end of Early Pleistocene age (time interval 28 000 000 – 990 000 years). The building of the last from them – the Post Early Pleistocene Orthoplain was follow from the big change of the neotectonic – beginning of the local Earth

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Superficial Uplifting Processes. They have provoked from the advance of the transcontinental collision between Gondwana and Neo Europe in the East Mediterranean Area. It affects the forming of the Late Quaternary Rila, Pirin and Rhodope High Mountain Relief Balkan Peninsula East Parts.

The East Balkan Peninsula Margin coincides with the border between the Bulgarian and Moesian Continental Microplates from the west and the Black Sea Oceanic Microplatte to the east (Figure 8). This border present the Neo Europe West Passive Continental Margin in the area of the last Tethys Oceanic Fragment – it Black Sea Oceanic Gulf (Figure 8).

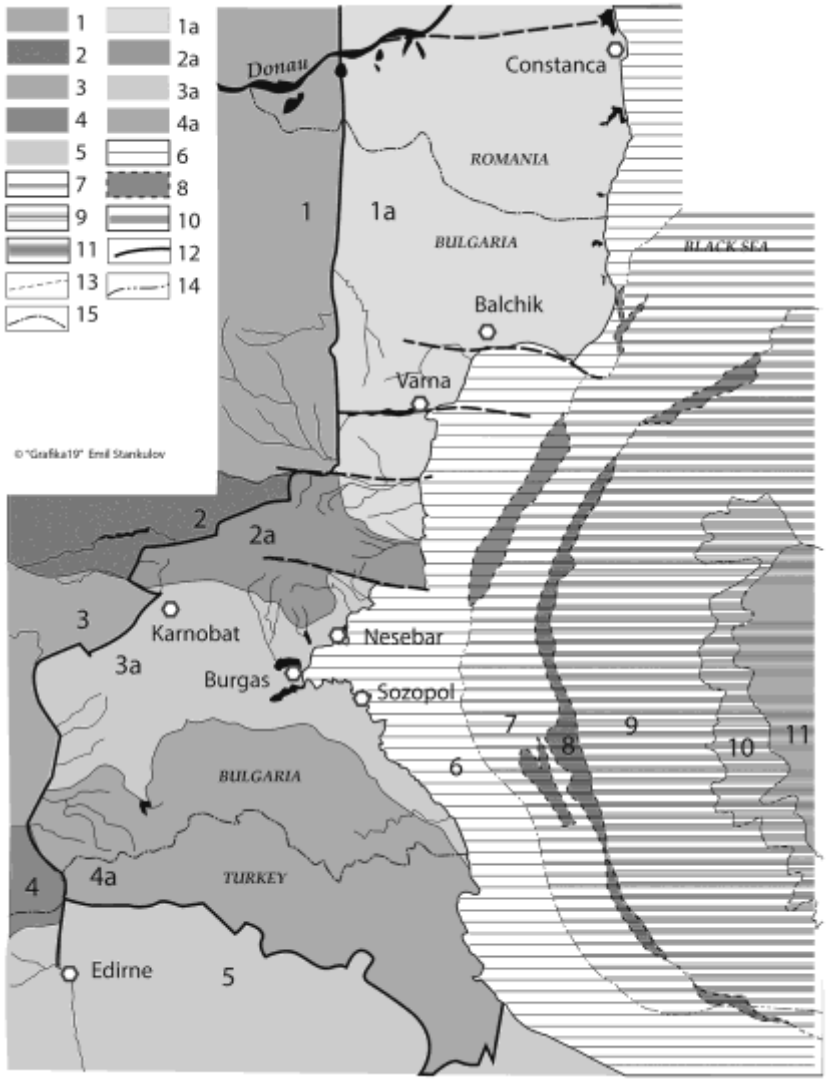

Figure 8. Survey morphostructural sketch of the West Black Sea Passive Continental margin [5, 6]

1-5 – subaeral margin area: 1-1a – South Moesian morphostructural zone: 1- continental part, 1a- margin part: 2-2a -Hemus morphostructural zone: 1- continental part, 1a- margin part: 3–3a - Upper Thracian

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morphostructural zone: 3- continental part, 3a- margin part: 4 – 4a - Sakar-Strandzha morphostructural zone: 4- continental part, 4a- margin part: 5- Lower Thracian morphostructural zone; 6-11 – subaqual margin area: 6-8 – continental shelf: 6- high step, 7- down step, 8- fault zone; 9- continental slope, 10- continental foot, 11- Black Sea bottom; 12 – west border of the West Black Sea Passive Continental margin, 13- some important faults, 14- border between the morphostructural zones, 15 – boundary between Turkey and Bulgaria.

Conclusion

The realized survey show, that the East Balkan Peninsula Area was a part from the Tethys Ocean until 72 000 000 years. The modern East Balkan Peninsula Relief is forming during the Late Quaternary Time. The pre Maestrichtian Geologic-Tectonic Pattern of cockle of the East Balkan Peninsula Area wasn't built on the Europe Continental Massif.

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