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Complex morphostructural passages in the East part of Balkan Peninsula

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Key words:
morphostructural passage, kettle morphostructure, morhostructural threshold, river valley morphostructure, morphostructural gorge, orthoplain relict

ABSTRACT

The Complex Morphostructural Passages are the first rare negative morphostructural units in the Late Quaternary (Late Pleistocene- Holocene) Relief of the Balkan Peninsula East Part. They are composed by morphostructural passages, kettle morphostructures, morhostructural thresholds, river valley morphostructures and morphostructural gorges. The mentioned negative compound morphounits present the contemporary relicts from the post Early Pleistocene Orthoplain Denudation or Denudation-accumulative Plane.
The Complex Morphostructural Passages participle together with the younger positive dome-like and mountain arched morphostructures in the contemporary relief building.

Object and purpose of the investigation

The building of contemporary morphotectonic model of the east part of Balkan Peninsula need the sufficient detailed knowledge of the morphostructural pattern of the area. The article object is the generalized mobility characteristic elaboration of the first rare regional negative compound morphounits - the Complex Morphostructural Passages. They participle together with the younger positive dome-like and mountain arched morphostructures in the contemporary relief building.

The article informs about the origin, building time, internal pattern, relationships with the neighbor regional positive morphostructures and kind of the Late Quaternary (Late Pleistocene- Holocene) Relief building participation of the Complex Morphostructural Passages in the east part of Balkan Peninsula. The investigation is based on the modern results from the regional morhohstructural analysis of those first rare regional negative compound morphounits (Tzankov, 2009; Tzankov, Stankova, 2011; Tzankov, 2012; Tzankov, Stankova, 2014; Tzankov, Iliev, 2015; Tzankov, Stankova, 2017; Tzankov, Stankova, 2017a; Tzankov et all. 2017; Tzankov et all. 2017a; Tzankov et all. 2017b; Stankova et all. 2018; Tzankov et all. 2018a).

Methodological basement of the study

The proposed regional mfrphostructural 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 (Tzankov, 2013). 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 I methodological model:

Terminological notisis

The complex morphostructural passages are the most negative regional morphounits in the relief. They are the morphostructural antipodes of the synkinematic positive morphounits hills or mountain terrenes.

The complex morphostructural passages are composed by alternate consecutive orderly morphostructural passages or kettle morphostructures with morhostructural thresholds.

Table 1. Methodological model of the investigation.

Science	Methods	Energy sources	Processes	*Results*
Morphotectonics	Morphostructural analysis	Astenospaere	Deformation	*Morphostructures*
Geomorphology	Morphosculptural analysis	Solar	Erosion Abrasion Deflation Exaration	*Morphosculptures*

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Those composite (complex) arranged morphounit form linear prolong relative cramped depression areas with block segmented (mosaic) internal pattern. It can be complicated with sinkinematic river valley morphostructures or morphostructural gorges. The complex moprphostructural passages end normally with kettle morphostructures. The investigated negative morphostructural coincide very often with the first rare river valleys with longitudinal variabile morphology.

The principal role for the complex morphostructural passages internal pattern have the contemporary relicts from the post Early Pleistocene Orthoplain denudation or denudation-accumulative plane. It is marking the bottoms of the morphostructural passages, kettle morphostructures, river valley morphostructures and the morphostructural thresholds primary superficies (Fig. 1). The mentioned negative compound morphounits participle together with the younger positive dome-like and mountain arched morphostructures in the contemporary relief building.

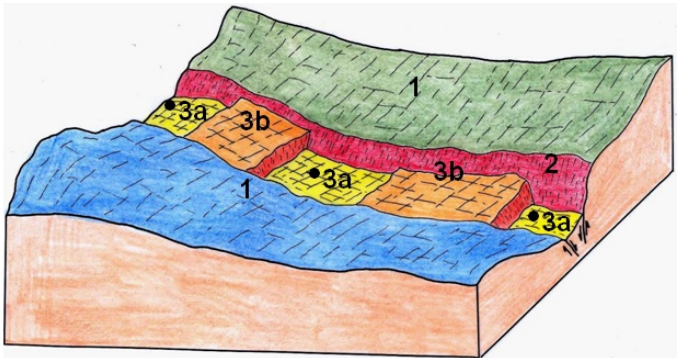

Figure 1. Complex morphostructural passage: 1- flanked positivemorphostructures; 2- fault planes; 3- complex morphostructural passage: 3a- negative morphostructures (kettles, passages); 3b- thresholds.

The type and the subordinal position of the Complex morphostructural passage are represent on the Table 2.

Orohydrographic overview

The eastern part of the Balkan Peninsula includes the area to the east from the Timok, Southern Morava, Pchinya and Vardar Rivers (Fig 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 (Fig. 2).

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.

Morphotectonic overview

The processes of the East Balkan Peninsula Relief forming are direct connected with the transcontinental collision between the Gondwana and New Europe Iontinental massifs (Fig. 3).

Table 2. Morphotectonic and morphostructural units.

MORPHOTECTONIC AND MORPHOSTRUCTURAL UNITS		
GLOBAL MORPHOTECTURAS		
CONTINENT		
Continental margin		
Active		*Passive*
Continental shelf		
Continental slope		
Accretionary prism		*Continental foot*
Collision zone		
Trans continental	*Intra continental*	*Suture*
OCEAN		
Oceanic bottom Oceanic ridge Oceanic trench Hot spot Island arc		
Volcanic		*Avolcanic*
Subduction zone Spreading zone Obduction zone		
REGIONAL MORPHOTECTURES		
Macrotecture - Macroplate Tecture - Plate Microtecture - Microplate		
Continental		*Oceanic*
REGIONAL MORPHOUNITS		
Obligatory		Optional
Morphostructural zone		Morphostructural sequence
Morphostructural area		Morphostructural group
Morphostructural region		Morphostructural line (row)
Morphostructure Diagonal		Longitudinal Transverse
REGIONAL MORPHOSTRUCTURES		
Initial Orthoplain Derivative		
Negative	*Faults*	*Positive*
Plain	High angular (normal)	Mountain arched
Lowland	Low angular listric	Concentric
Passage	Strike-slip	Dome-like
Complex passage	Overthrust	Comb-like
Kettle Threshold Hemianteclise Fault bundle	Upperthrust Transform Syneclise	Anteclise Gorge
Hemisyneclise	Fault zone	
Listric prisms		
Listric prisms Line (row)		

Figure 2. Overview map of the Balkan Peninsula Boundary between the estern and eastern part of the Peninsula (interrupted black line).
Borders of the Bulgarian Continental Microplate (pointed black line).

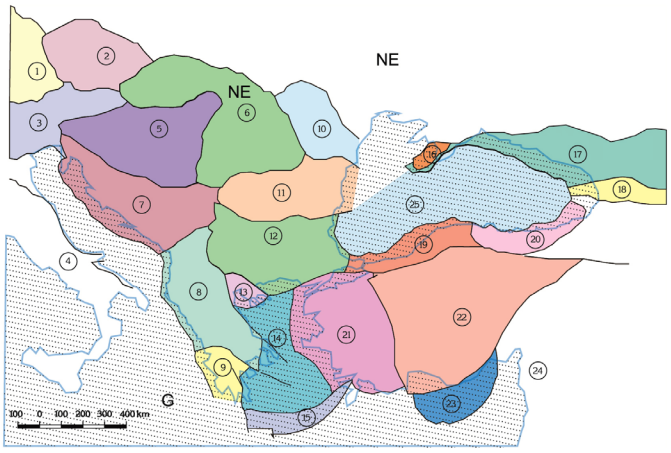

Figure 3. Mosaic tectonic pattern schematic model of the Neo Europe Southeastern part (after Tzankov, Iliev, 2015 with modification and addition).

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

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.

Table 3. Quaternary mosaic morphostructure of the Eastern part of Balkan Peninsula.

Age	Geotectonic events	Neo Europe evolution	Relief type	Morphogenerations	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 hilly-plane relief	Orthoplaines	
Late Oligocene – most Early Pleistocene	Trans continental collision	Neo Europe origin	Planne or hilly-plane 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		

Table 4. Neozoic morhotectogenesis of the Bulgarian continental microplate (Tzankov, Stoyanov, Spassov, 2004).

End of Early Oligocene – finish of Alpine Orogenesis
Late Oligocene- Middle Miocene – superficially tectonic "calm" and sicinematic deep crustal block destruction. Denudation of the Late Alpine Relief and orthoplan building.
Late Miocene – deposition of potent continental (alluvial and alluvial-proluvial) deposits of the braded rivers on the fragments of the older orthoplan superficias.
End of Late Miocene – origin of the post Late Miocene orthoplan
Pliocene- Early Pleistocene – manifestation of slight, local short-lived superficial crustal block movements.
End of Early Pleistocene – forming of the post Early Pleistocene orthoplan. Before 990000 years – beginning of the intensive destruction and block denivelation of the post Early Pleistocene orthoplan under the influence of the listric tectonics. The big orthoplan fragments were build the bottom of the kettle morphostructures and morphostructural passages. The other orthoplan fragments were marked the morphostructurell river valleys. Beginning of the dome-like morphostructure building.
Late Pleistocene-Early Holocene – forming and rapid denudation of the first generation of dome-like concentric morphostructures.
Late Holocene – forming of the second generation of dome-like and mountain morphostructures. Contemporary relief building.

Table 5. Succession of the late Neogene-Quaternary morphostructural generations in the East part of Balkan Peninsula. (after Tzankov et all., 2018).

POST EARLY PLEISTOCENE ORTHOPLAIN
Origin time – **the end of Early Pleistocene.**
Essence – **large alluvial savanna similar plane with mesas and plates.**
Beginning of destruction and out of level– **after the Early Pleistocene, parallel with the starting of the Quaternary Mountain building processes as Gondwana- Neo Europe Transcintinental collision results.**
Contemporary relicts – **block out of level bottoms of the kettle morphostructures, morphostructural passages, river valey morphostructures, morphostructural thresholds, fragments of villa frangian accumulative planes on the top of some listric prisms.**
LATE PLEISTOCENE CONCENTRIC MORPHOSTRUCTURES
Origin time –**end of Early Pleistocene – beginning of Late Pleistocene.**
Essence – **relicts from early generation of dome-like morphostructures, transformed, trough very active erosion, in concentric morphostructures. Beginning of destruction – simultaneously with the creasing of the primary dome-like morphostructures under the influence of the very active erosion processes.**
Contemporary relicts – **traces of concentric morphostructures.**
MIDDLE PLEISTOCENE – HOLOCENE DOME-LIKE MORPHOSTRUCTURES
Origin time – **From Middle Pleistocene till today.**
Essence - **numerous dome-like morphostructures.**
Contemporary relicts – **The dome-like morphostructuires (with the older negative and concentric morphostructures) are building the contemporary mountain relief.**
HOLOCENE CENTRUMS OF CONTEMPORARY ELEVATON
Origin time – **Holocene - today.**
Essence - **synmorphogene uplifting on the bottoms of the kettle morphostructures.**
Beginning of destruction – **very active contemporize uplifting of this embryonic dome-like morphostructures prevent the activity of the destructive exogenous processes.**
Contemporary relicts – **positive relief forms on the bottom of the kettles.**

Building time

The modern morphotectonic investigations of the Balkan Peninsula East Part are constituted the relics from four Quaternary morphostructural generations (Table 5). 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 this sense participle the mentioned compound negative morphostructures in the Balkan Peninsula East Part modern relief forming.

Regional morphostructure

The mosaic pattern of the eastern part of Balkan Peninsula (Tab. III and IV) was predetermined during the Neo Europe Continental Massif building (Fig. 3). The mosaic internal character of the Bulgarian Continental Microplate was formed in connection with the pre Early Pleistocene Orthoplain destruction during the regional processes of the transcontinental collision between Gondwana and Neo Europe (Fig. 4.2).

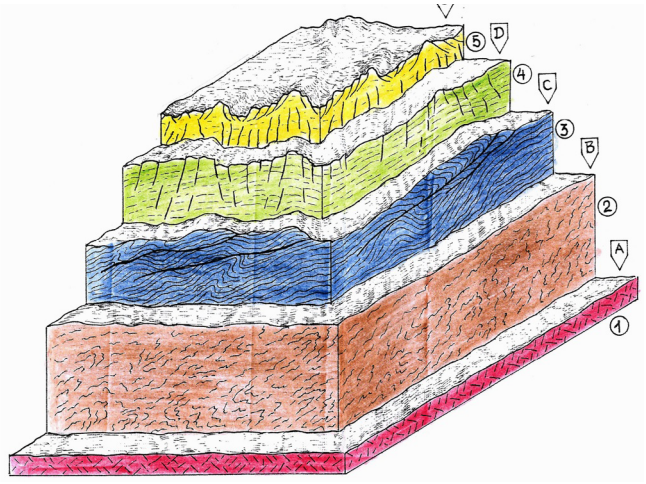

Figure 4.1. lithostructural layers of the continental Earth crust (after Tzankov, 2013):

E – Earth superfition;

5. SUPERFICIAL LITHOSTRUCTURAL LAYER; Contemporary morphostructural block mosaic of the relief. Orthoplans, regional fault net (listric tectonics), negative and positive morphostructures;

D – Mosaic block relief lover border;

4. DEEP BLOCK LITHOSTRUCTURAL LAYER; Terminating of the plastic deformations. Building of the lithosphere deep block structures;

C – Upper border of the Plastic deformations;

3. FOLD-OVERTHRUST LITHOSTRUCTURAL LAYER
Plastic and ruptural deformations;

B – Lower/high metamorphisms border ;

2. HIGH METHAMORPHIC LITHOSTRUCTURAL LAYER; Plastic deformations in high metamorphic rocks;

A- Lithosphera/Upper Mantil border;

1. UPPER MANTIL.

The deep block destruction of the Earth Crust (in the deep block lithostructural layer – Fig 4.1) has limited the borders of the morphostructural zones, areas and some of the regions. Its internal patterns was and is formed from the composed by hay angular and listric faults regional fault net. The last one has limited the most little Earth superficial blocks in which are closed the single positive dome-like morphostructures.

The mosaic pattern of the Balkan Peninsula eastern part supplement to the relics from the pre Late Pleistocene Orthoplain (Fig. 5) – planes, low planes complex morphostructural passages, isolated morphostructural kettles and others.

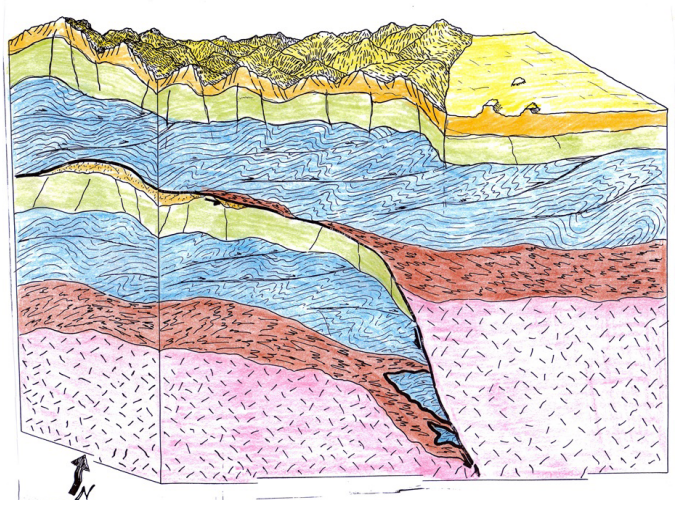

Figure 4.2. – Transcontinental collision between Gondwana (lower continental massif) and New Europe (upper continental massif -after Tzankov, 2013). The designations are the same with Fig. 4.1.

The mentioned specifics of the mosaic pattern determine the highly varied and regional rapid changing character of the relief in the eastern part of the Balkan Peninsula. The Complex Morphostructral Passages are the first rare regional negative compound morphounits in the area. They unit the negative morphostructures – relics of the pre Late PLeistocne Orthoplain in different regions.

The regional disposition of the Complex Morphostructural Passages in the Balkan Peninsula East Part is presents on the Table 4. and Fig. 6. The investigated negative compaund morphounits are include in the separated morphostructural zones or they build the all zones – Sub Hemus Morphostructural zone, Upper Thracian Morphostructural zone. The sizes, spatial parameters, form, hypsometric position and internal pattern of the Complex Morphostructural Passages are very different. This circumstance confirms the fact, thath the mentioned compaund morphounits presnt relics from the destructed post Early Pleistocene Orthoplain.

Figure 5. The post Early Pleistocene Orthoplain near the Emine cape – Black Sea coast. On a fore ground: relics from pre Neogene structures (anticline), cover by the post Early Pleistocene Orthoplain; on the second distance: fragment from the post Early Pleistocene Orthoplain; on the back graund (left): Early and Late Holocene dome-like morhostructures.

Table 6. Internal pattern of the complex morphostructural passages in the Bulgarian continental microplate.

Abreviations: MSZ- MORPHOSTRUCTURAL ZONE, MSA- MORPHOSTRUCTURAL AREA, CMSP - Complex Morphostructural Passage, MSP - Morphostructural Passage, FLMS – Flatland Morphostructure, LLMS – Lowland Morphostructure, KMS – Kettle Morphostructure, MST- Morphostructural Threshold, RVMS – River-Valley Morphostructure, MSG – Morphostructural Gorge

PRESLAV MSA

1 Ticha CMSP – Slannik KMS, Kamburovo MST, Belomortsi KMS, Vardun MST, Gerlovo KMS, Filaretovo KMS, Malko selo MST, Mengishevo UMS, Vrani kon MST, Blorech MST, Aleksandrovo KMS.

WEST HEMUS MSA

2 Ogosta-Botunya CMSP – Kutlovitsa KMS, Milin Kamak , Mramoren MST, Peshtene KMS.

3 Barziya CMSP – Berkovitsa KMS, Pesochnitsa MST, Varshets KMS.

ZENTRAL HEMUS MSA

4 Botevgrad CMSP – Tipchenitsa KMS, Lyuti Dol MST, Orhane KMS, Pravets MST, Etropole KMS, Lakavitsa MST, Dzhurovo KMS, Yablanitsa MSG.

5 Sevlievo –Debelets CMSP - Sevlievo MSP, Yantra MSG, Dryanovo KMS.

6 Troyan –Apriltsi CMSP –Troyan KMS, Velchevo MSG, Apriltsi KMS.

UDVOY- MATORIA MSA

7 Luda Kamchiya CMSP – Katunishte RVMS, Gradets MST, Beronovo KMS, Podvis MSP

SUB HEMUS MSA

8 Tsaribrod – Tvarditsa CMSP – Byala PalankaMSP, Pirot KMS, Nisava MSG, Gaber MSP, Aldomirovtsi MST, Serdica KMS, Negushevo MST, Sarantsi KMS, Opor SMT, Doflno Kamartsi KMS, Galabets MST, Zlatitsa KMS, Koznitsa MST, Karlovo KMS, Strazhata MST, Kszanlak KMS, Mezhdenik MST, Tvarditsa KMS, Binkos MSG.

KRAISHTE MSZ

9 Shoppe CMSP – Vlasina KMS, Erma MSG, Znepole KMS, Strazha MST, Pernik KMS, Golo bardo MST, Radomir KMS, Bobov dol MSP, Dyakovo MST, Delyan MSP, Yahino KMS, Verila MST, Palakariya KMS, Shiroki dol MSG, Iskar KMS, Venkovetz MSG, Ihtiman KMS, Cherni rid MST, Kostenets KMS, Momino MSG.

10 Velbadzh CMSP - Gyushevo MSG, Kamenitsa KMS, Garlyano MSP, Kyustendil KMS, Babino MST, Dolistovo KMS, Razmetanitsa MST .

UPPER THRACIA MSZ and LOWER THRACIA MSZ

11 Thracia CMSP- Plovdiv FLMS, Chirpan MST, Oragoyna MST, Parvomay MSG,Zagore FLMS, Straldzha KMS, Yambol MST, Konyovo MSP, Kermen MST, Bikovo MSP, Sveti Iliya MST, Manastirski MST, Mochuritsa KMS, San Stefano – Karnobat MST, Bakadzhitsite MST, Bolyarovo KMS, Burgas LLMS, Sakar MST, Strandzha MST, Lower Thracia LLMS.

BREGALNITSA MSZ

12 Bregalnitsa CMSP – Kochani KMS, Dulitsa MSG, Delchevo KMS, Stamer MSP, Razpovtsi MSP, Rozovo MST, Tsarnik MSP, Berovo KMS.

13 Strumeshnitsa CMSP – Kriva Lakavitsa MSP, Smardesh MST, Radovish MSP, Strumitsa KMS, Novo Selo MSP, Samuilovo MST, Petrich KMS.

RILA-PIRIN MSZ

14 Struma CMSP – Dupnitsa MST, Dzherman KMS, Slatino MST, Mursalevo KMS, Kocherinovo MST, Riletska KMS, Byalo pole MST, Blagoevgrad KMS, Zheleznitsa MSG, Simitli KMS, Kresna MSG, Sandanski MSP, Damyanitsa MST, Petrich KMS, Rupel MSP.

15 Mesta CMSP – Chepino KMS, Avramov MST, Yakoruda MSP, Razlog KMS, Momina kula MST, Gotse Delchev KMS, Peterlik MST, Lefteriya KMS, Shtudera MST, Drama KMS.

RHODOPE MSZ

16 Arda CMSP – Kardzhali MSP, Rabovo MST, Madzharovo MSP.

Seismic overview

The seismic overview of the Balkan Peninsula East Part show, that the effects of the not so high (in comparison with the Balkan Peninsula West Part) seismic activity manifests only on the enclosure faults of some negative morphostructures from the Complex Morphostructural Passages (Fig. 7). The central part of this ngative morphoelements are seismic passiv. This circumstance confirms the fact that the bottoms of the negative morphostructures are fragments from the seismic passive post Early Pleistocene Orthoplain.

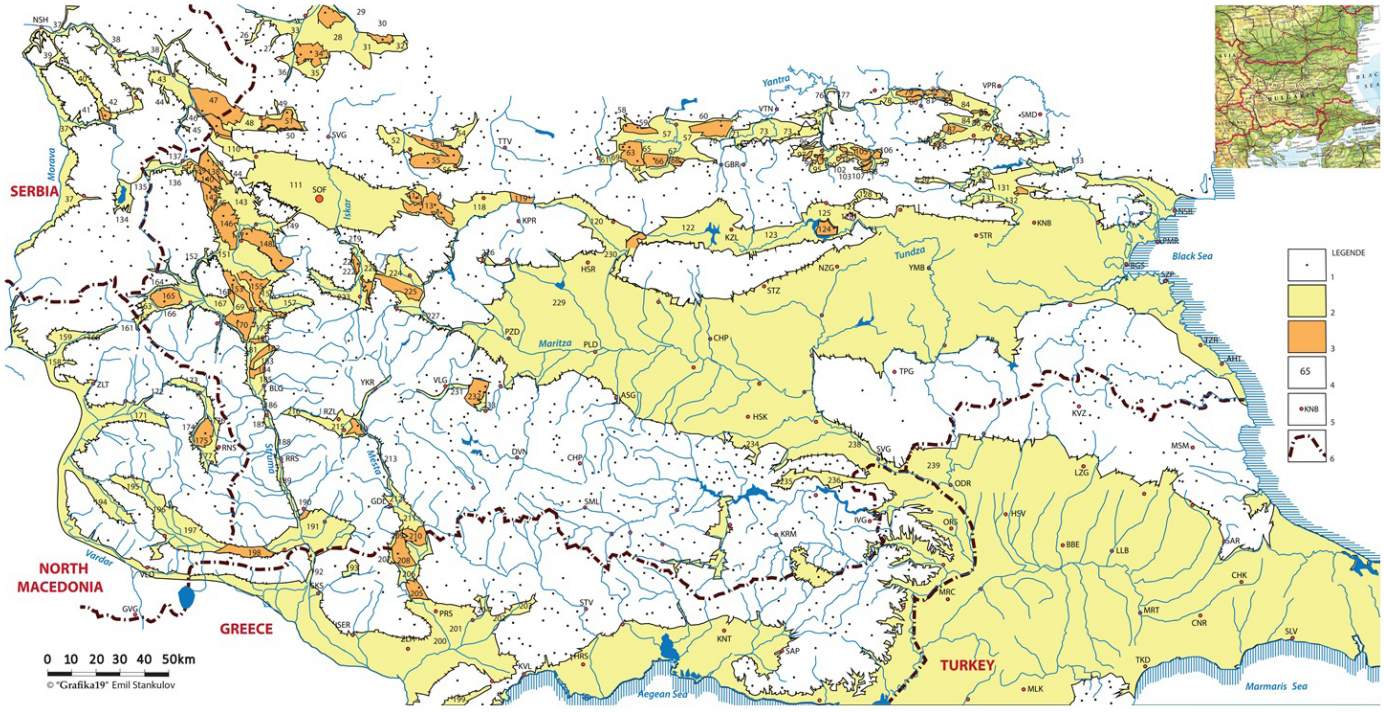

Fig.ure 6. Overview map of the Complex Morphostructutal Passages regional disposition in the Balkan Peninsula East Part 1- positive morphostructures with the centrums of maximal contemporary elevation (black points), 2-3 – negative morphostructures: 2- low land, kettle, river valley morphostructures, 3-morphostructural thresholds; 4- number of negative morphostructure, 5- city and towns: 6- border.

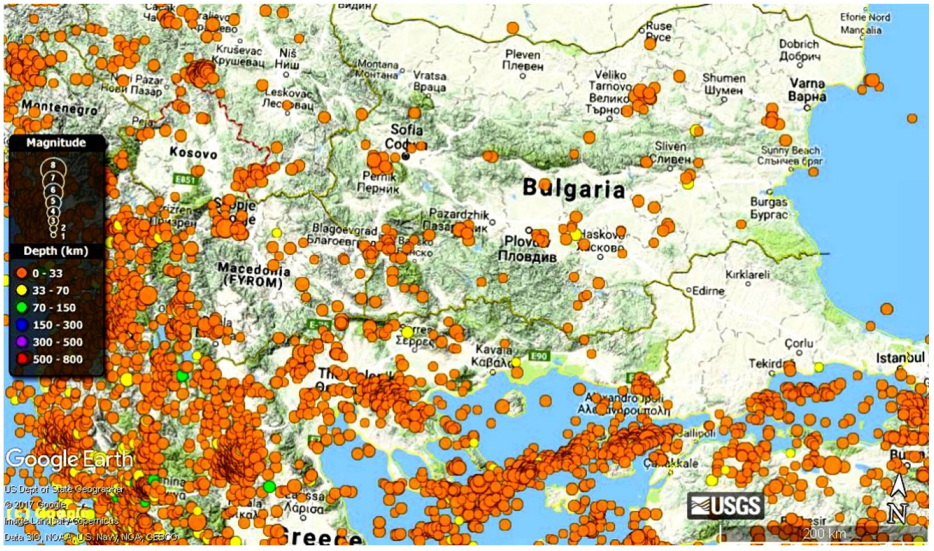

Figure 7. Comparative map of the seismic activity in the eastern part of Balkan Peninsula during the period of fifty years (1965 – 2016).

Conclusion

The Complex Morphostructural Passages are the first rare negative morphostructural units in the Balkan Peninsula East Part. They are compound constructed morphoelements from the relics of the post Early Pleistocene Orthoplain in the area. It destruction, respectively the positive dome-like morphostructures is controlled by the deep crustal processes of the transcontinental collision between Gonwana and Neo Europe in the Balkan Peninsuls Area. This endogen geodynamics predetermines the future reduction of the Complex Morphostructural Passages spatial dimensions on account of the enlargement of the areas of the positive morphostructures.

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