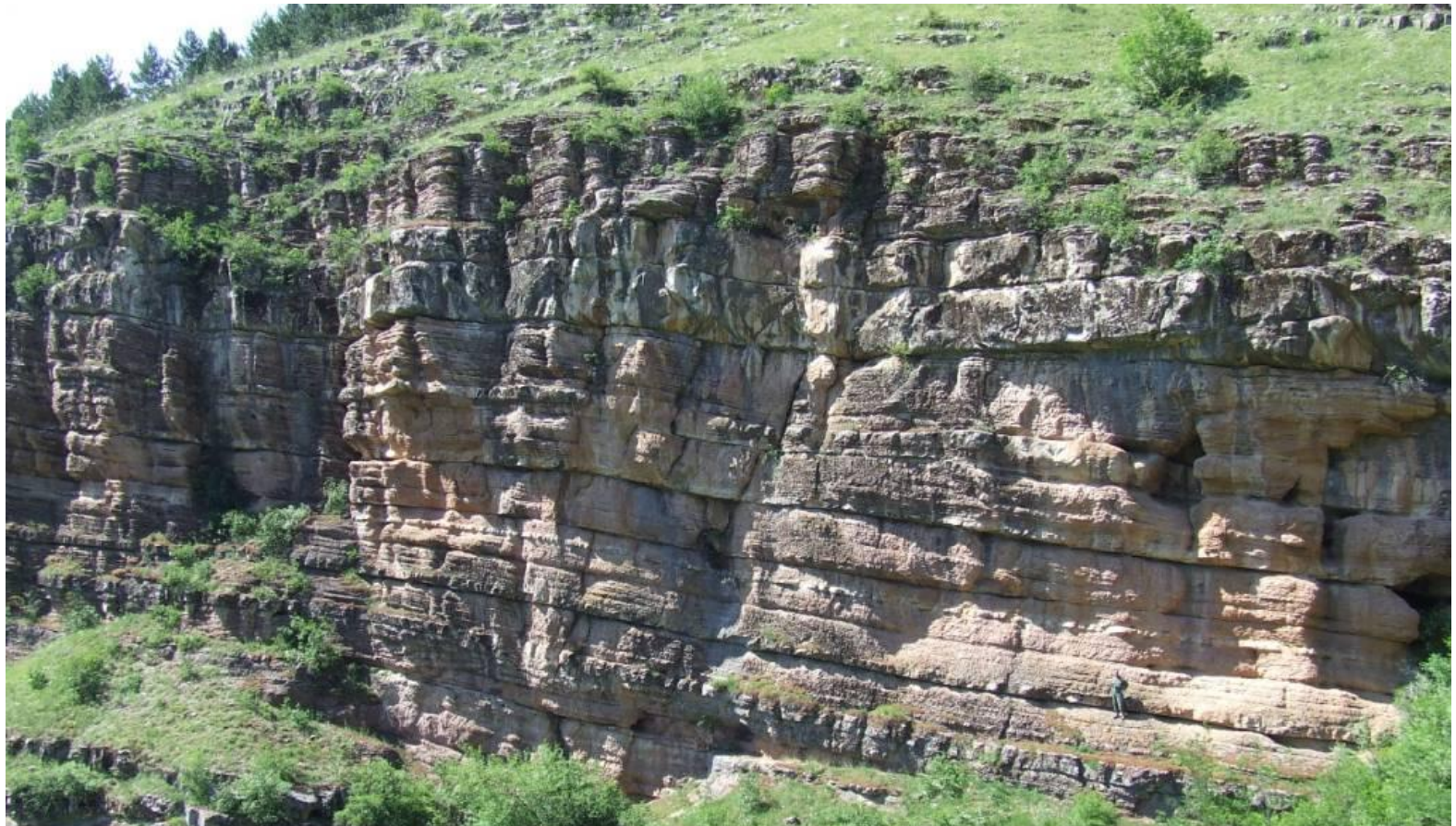




Универзитет у Новом Саду  
Природно-математички факултет  
Департман за географију, туризам и хотелијерство

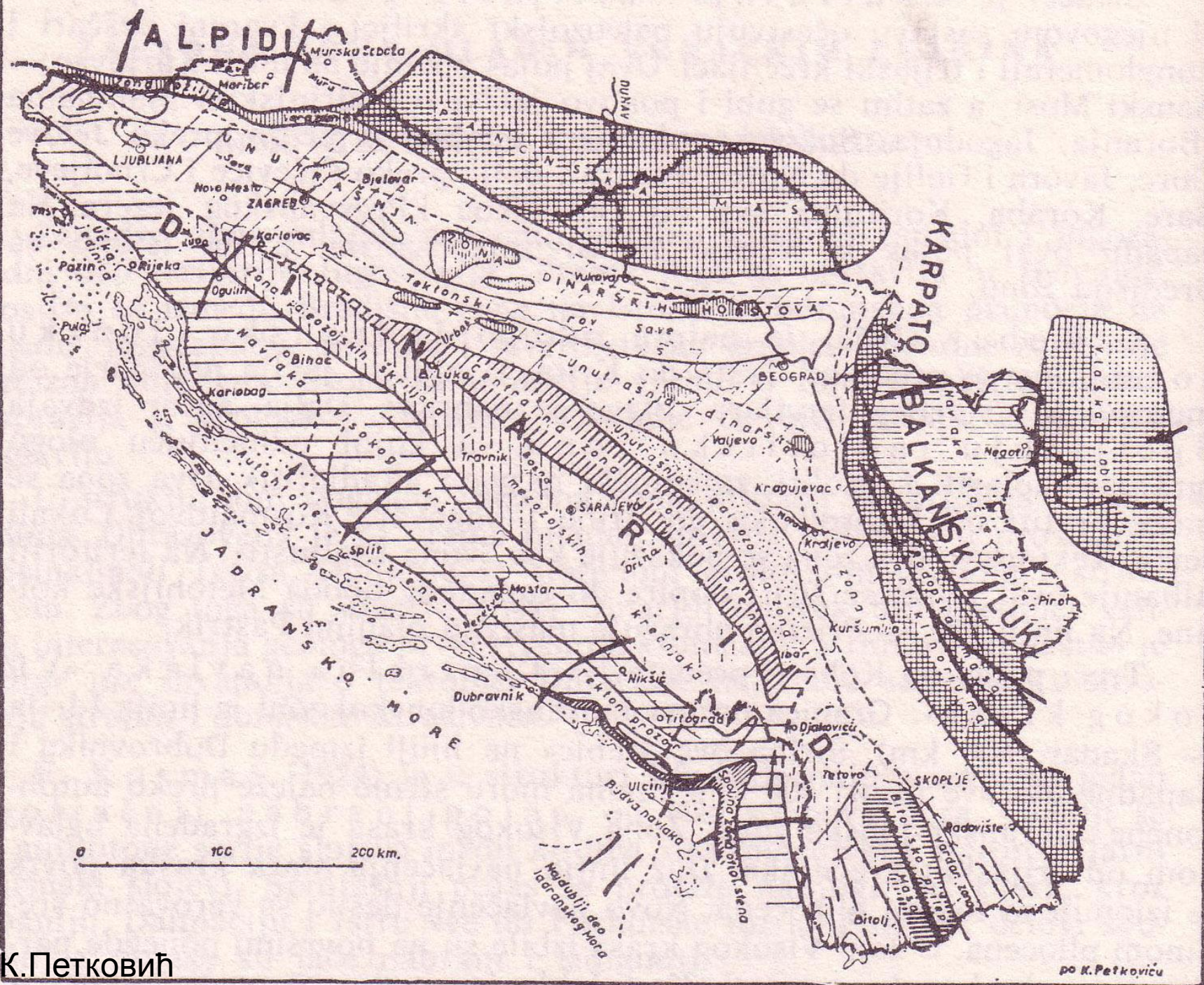
**Др Млађен Јовановић**

*Катедра за Физичку географију*

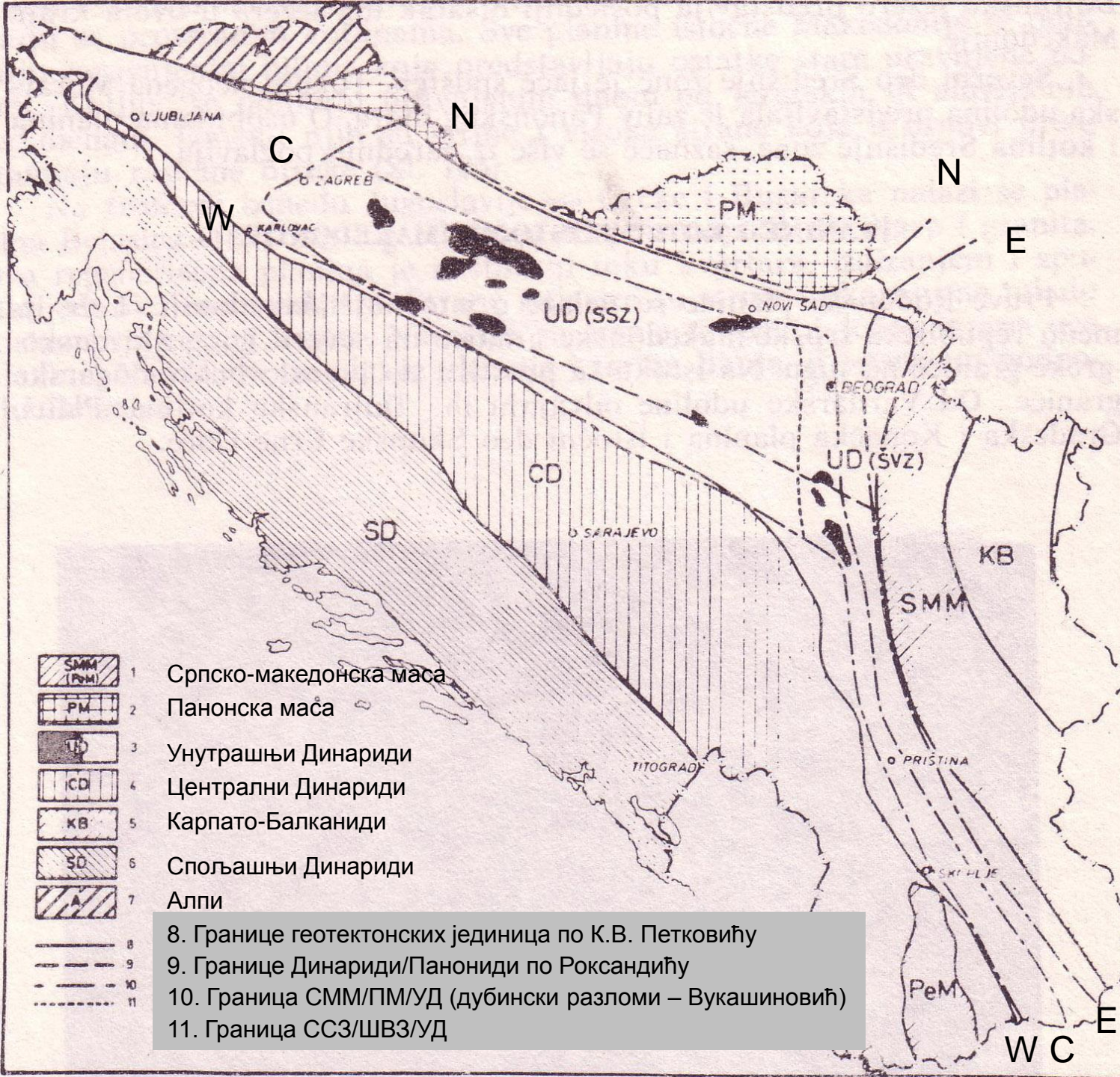


# ГЕОТЕКТОНСКА ПОДЕЛА СРБИЈЕ









### ИСТОЧНИ ДР

Дојран-Струмица-Црни врх (Кратовско-злетовска област) – Тулари – Александровац – Крагујевац – Иланца – Бузијаш (ROM)

### ЦЕНТРАЛНИ ДР

Ђевђелија-Куманово-Приштина-Брзеће-Гледић-Космај-Авала-Ковачица-Фрушка гора-источни обод Славонских планина

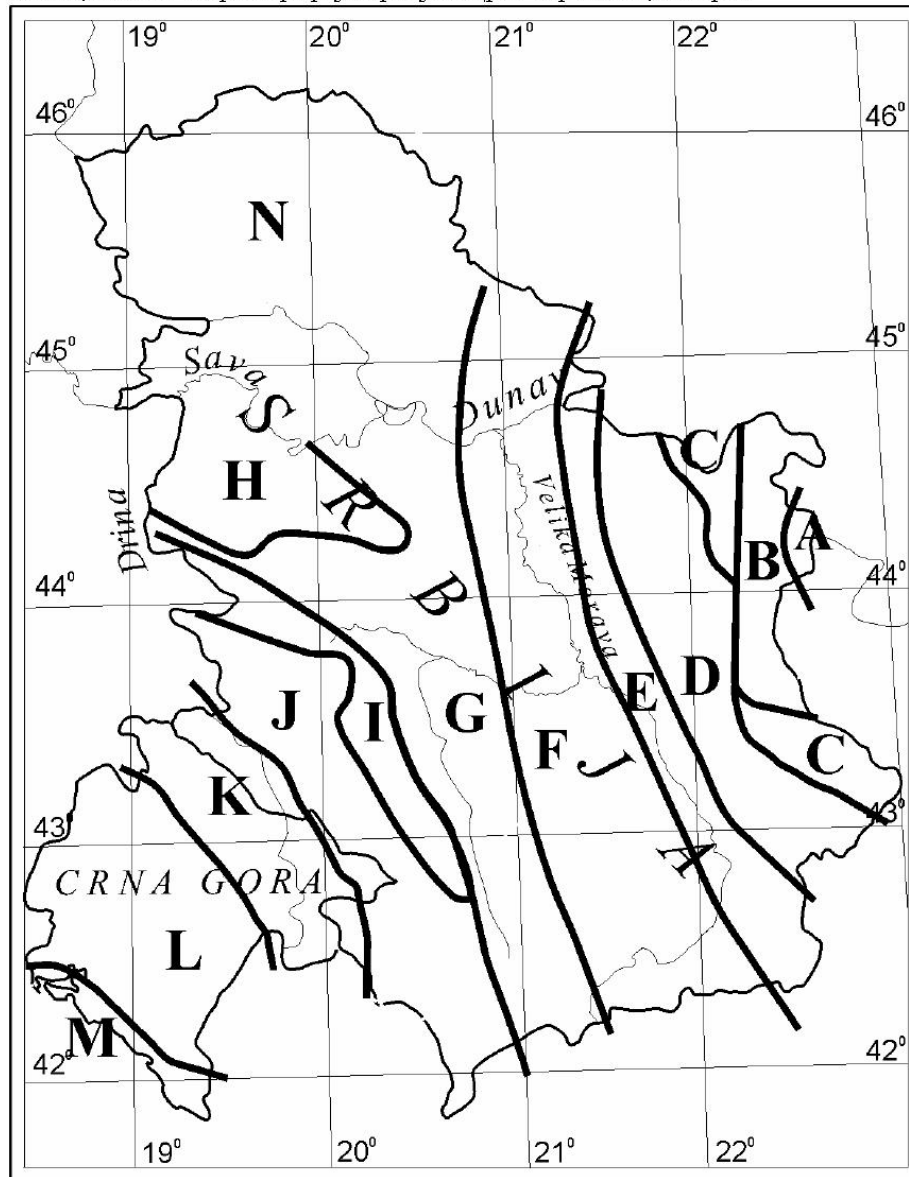
### ЗАПАДНИ ДР

Велес-Радуша-Голеш-Рашка-Маљен-Зворник-Озрен-Козара-Костајница

### СЕВЕРНИ ДР

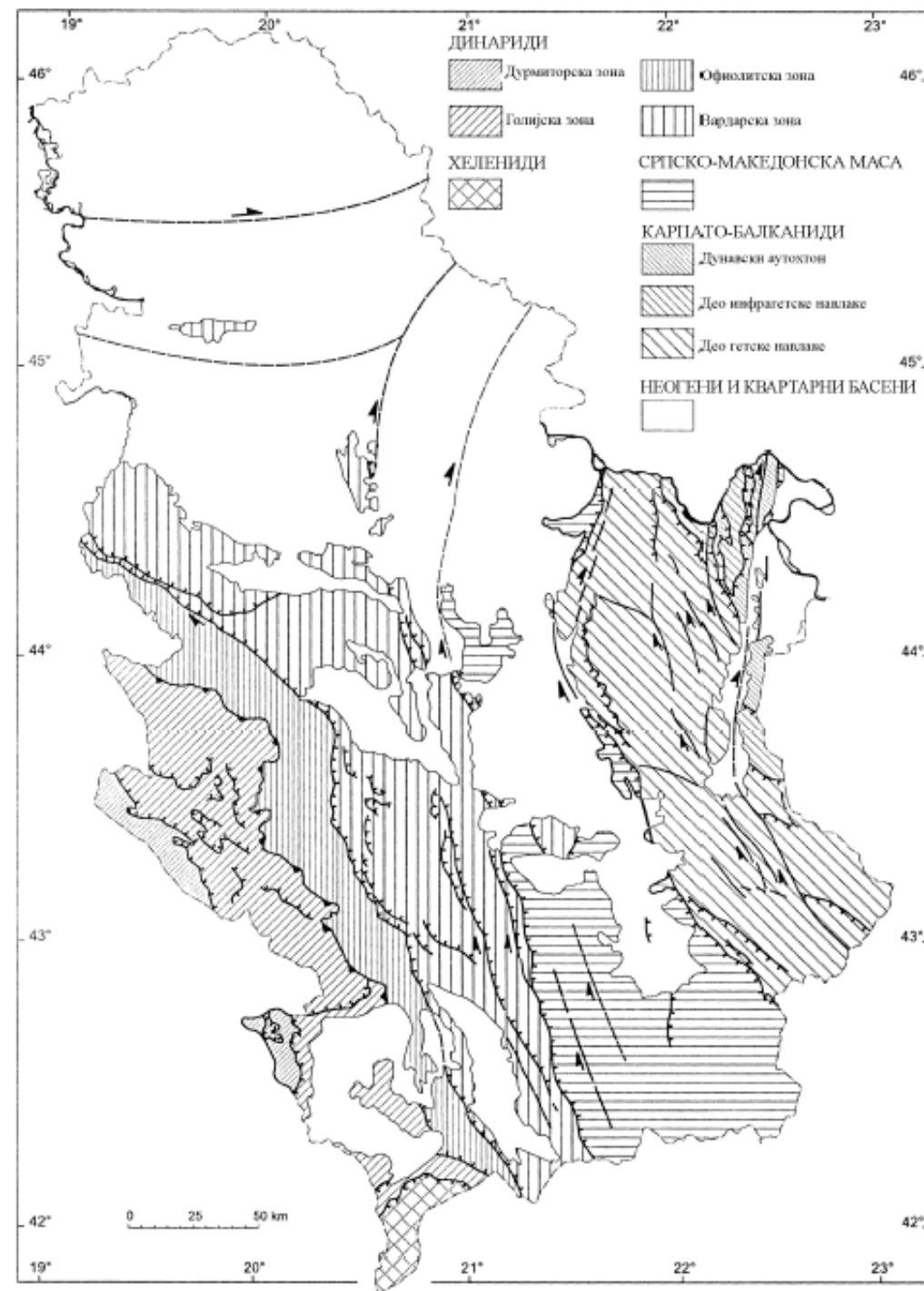
Апусени-Темишвар-Зрењанин-Оџаци-Осијек-Барч

- |  |    |  |
|--|----|--|
|  | 1  | Српско-македонска маса                             |
|  | 2  | Панонска маса                                      |
|  | 3  | Унутрашњи Динариди                                 |
|  | 4  | Централни Динариди                                 |
|  | 5  | Карпато-Балканиди                                  |
|  | 6  | Спољашњи Динариди                                  |
|  | 7  | Алпи   |
|  | 8  | Границе геотектонских јединица по К.В. Петковићу   |
|  | 9  | Границе Динариди/Панониди по Роксандићу            |
|  | 10 | Граница СММ/ПМ/УД (дубински разломи – Вукашиновић) |
|  | 11 | Граница ССЗ/ШВЗ/УД                                 |

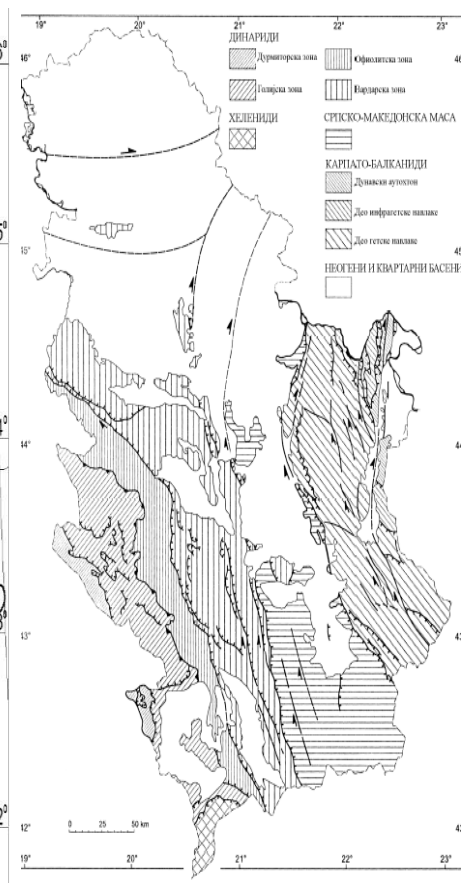
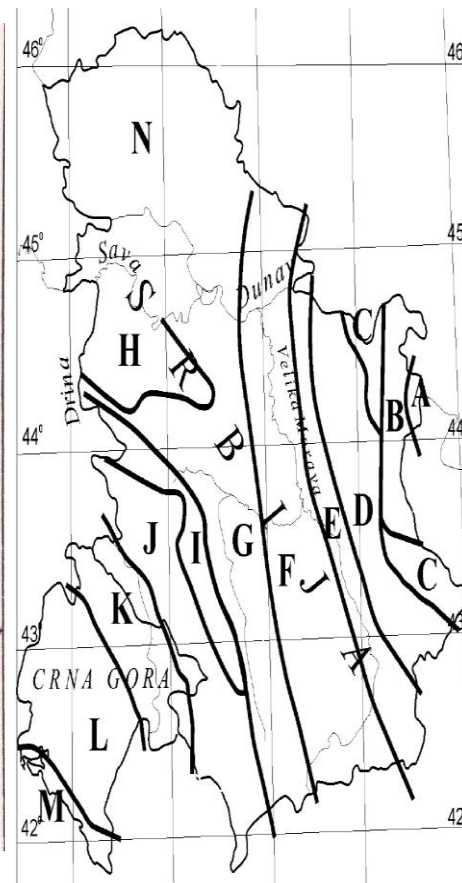
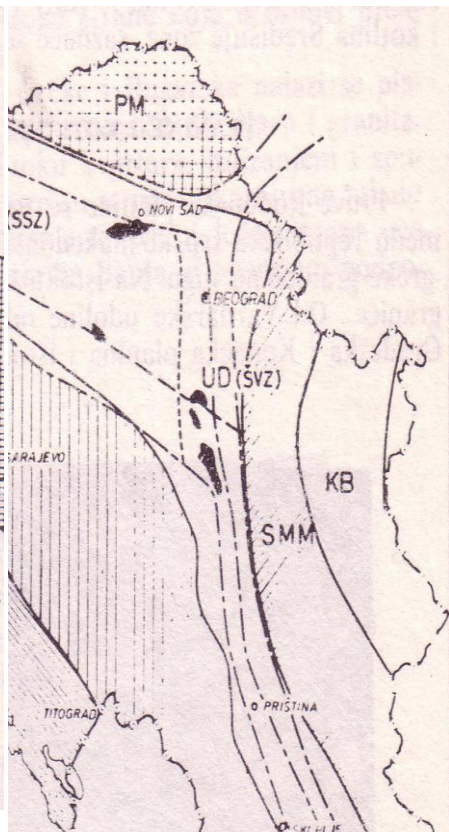
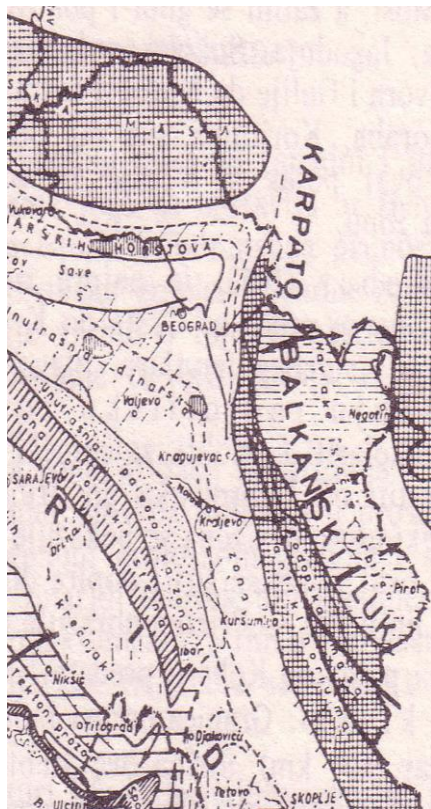


Sl. 1. Osnovne jedinice u okviru kojih je prikazana stratigrafska građa. Legenda: A. Meziska jedinica, B. Jedinica Vrške Čuke – Miroča, C. Stara planina – Poreč, D. Kučajska jedinica, E. Ranovac Vlasina, F. Srpsko makedonska masa, G. Vardarska zona, H. Jadarska blok, I. Drinsko ivanjička jedinica, J. Dinaridski ofiolitski pojas, K. Durmitorska jedinica, L. Dalmatinsko hercegovačka jedinica, M. Jedinica Budve, N. Panonski basen (KARAMATA i dr. 1997, prilagođeno).

Marović, M. et al. 2007. Neopalpine Tectonics of Serbia. SGD, Belgrade







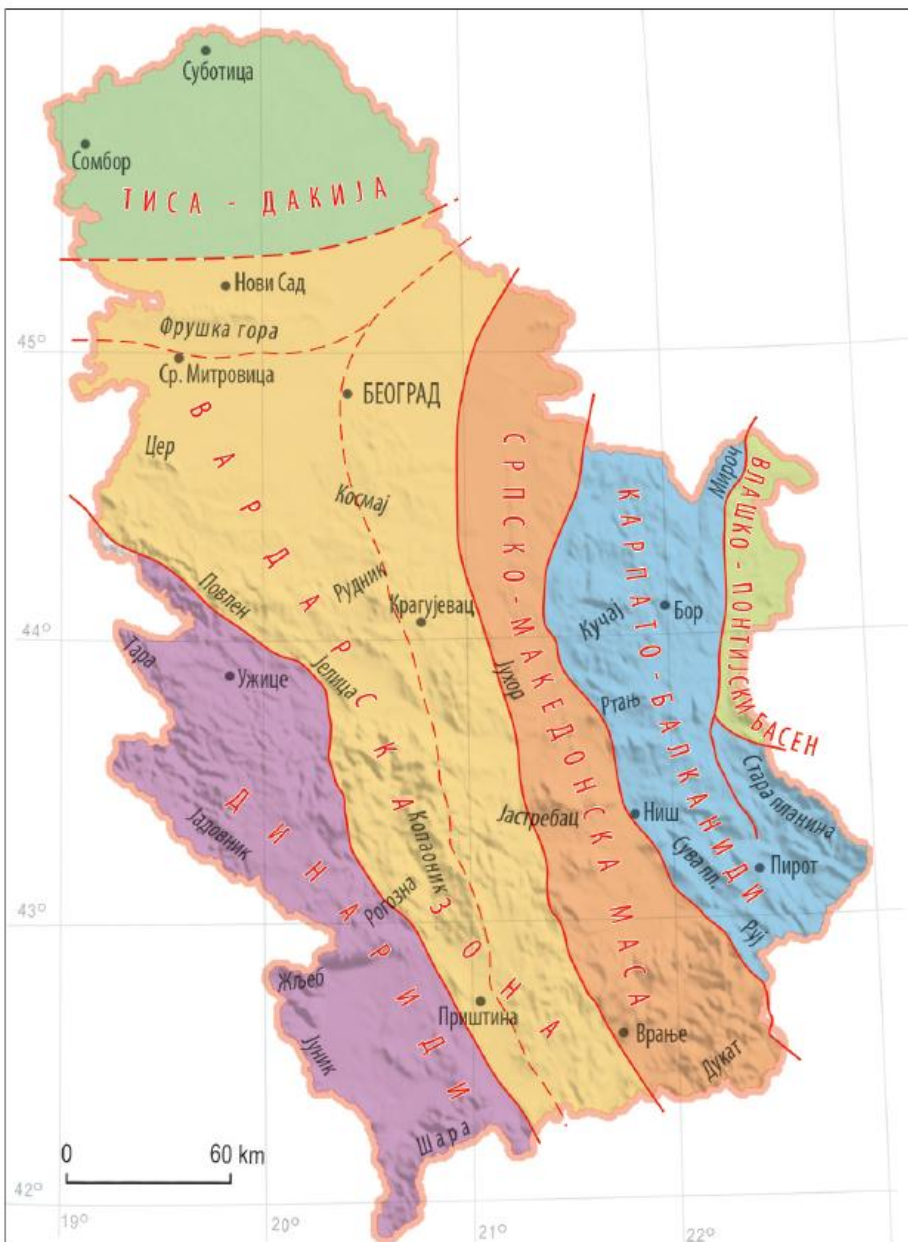


Схема 2. Геотектонске јединице Србије  
(према: Dimitrijević 1995, прилагођено)

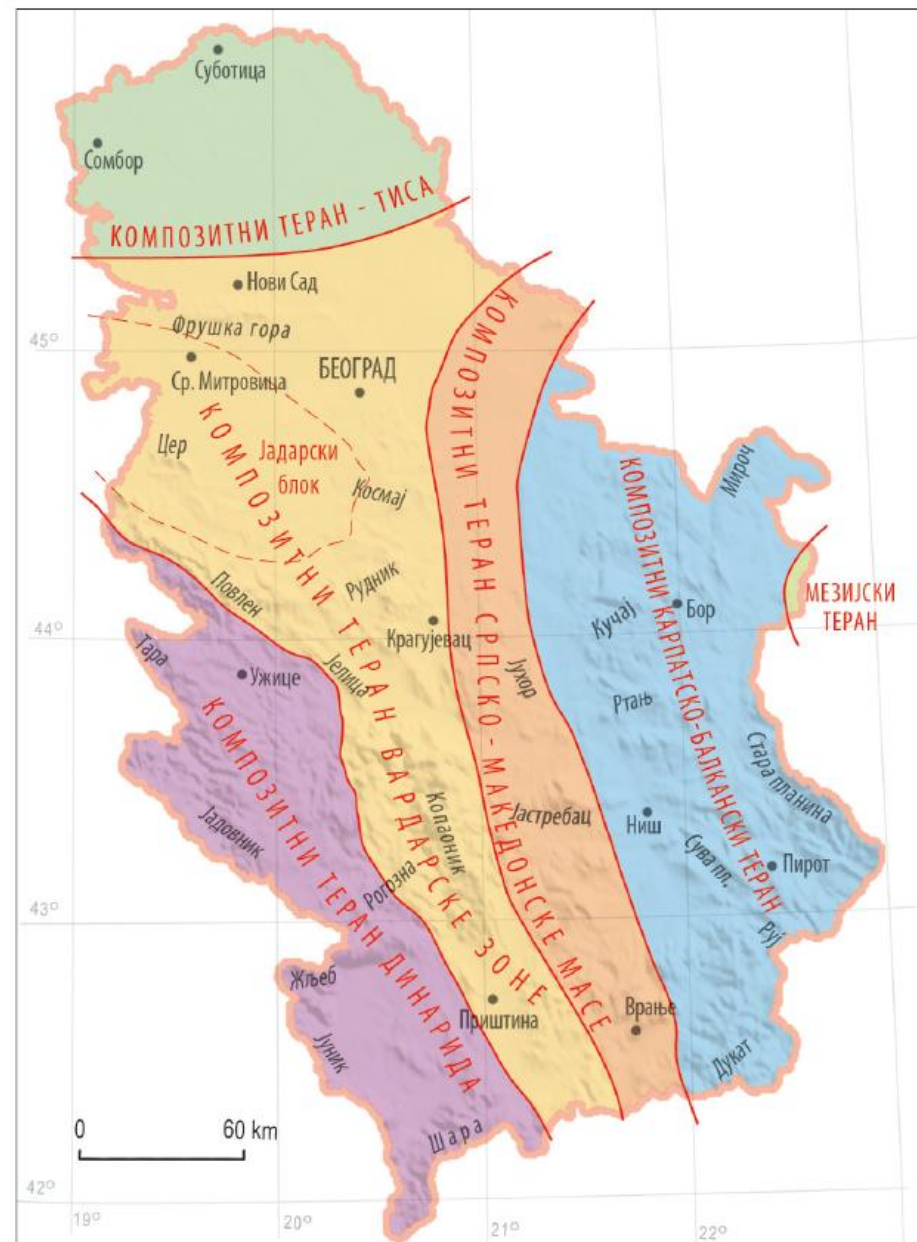
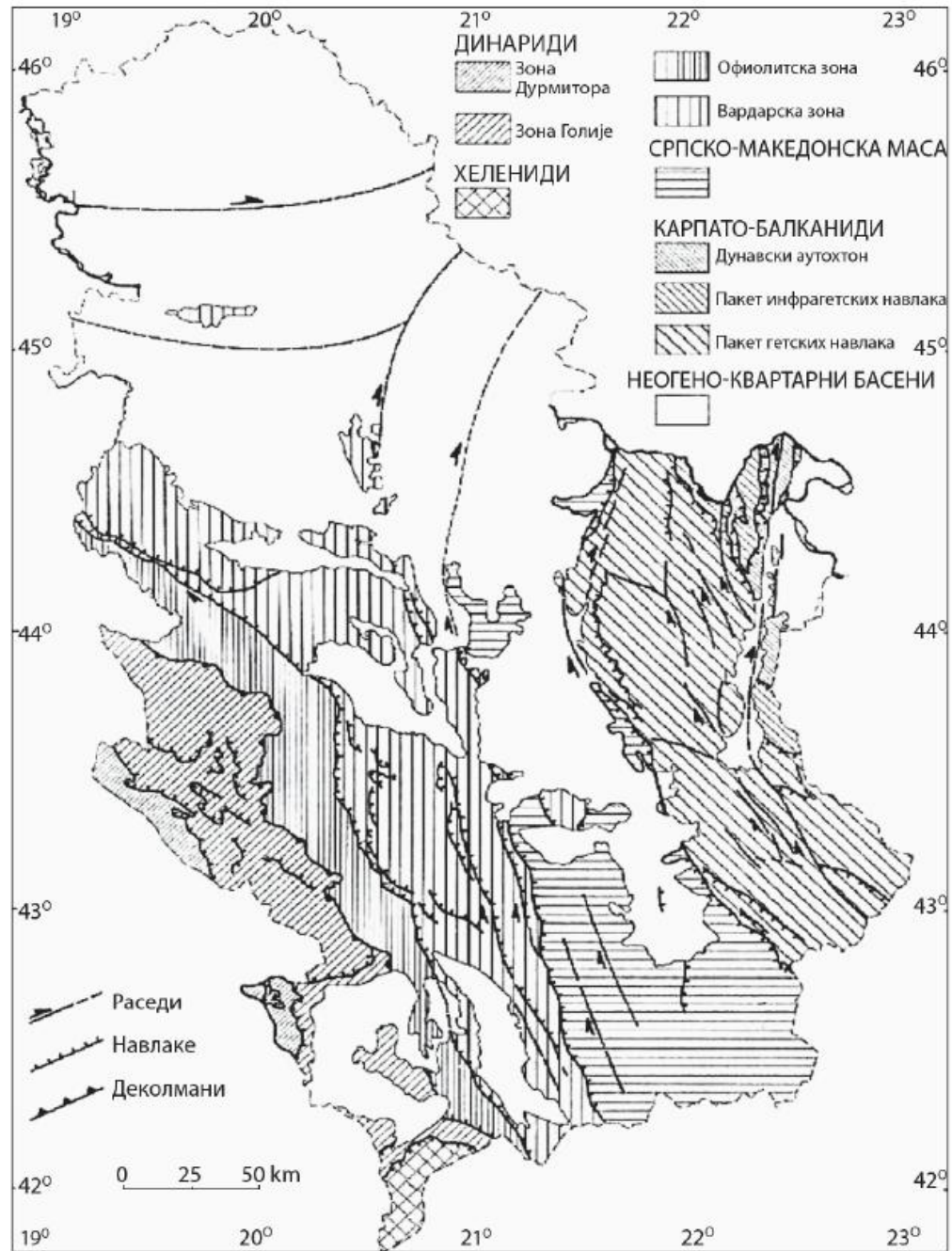


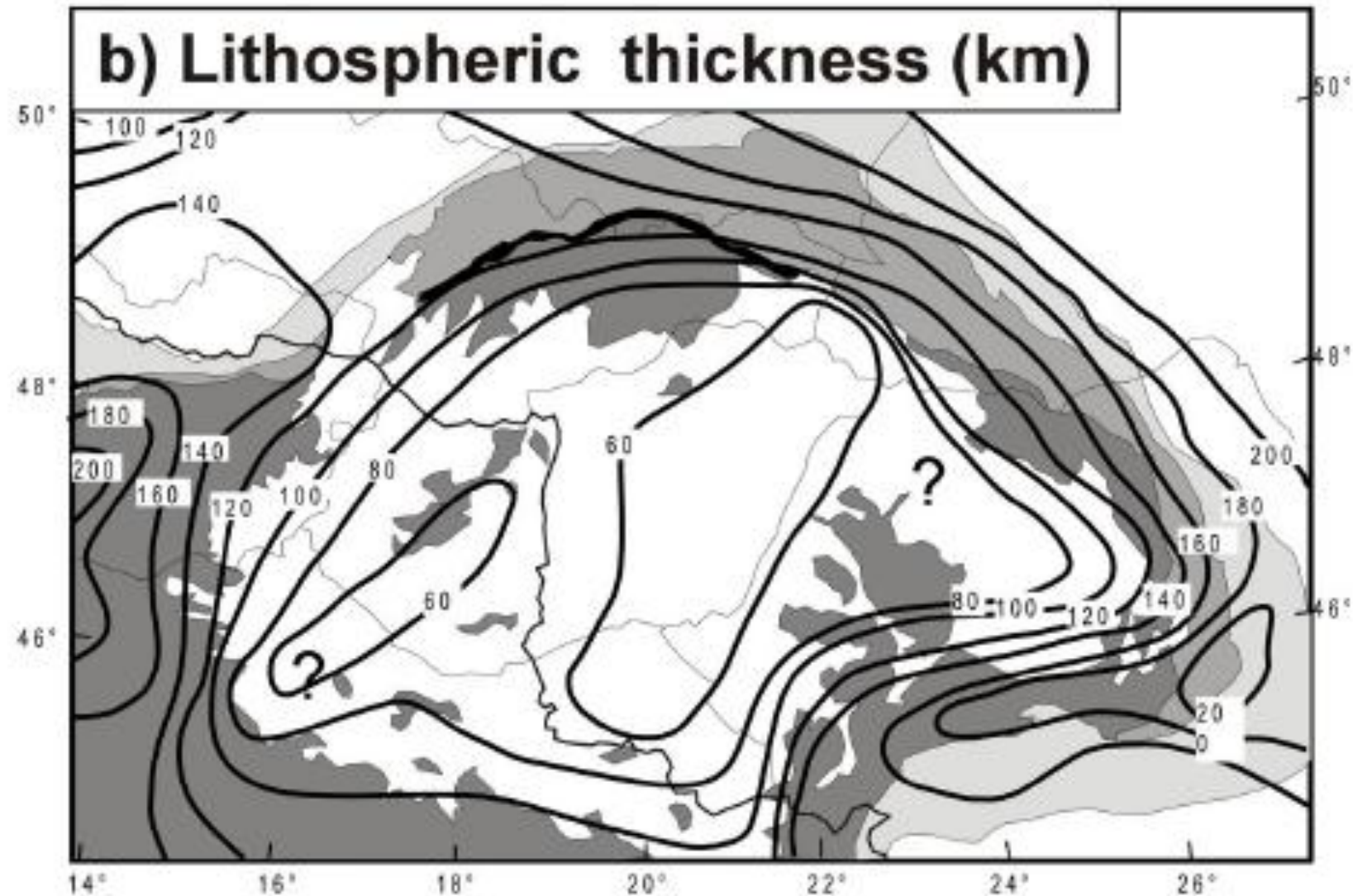
Схема 3. Терани Србије  
(према: Karamata i sar., 1998, прилагођено)





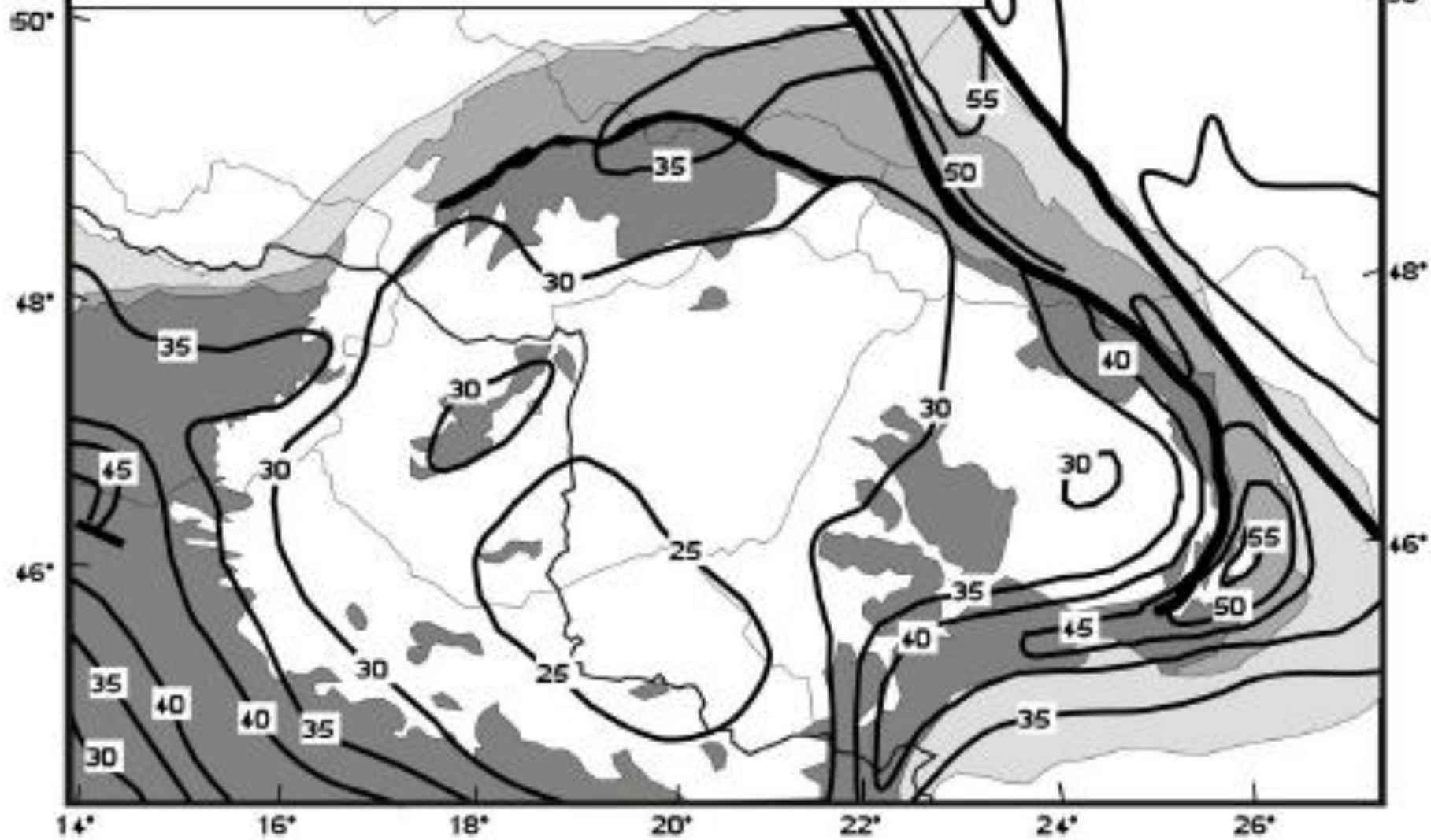
Схema 4. Тектонска скица Србије  
 (према: Marović et al., 2007, прилагођено)





**Fig. 2.** Crust and mantle lithosphere thickness in the Pannonian region after Horvát (1993). Note the very high gradients in lithosphere thickness in the eastern and western part of the system.

# a) Crustal thickness (km)





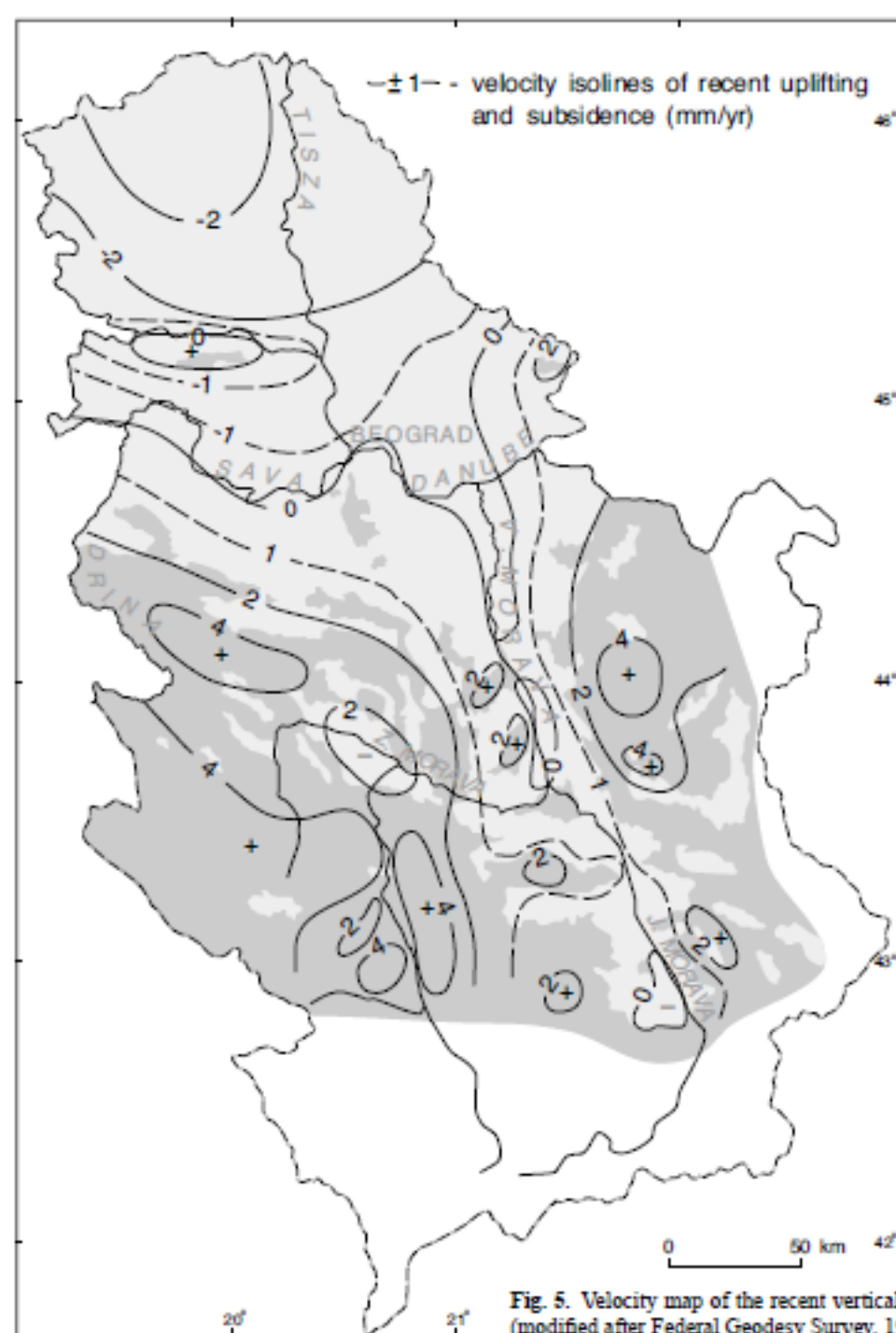


Fig. 5. Velocity map of the recent vertical tectonic movements within the Serbian part of the Pannonian Basin and its wider surroundings (modified after Federal Geodesy Survey, 1972).

Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
	Pliocene	Piazenian	Romanian
		Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	Pannonian
	Tortonian	11.5	
15	Middle Miocene	Serravalian	Sarmatian 13.0
		14.8	Badenian
	Langian	16.4	
	Early Miocene	Burdigalian	20.5
18.3			Ottnangian
Aquitanian		Egerian	
23.8			

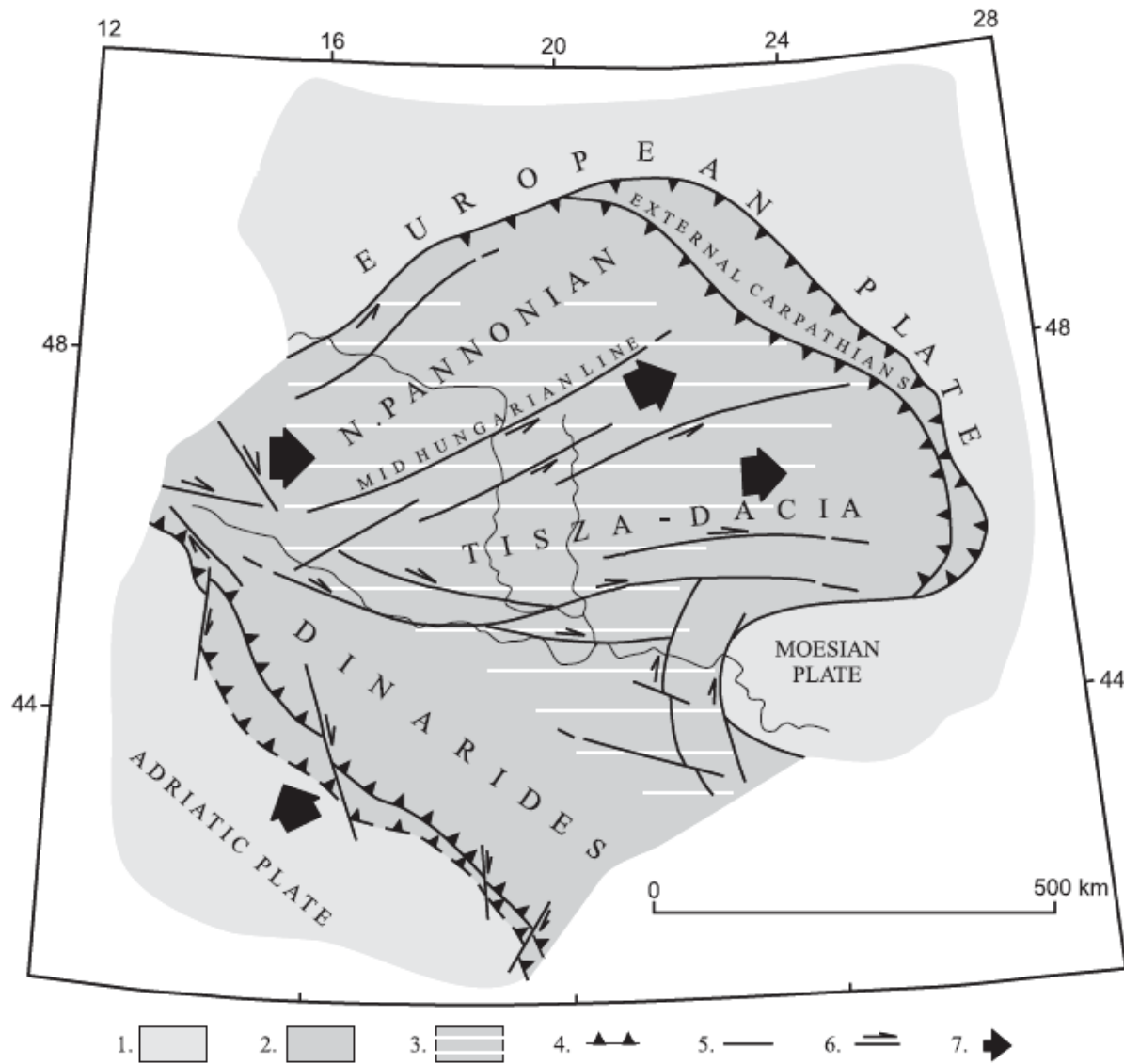
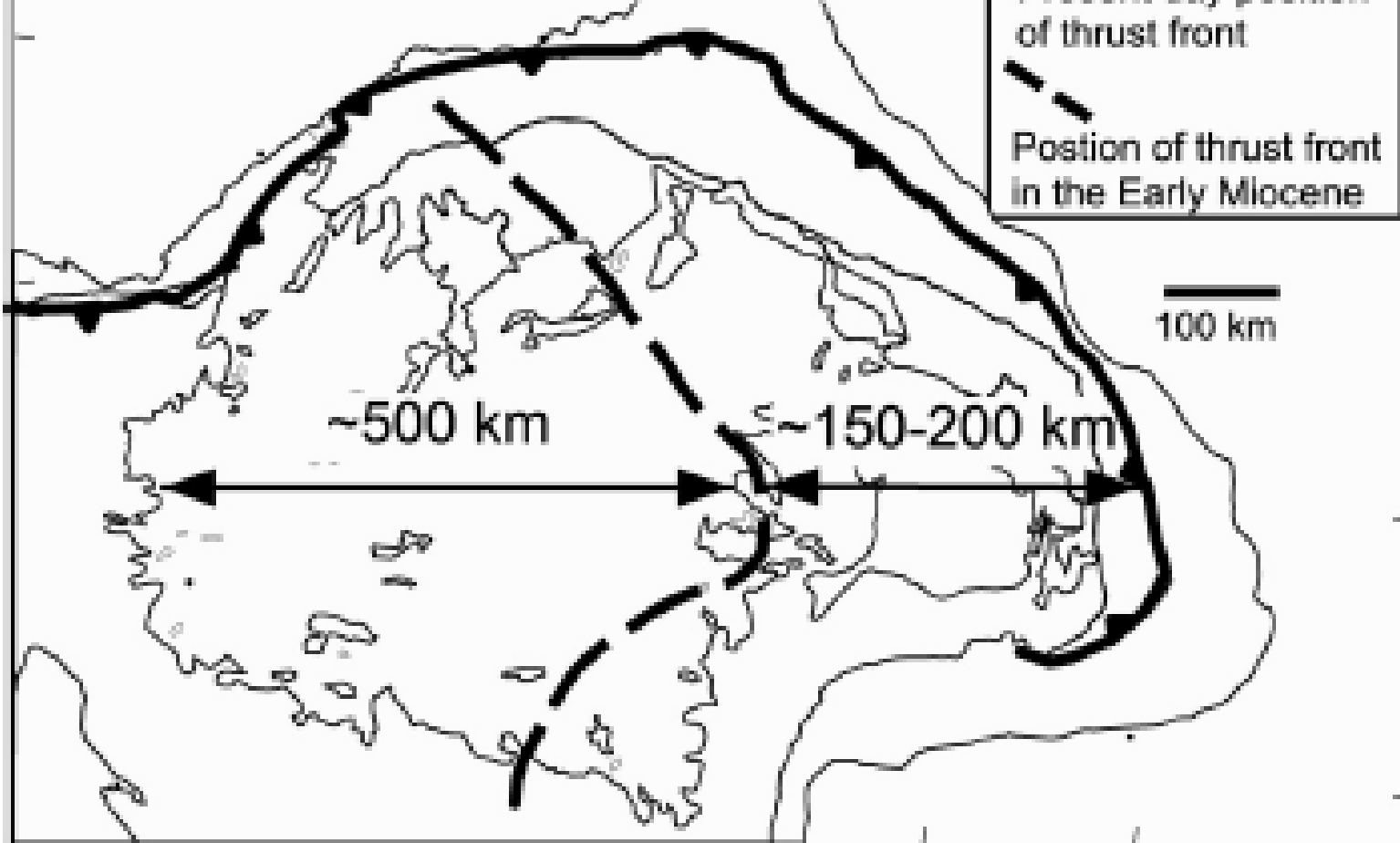


Fig. 20. Kinematics of the general Serbian sedimentation domain during the Middle Miocene (Data on Pannonian basin from Horvath, 1993 – Marović et al., 1999 – modified). Legend: 1. Continental crust of platform, 2. Continental crust of orogene, 3. Areas of manifested extension, 4. Orogene and platform convergence boundary, 5. Faults, 6. Strike-slip faults, and 7. Large tectonic unit (block, plate) movement direction.



# Early Miocene Paleogeography



# ПАРАТЕТИС

старија фаза – доњи миоцен

млађа фаза – средњи миоцен

морска фаза – баден;

бракична – сармат

“Панонско море”

Крајем сармата, издизањем Алпа, Карпата, Балканида и Динарида, Паратетис се цепа на:

западни: алпска сед. област, западно од Источних Алпа

средишњи: Бечки, Штајерски, Панонски и Трансилванијски басен

(унутар венца Карпата и Источних Алпа, северно од Динарида)

источни: источно од Карпата: Дакијски, Црноморски, Каспијски и Аралски

Почетком горњег миоцена (панон, 11,6 My) “Панонско језеро” (касшибракично)

Почетком плиоцена (после понта, 4,6 My) “Палудинско језеро” (слатководно)

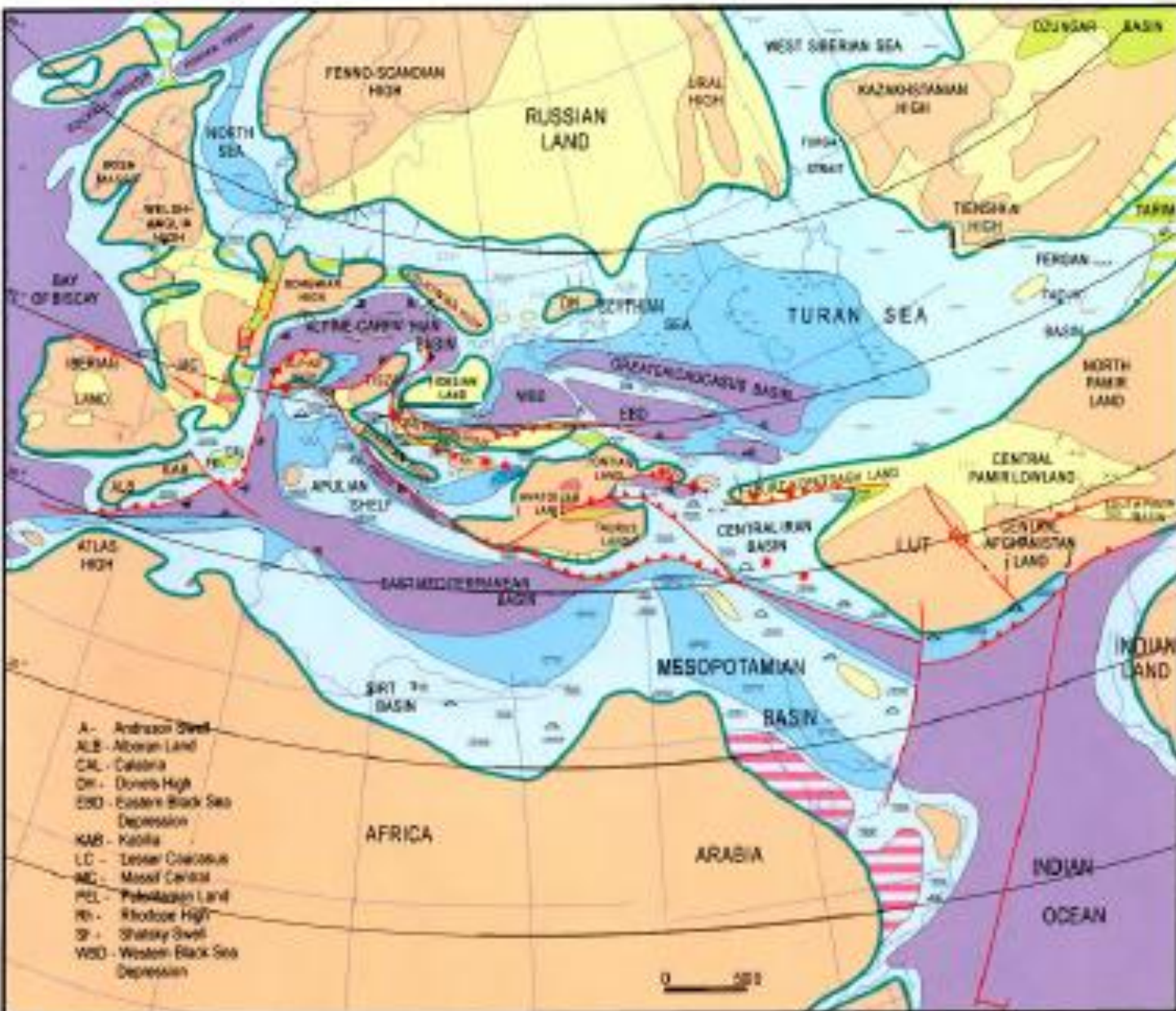


Табела 5. Хронологија еволуције Панонске седиментационе области Србије од почетка неогена до данас

палеогеографска област	тип средине	преовлађујући седименти	Геохронологија	Оквирна старост (Ma)
Панонска низија	Копнена	еолски и речни седименти	Квартар (без најстаријег дела доњег квартара)	Речни седименти: од ~2,0 до данас; лесне серије: од ~1,3 до ~0,01
Палудинско језеро	језерско (слатководна) – копнена	Барски и језерски седименти (палудински слојеви)	плиоцен, до млађег дела доњег квартара	~4,5 до ~2,0
Панонско језеро	језерско (каспи-бракична) – копнена	језерски седименти	горњи миоцен (укључујући и понт)	~11,6 до ~4,5
Паратетис „Панонско море“	морска и морско-бракична	морски седименти	средњи миоцен (сармат и баден)	~16,3 до ~11,6
Динарски систем језера (југозападна Србија)	копнено-језерска	континентално - језерски седименти	Доњи миоцен	~23 до ~16,3

# Late Eocene 37-34 Ma

- Marine environments:
- Shallow shelf
  - Deep shelf
  - Deep shelfal depression
  - Continental slope and basin bottom



- A - Androsz Shelf
- ALB - Albanian Land
- CAL - Calabria
- DR - Donets High
- EDD - Eastern Black Sea Depression
- KAB - Kabala
- LC - Lesser Caucasus
- MC - Messid Central
- PEL - Peloponnese Land
- RH - Rhodope High
- SI - Shansky Shelf
- WSD - Western Black Sea Depression

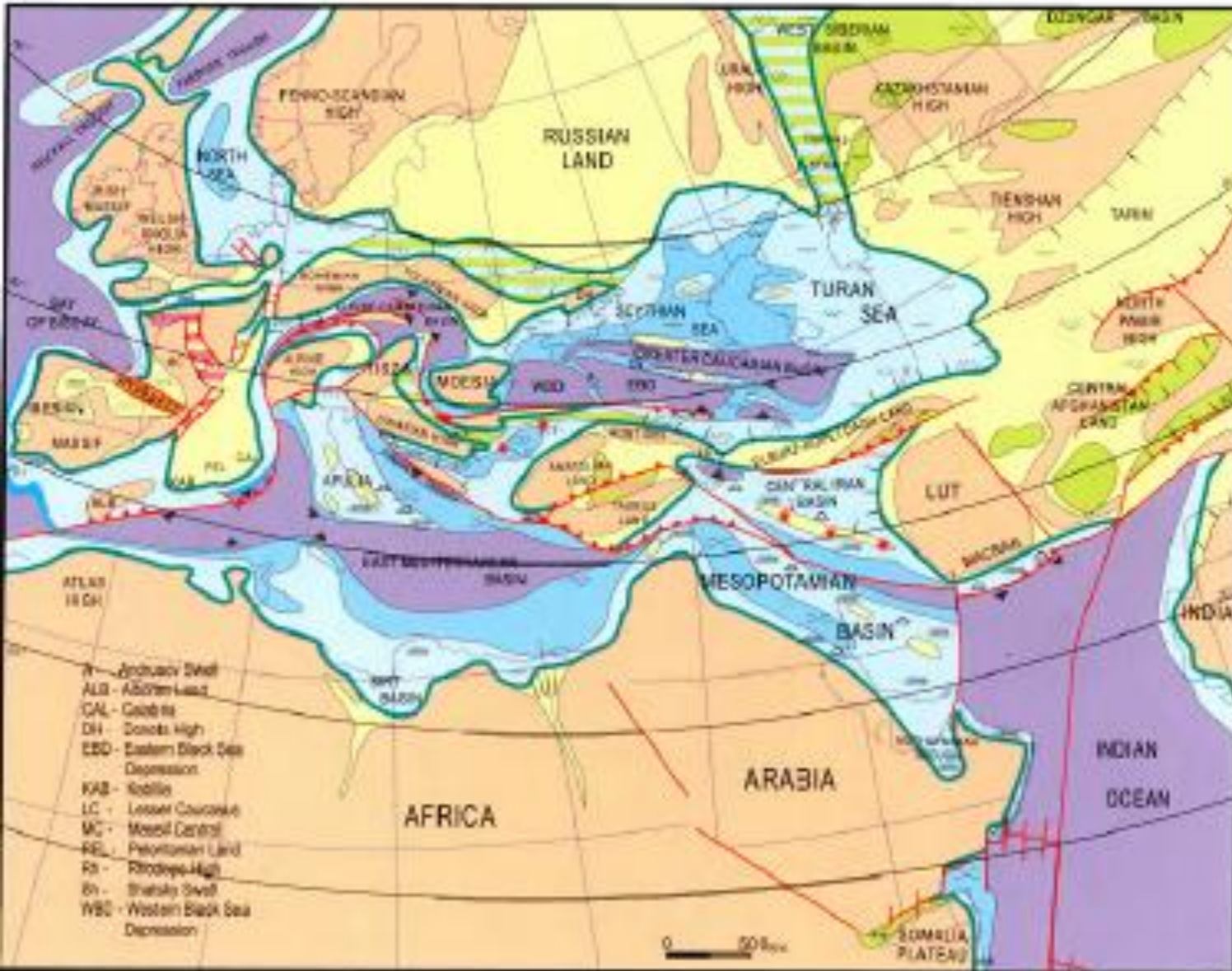
Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
		Pliocene	Romanian
	5.3	Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
	Tortonian	Pannonian	
15	Middle Miocene	11.5	
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	Langian
20	Early Miocene		Karpathian 17.2
		Burdigalian	Ottnangian 18.3
		20.5	Eggenburgian
		Aquitanian	Egerian
23.8			



# Early Oligocene

34-32 Ma



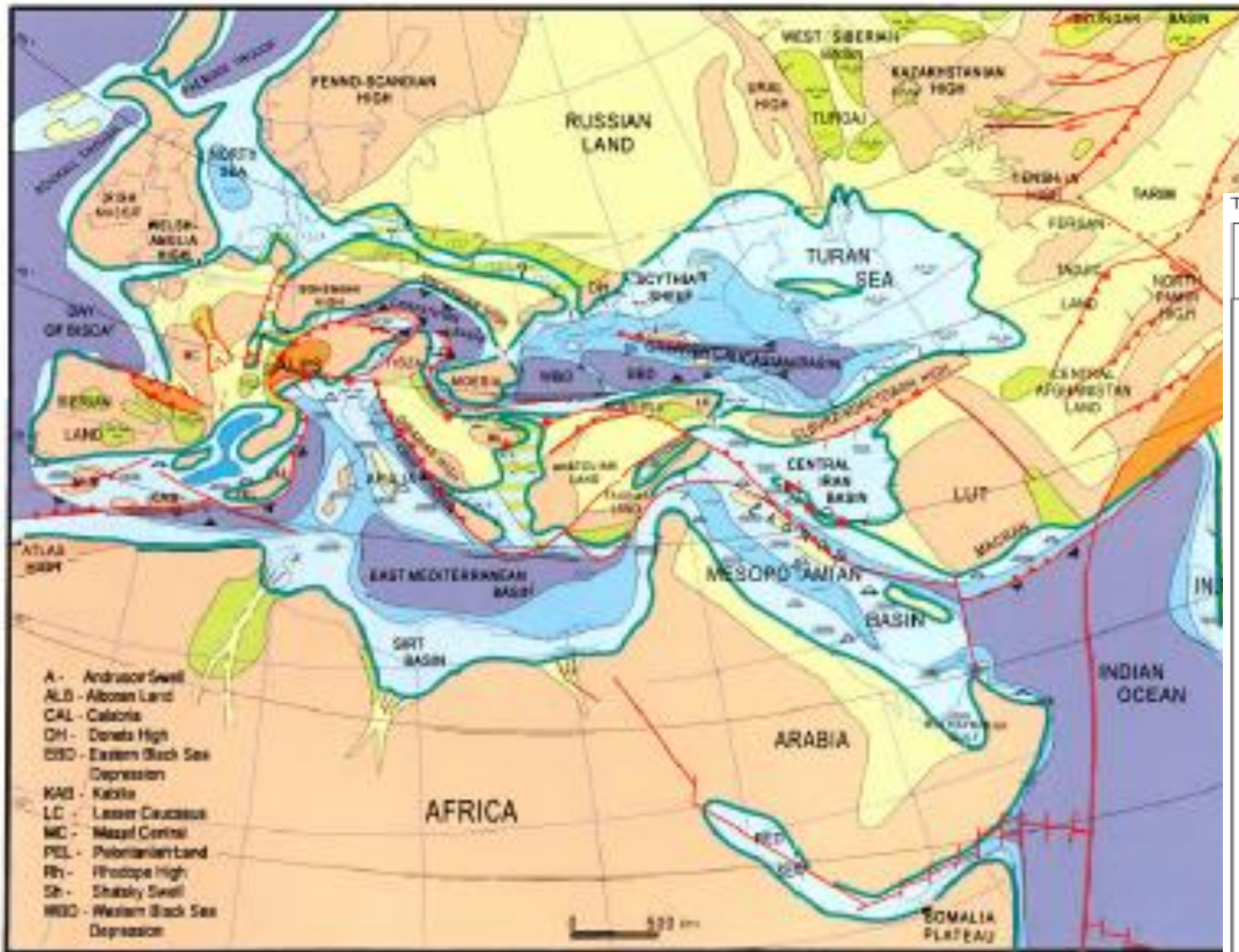
Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
		Pliocene	Romanian
	5.3	Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
	Tortonian	Pannonian	
15	Middle Miocene	11.0	11.5
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	Langian
20	Early Miocene		Karpathian 17.2
		Burdigalian	Otnangian 18.3
		20.5	Eggenburgian
		Aquitanian	Egerian
23.8			



# Late Oligocene

29 - 24 Ma



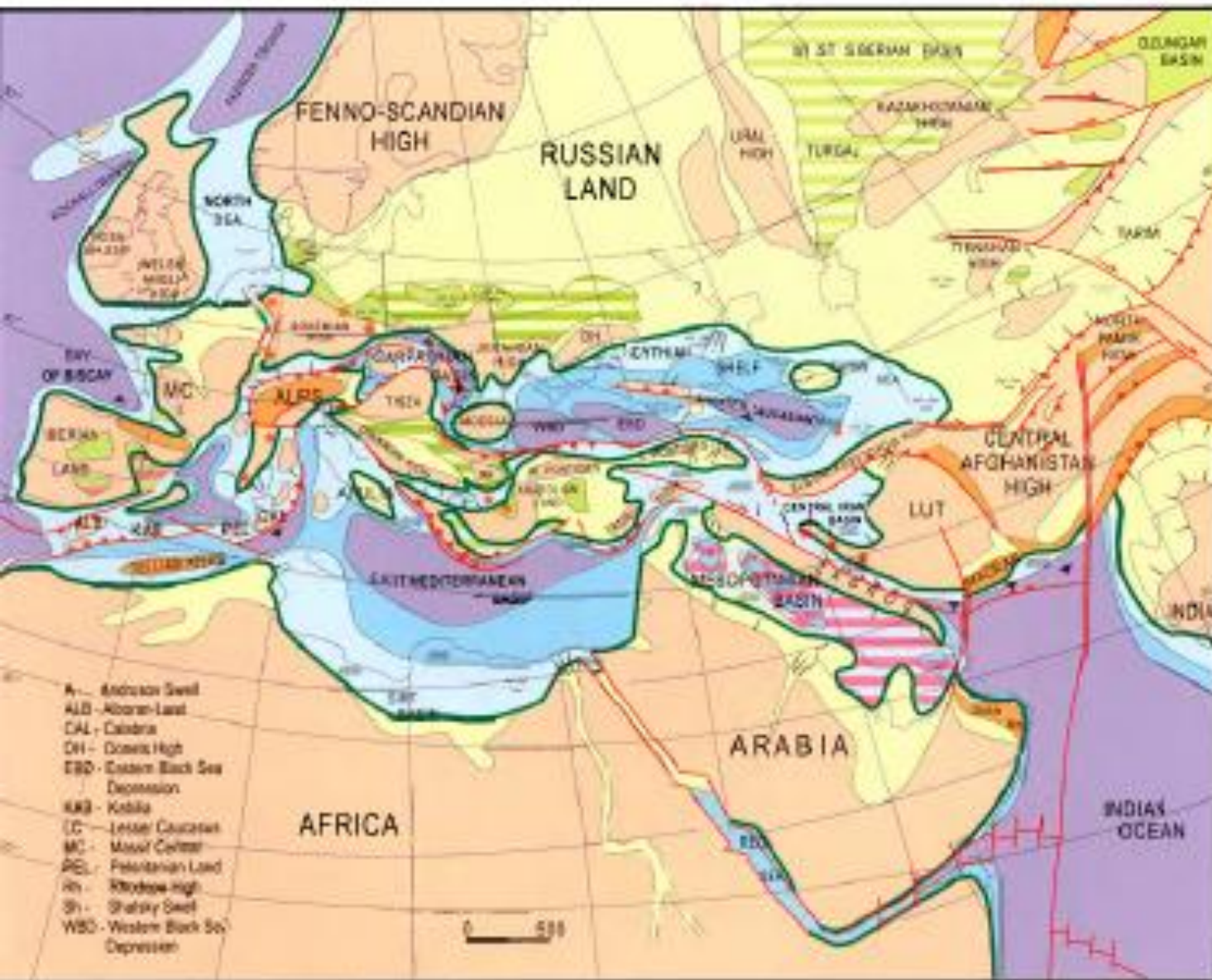
Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Pliocene	Calabrian	Pleistocene
		Piazzenzian	Romanian
	5.3	Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
	11.0	Tortonian	Pannonian
15	Middle Miocene		11.5
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	Langian
20	Early Miocene		Karpathian 17.2
			Otnangian 18.3
		20.5	Eggenburgian
		Aquitanian	Egerian
23.8			



# Early Miocene

20,5-19 Ma



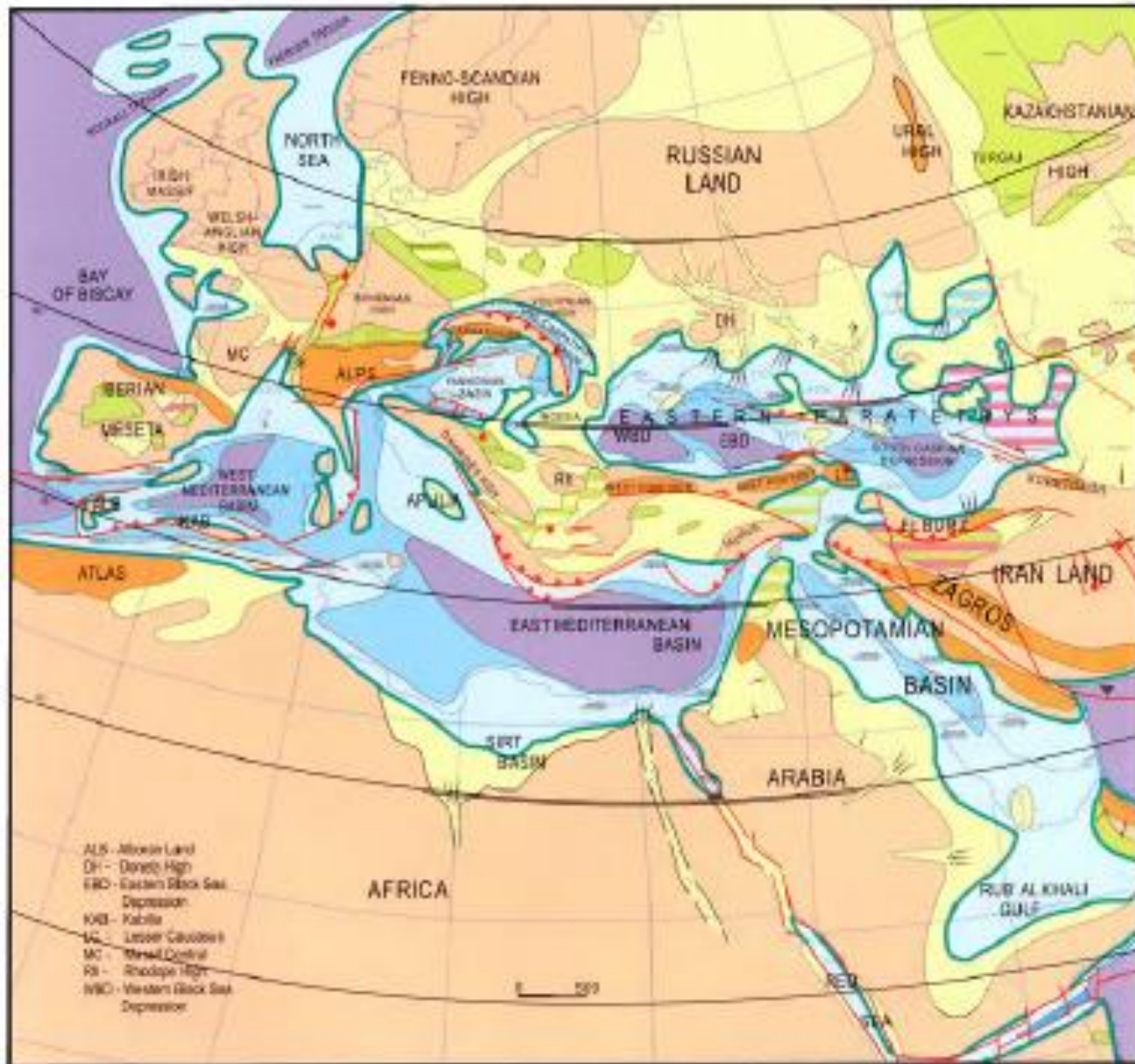
Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
	Pliocene	Piazzanian	Romanian
		Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	Pannonian
	Tortonian	11.5	
15	Middle Miocene	Serravalian	Sarmatian 13.0
		14.8	Badenian
		Langian	
20	Early Miocene	Burdigalian	Karpathian 17.2
			Ottományian 18.3
		20.5	Eggenburgian
		Aquitanian	Egerian
23.8			

M. Kováč, V.A. Krasheninnikov,  
T.N. Pinchuk, B.I. Pinkhasov, S.V. Popov,  
G. Popescu, F. Rögl, A. Rusu,  
A.V. Zaitsev, A.S. Zastrowinov

# Early Middle Miocene

16 - 15 Ma



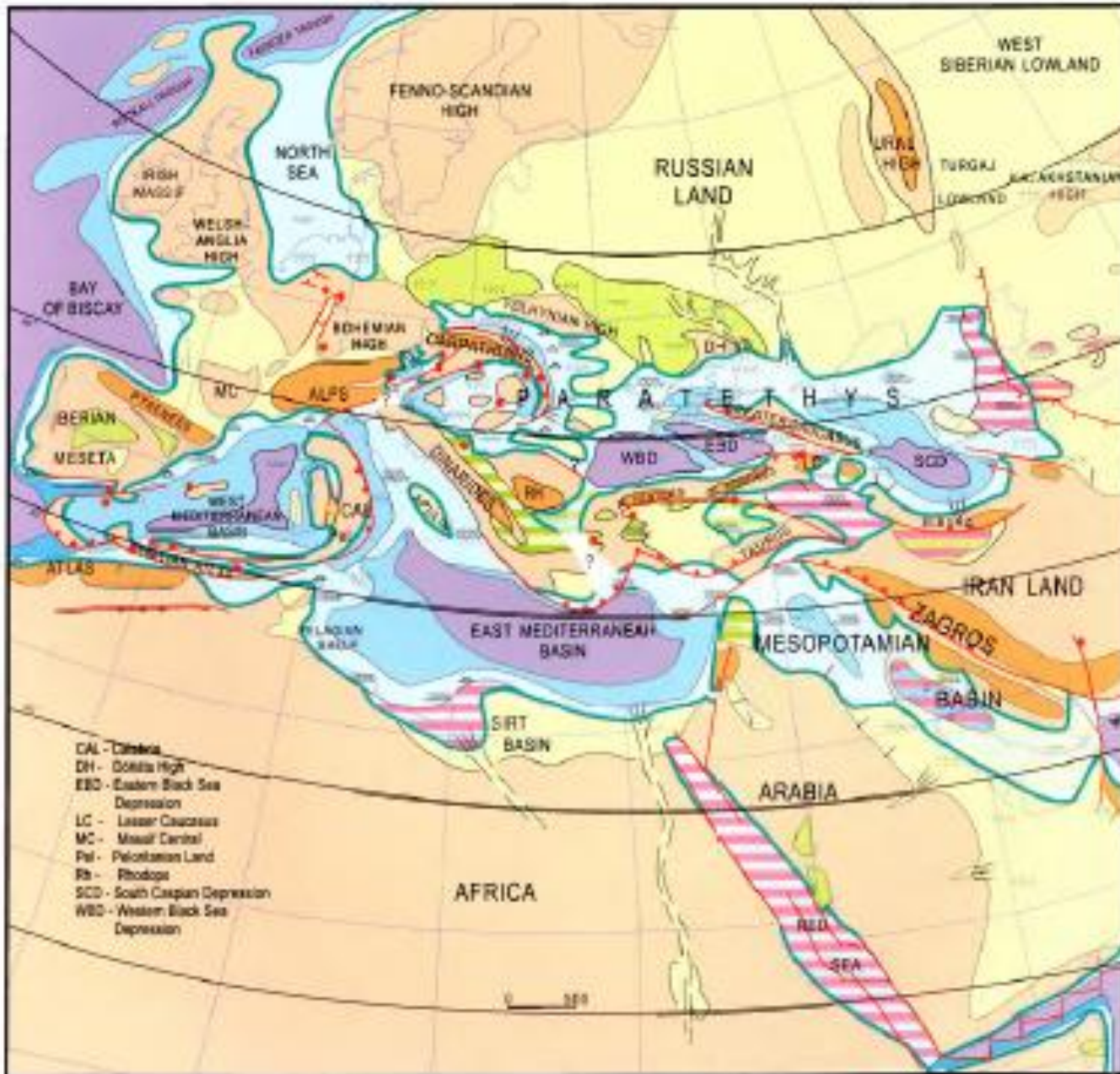
Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Pliocene	Calabrian	Pleistocene
		Piazzian	Romanian
	5.3	Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
	11.0	Tortonian	Pannonian
15	Middle Miocene		11.5
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	Langian
20	Early Miocene		Karpathian 17.2
		Burdigalian	Ottangian 18.3
		20.5	Eggenburgian
		Aquitanian	Egerian
23.8			



# Mid Middle Miocene

14 -13 Ma



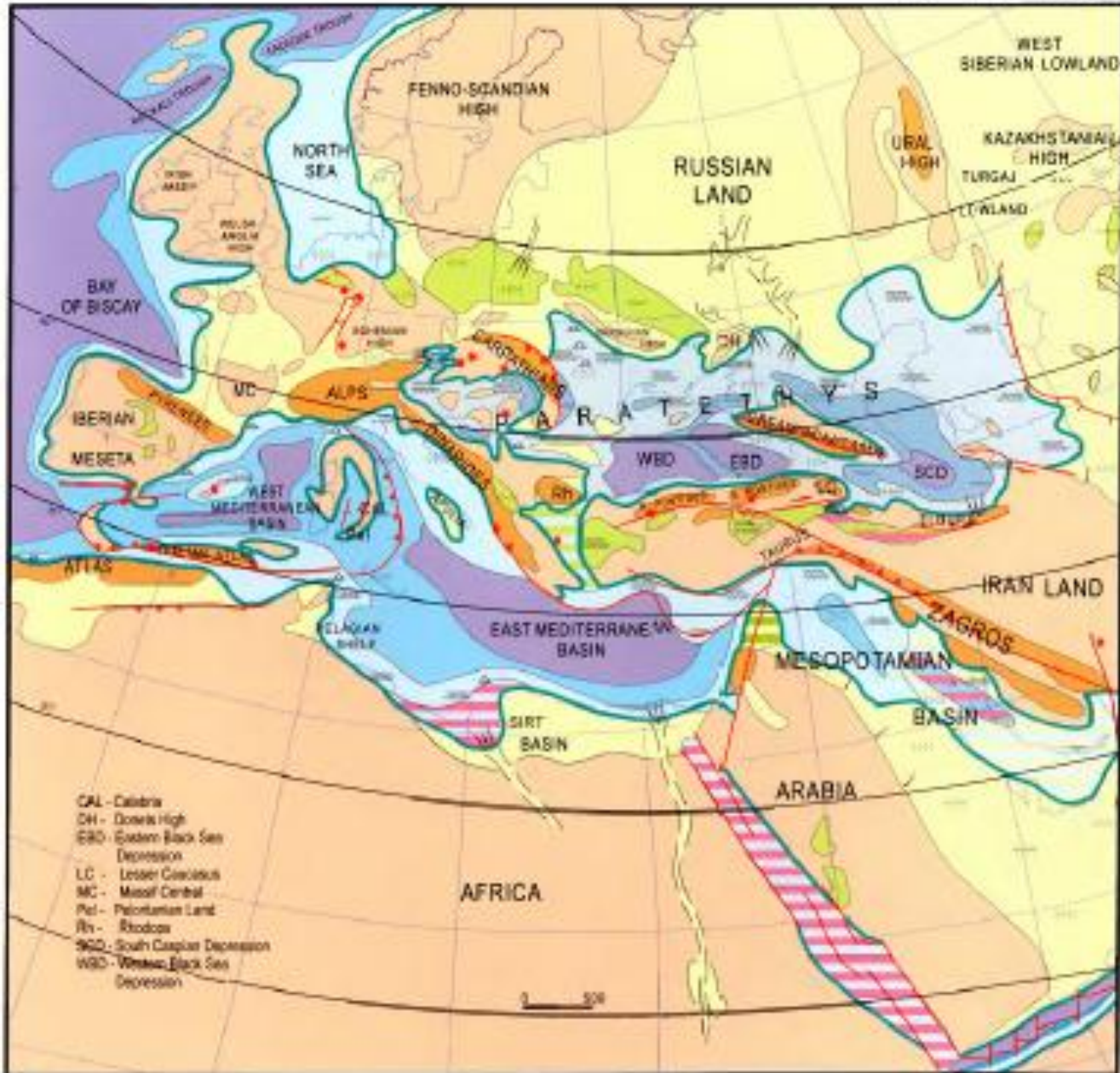
Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATETHYS STAGES
5	Quaternary	Calabrian	Pleistocene
	Pliocene	Piazzanian	Romanian
5.3		Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
	Tortonian	Pannonian	
15	Middle Miocene	11.0	11.5
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	Langian
20	Early Miocene	Burdigalian	Karpathian 17.2
			Ottományian 18.3
		20.5	Eggenburgian
		Aquitanian	Egerian
23.8			

# Late Middle Miocene

12 -11 Ma

Podela Paratetisa  
Panonsko jezero (11,6 Ma)



Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATETHYS STAGES
5	Quaternary	Calabrian	Pleistocene
	Pliocene	Piazzenzian	Romanian
		5.3	Zanclean
10	Late Miocene	Messinian	Pontian
		7.1	
	Tortonian	Pannonian	
15	Middle Miocene	11.0	11.5
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	Langian
20	Early Miocene	20.5	Karpathian 17.2
			Ottangian 18.3
			18.3
		Aquitainian	Egerian
23.8			



# David vs Goliath?

AN UNBALANCED RELATIONSHIP



~ same  
area  
as the Med



of the  
system's  
volume

**7** Paratethys volumes  
are required  
to fill the whole  
Mediterranean Sea

Mediterranean Sea

Paratethys Realm

## Major differences

in the surface, bathymetry, connectivity & volumes of the two seas produce different responses to climate changes and different challenges for the biota.

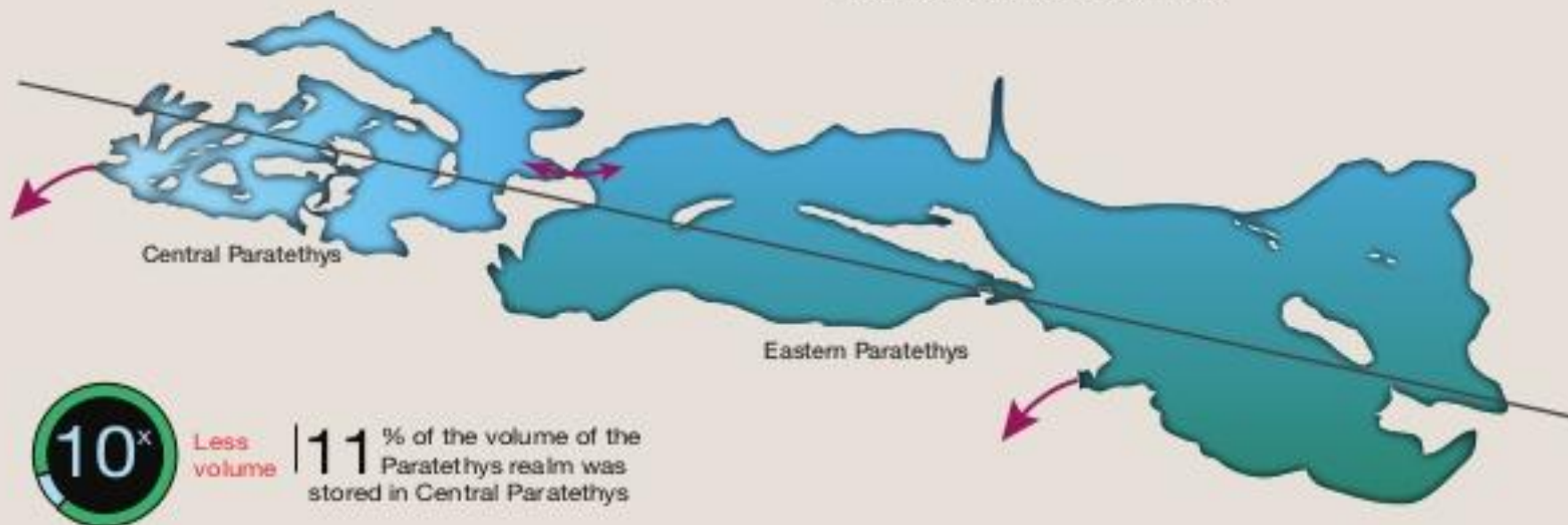
# the Sea of Seas

## FRAGMENTATION OF PARATETHYS



Less surface

22% of the surface of the Paratethys realm was Central Paratethys



### Major differences between sub-basins

in the surface, bathymetry, connectivity & volumes of the east and west realms of Paratethys produce more challenges for the biota and increase the diversity of reactions to climate.



Less volume

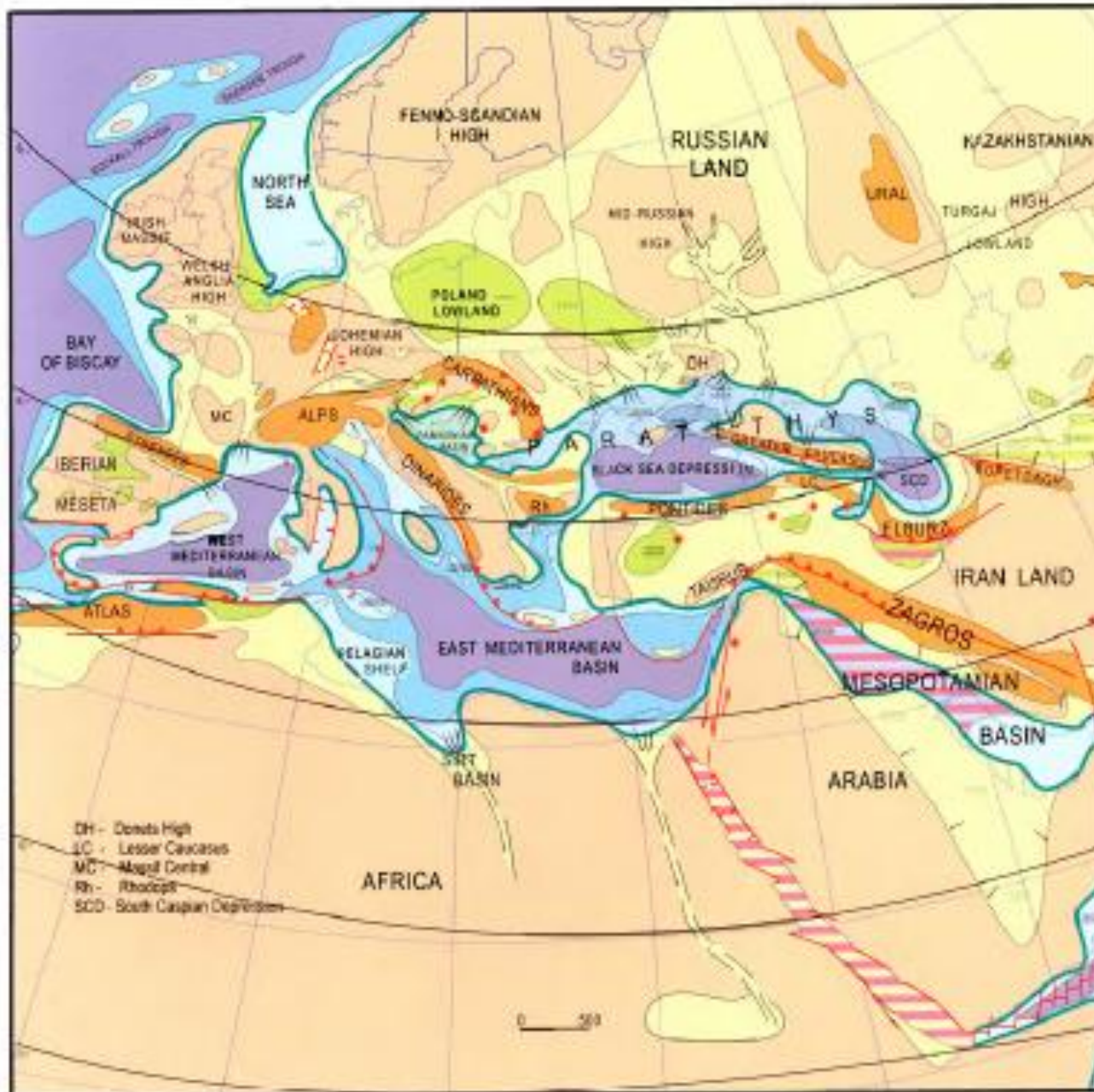
11% of the volume of the Paratethys realm was stored in Central Paratethys





# Mid Late Miocene

8.5 - 7.0 Ma

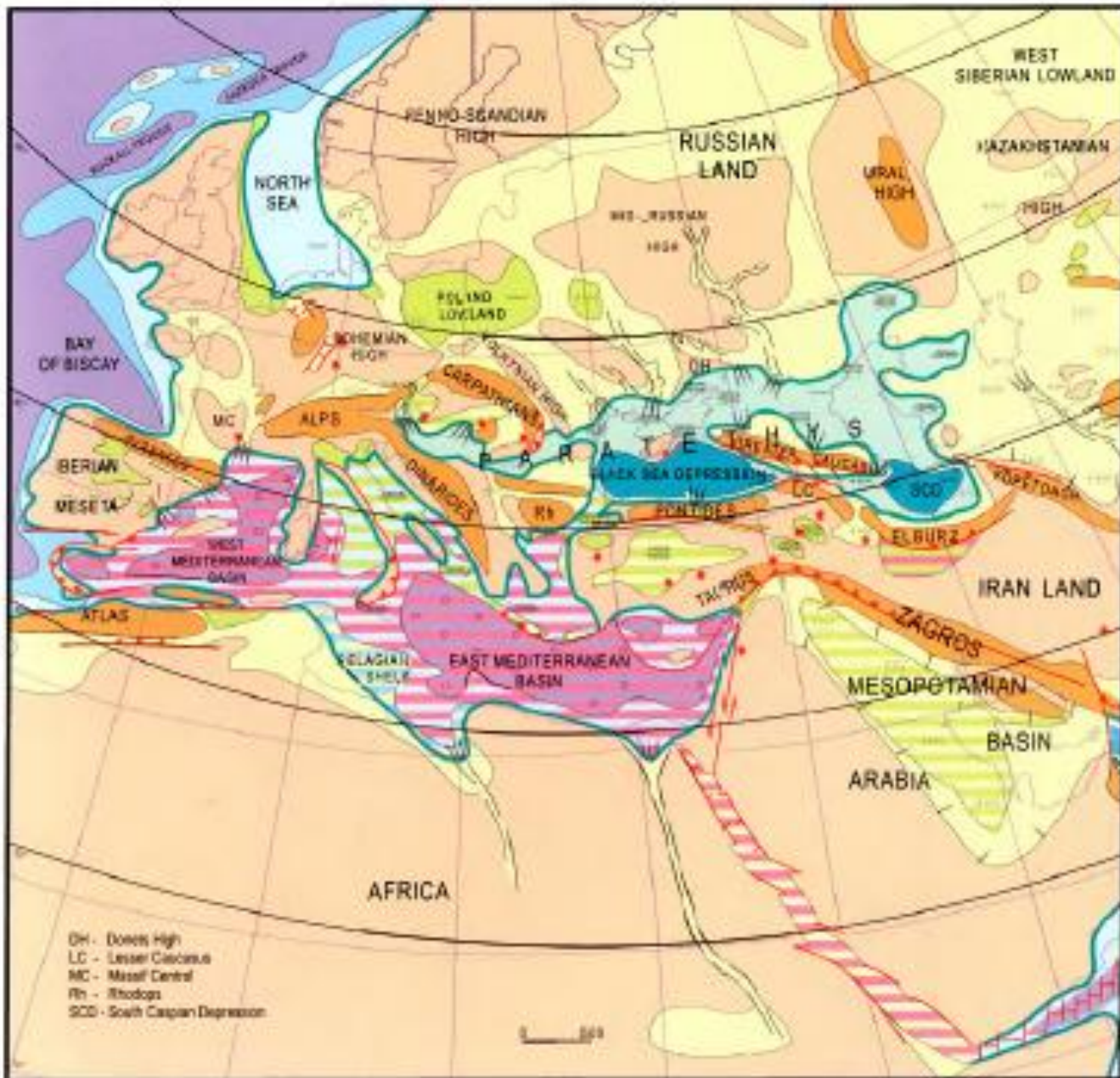


Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
	Pliocene	Piazzian	Romanian
		5.3	Zanclean
10	Late Miocene	Messinian	Pontian
		7.1	
	Tortonian	Pannonian	
15	Middle Miocene	11.0	11.5
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	Langian
20	Early Miocene	Burdigalian	Karpathian 17.2
			Ottnangian 18.3
			Eggenburgian
		20.5	
Aquitanian	Egerian		
23.8			

# Latest Miocene

6,1 - 5,7 Ma

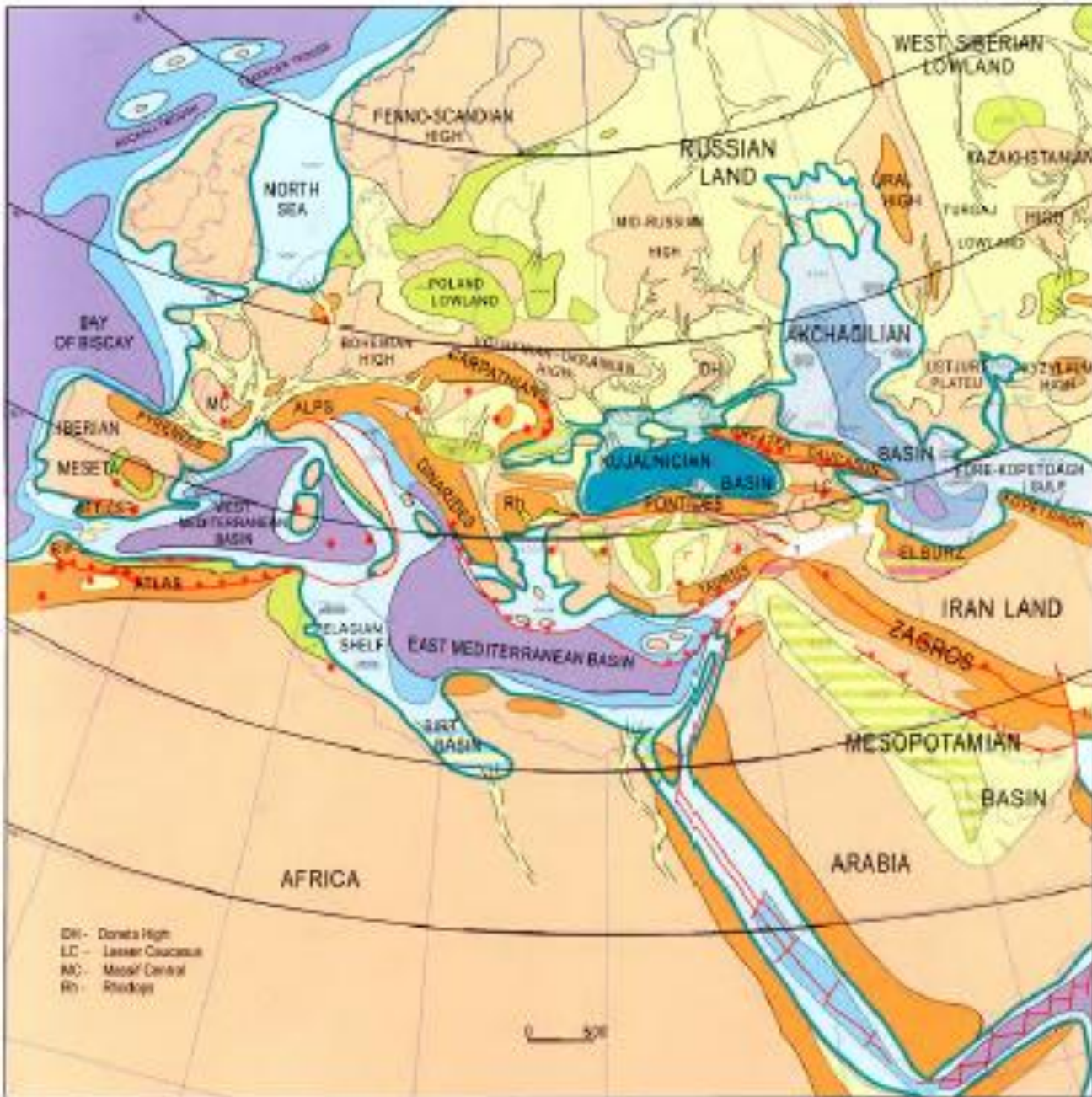


Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
	Pliocene	Piazzenzian	Romanian
		5.3 Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
		Tortonian	Pannonian
15	Middle Miocene	11.0	11.5
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4 Langian	
20	Early Miocene	Burdigalian	Karpathian 17.2
			Ottományian 18.3
		20.5	Eggenburgian
		Aquitanian	Egerian
23.8			



# Middle - Late Pliocene 3,4 - 1,8 Ma

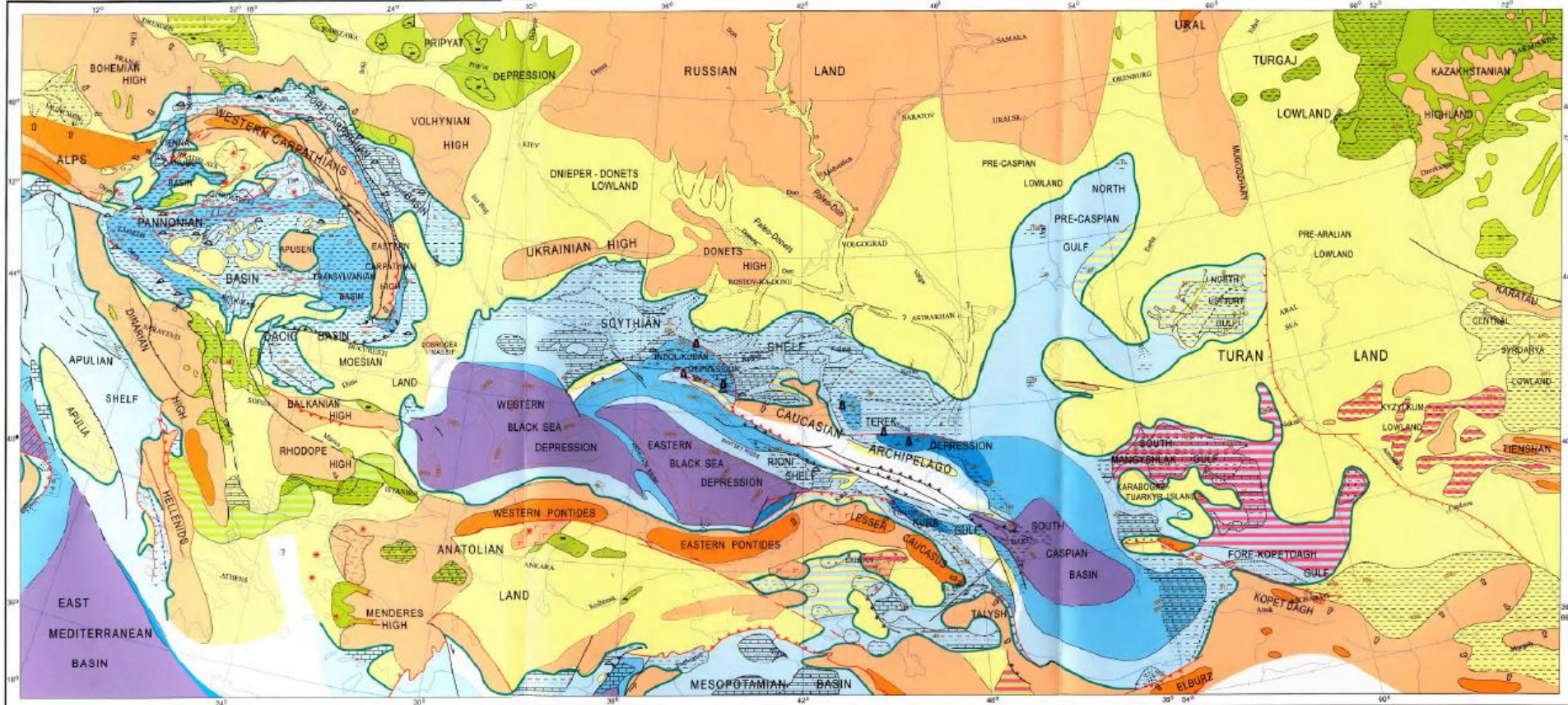


Time table of the Pannonian basin system

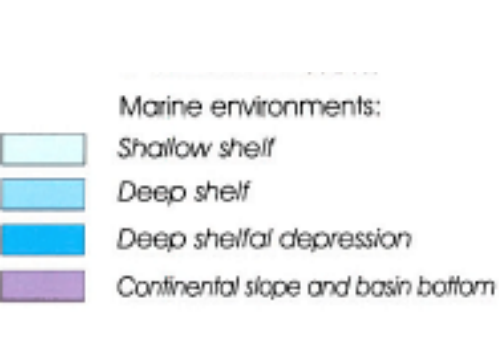
M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
	Pliocene	Piazzian	Romanian
		5.3	Zanclean
10	Late Miocene	Messinian	Pontian
		7.1	Pannonian
	11.0	Tortonian	
15	Middle Miocene	Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	
20	Early Miocene	Burdigalian	Karpathian 17.2
			Ottangian 18.3
		20.5	Eggenburgian
		Aquitainian	Egerian
23.8			



Map 5. Early Middle Miocene (LANGHIAN - Early BADENIAN, CJKOZMANIAN)



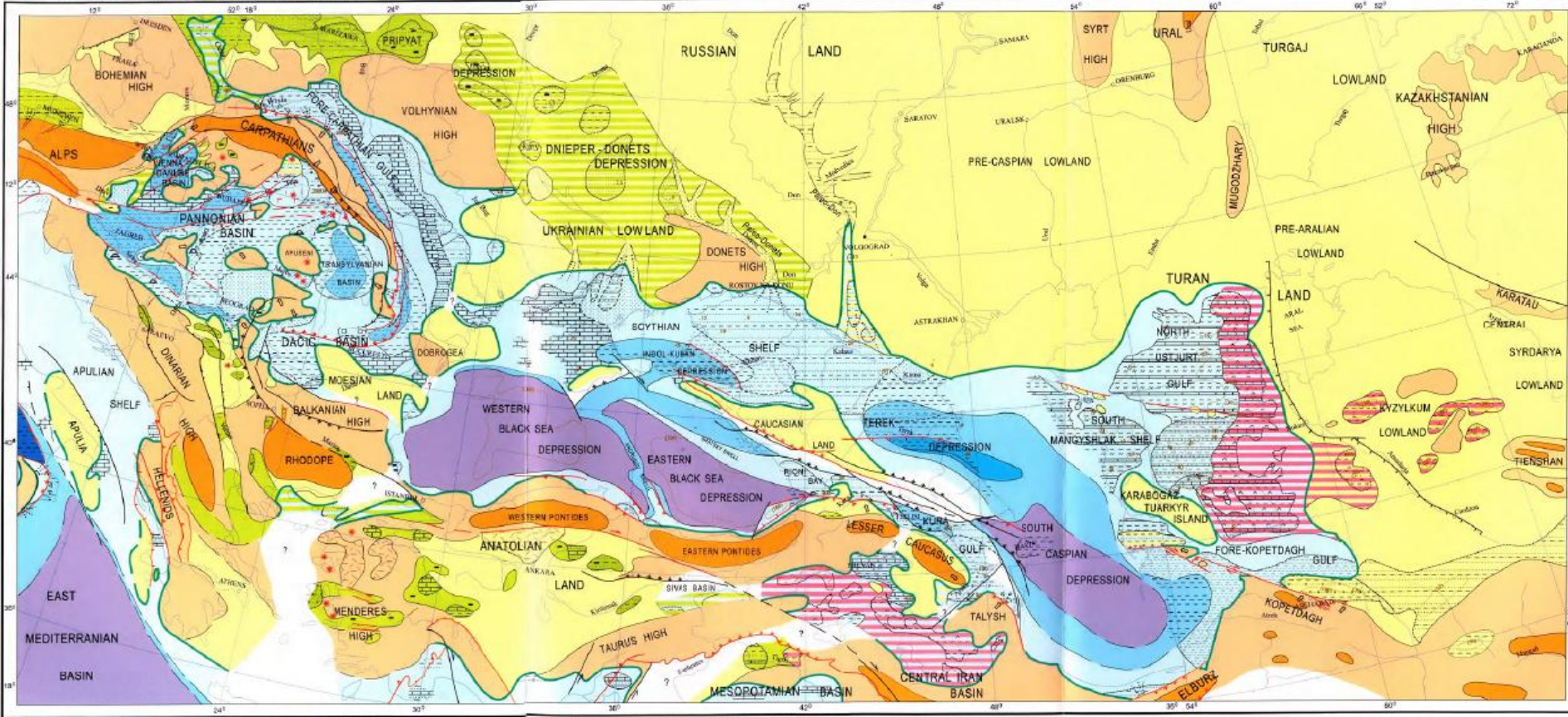
SCALE 1: 7 500 000 Time table of the Pannonian basin system



M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
		Pliocene	Romanian
	5.3	Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
	11.0	Tortonian	Pannonian
15	Middle Miocene	11.5	
		13.0	Sarmatian
	14.8	Serravallian	Badenian
20	Early Miocene	18.4	Langian
		18.4	Karpathian
	18.4	Ottományian	
	18.3	Burdigalian	
	18.3	Eggenburgian	
23.8	Aquitanian	Egerian	



Map 6. Mid-Middle Miocene (Middle SERRAVALLIAN, Late BADENIAN, KONJAN)



- Marine environments:**
- Shallow shelf
  - Deep shelf
  - Deep shelfal depression
  - Continental slope and basin bottom

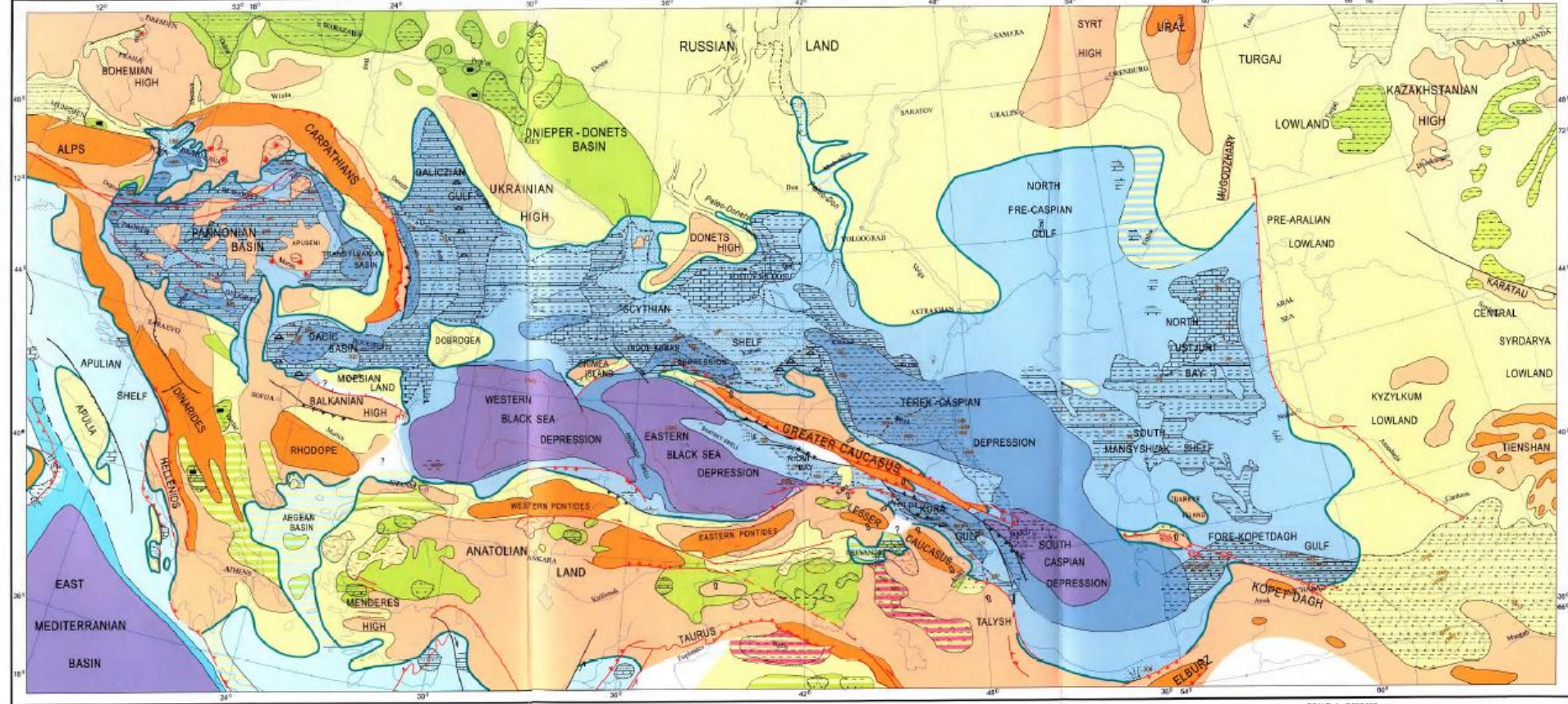
- Brackish environments:**
- Shallow shelf
  - Deep shelfal depression
- Continental environments:**
- Freshwater lake, marsh
  - Lowland
  - Highland
  - Mountain range

Time table of the Pannonian basin system

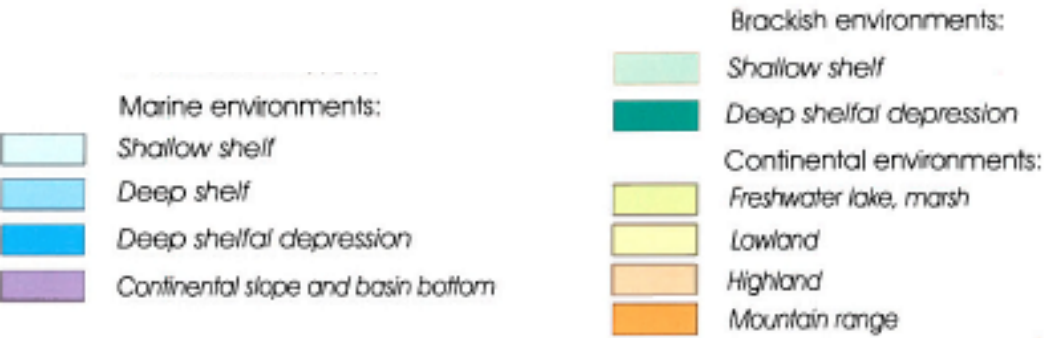
M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
		Pliocene	Romanian
	5.3	Zanclean	Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
		Tortonian	Pannonian
15	Middle Miocene	11.5	
		Serravallo	Sarmatian
		14.8	Badenian
20	Early Miocene	18.4	
		Langian	
			Karpathian
			Ottományian
			18.3
23.8	Aquitanian	Egerian	



Map 7. Late-Middle Miocene (Lata SEIKRAVILLIAN, SARMATIAN s.s., Middle SARMATIAN s.l.)



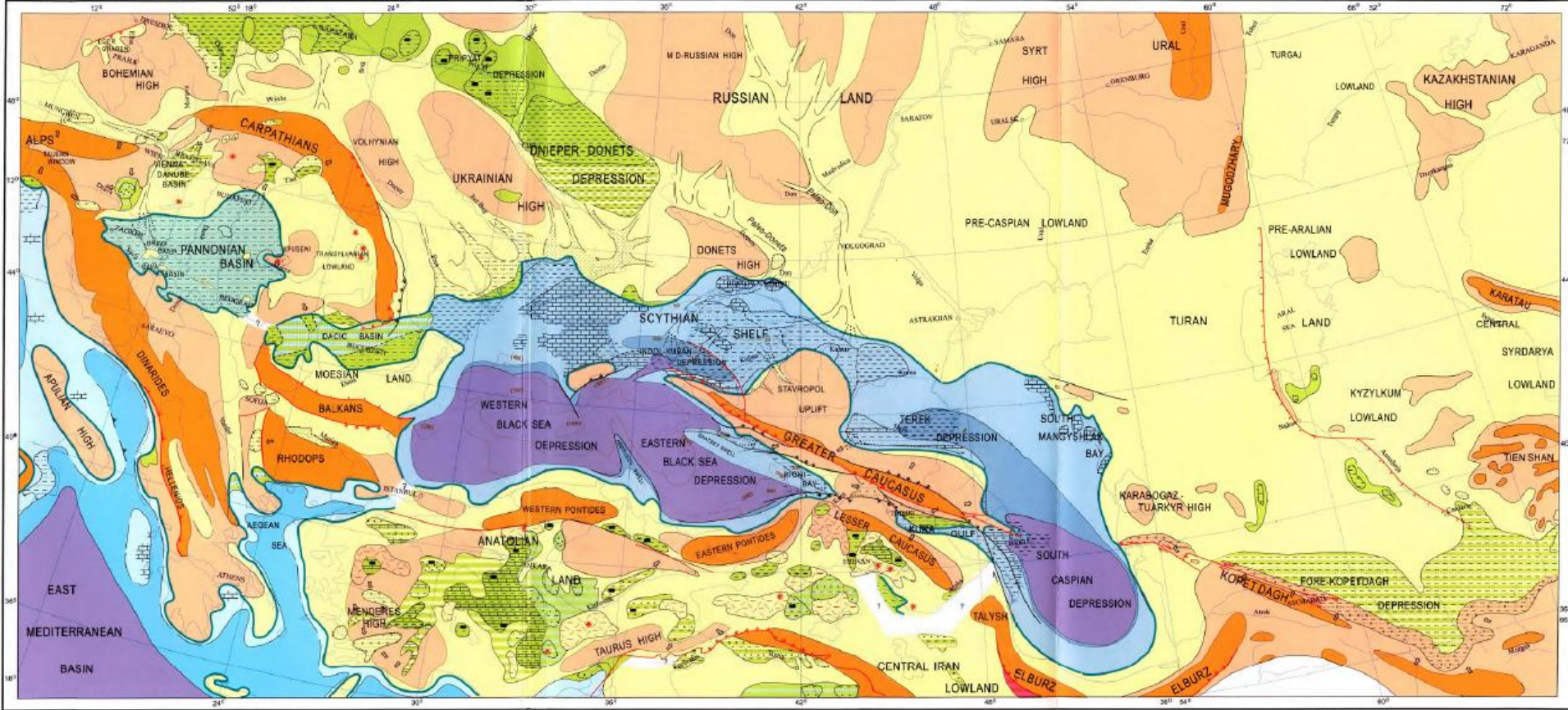
SCALE 1: 7500000  
Time table of the Pannonian basin system



M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
		Pliocene	Piazenzian
	5.3	Zanclean	Romanian Dacian 5.6
10	Late Miocene	Messinian	Pontian
		7.1	
		Tortonian	Pannonian
15	Middle Miocene	11.0	11.5
		Serravallo	<b>Sarmatian</b>
20	Early Miocene	14.8	Badenian
		16.4	Langian
			Karpathian Ottungian Eggenburgian
23.8		20.5	
		Aquitanian	Egerian



Map 8. Mid Late Miocene (Late Tortonian - Early Messinian - Early Maeotian - Late Panninian)



Scale 1:10000000. Time table of the Pannonian basin system

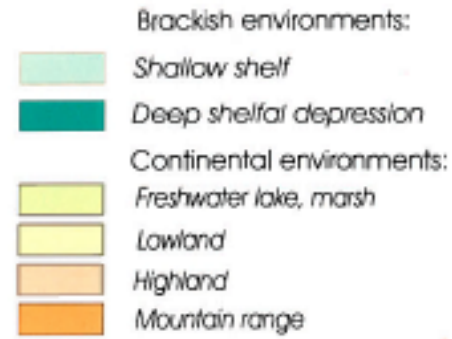
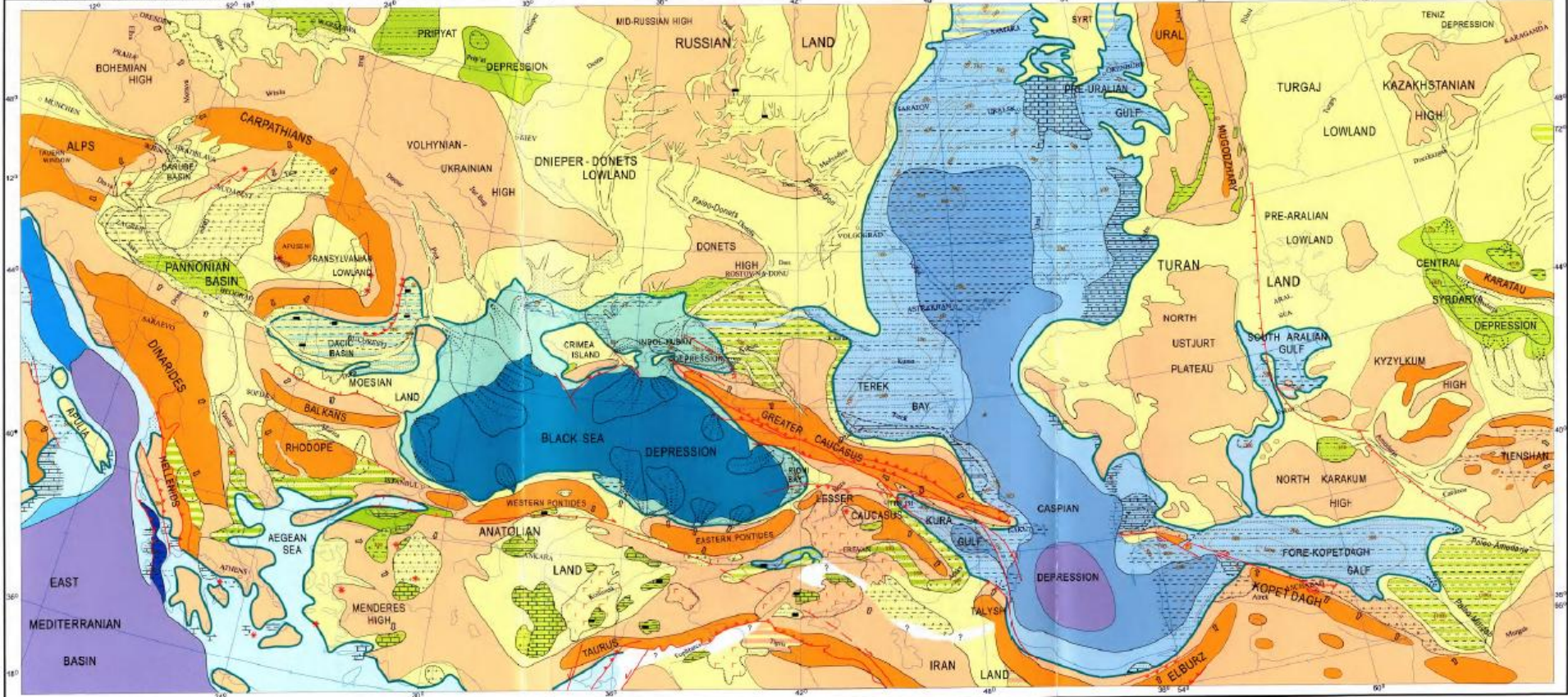
- Marine environments:
- Shallow shelf
  - Deep shelf
  - Deep shelfal depression
  - Continental slope and basin bottom

- Brackish environments:
- Shallow shelf
  - Deep shelfal depression
- Continental environments:
- Freshwater lake, marsh
  - Lowland
  - Highland
  - Mountain range

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
		Pliocene	
10	Late Miocene	Piavenzian	Romanian
		Zanclean	Dacian 5.6
		Messinian	Pontian
15	Middle Miocene	7.1	Pannonian
		Tortonian	11.5
		Sarmatian	13.0
20	Early Miocene	14.8	Badenian
		Langian	
23.8		18.3	Karpathian
		20.5	Ottományian
		23.8	Eggenburgian
			Egerian



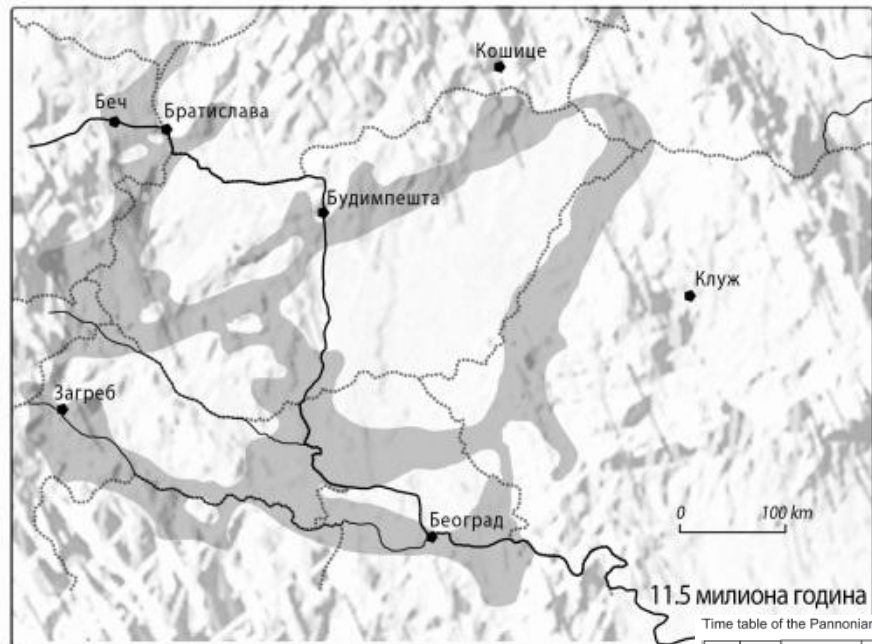
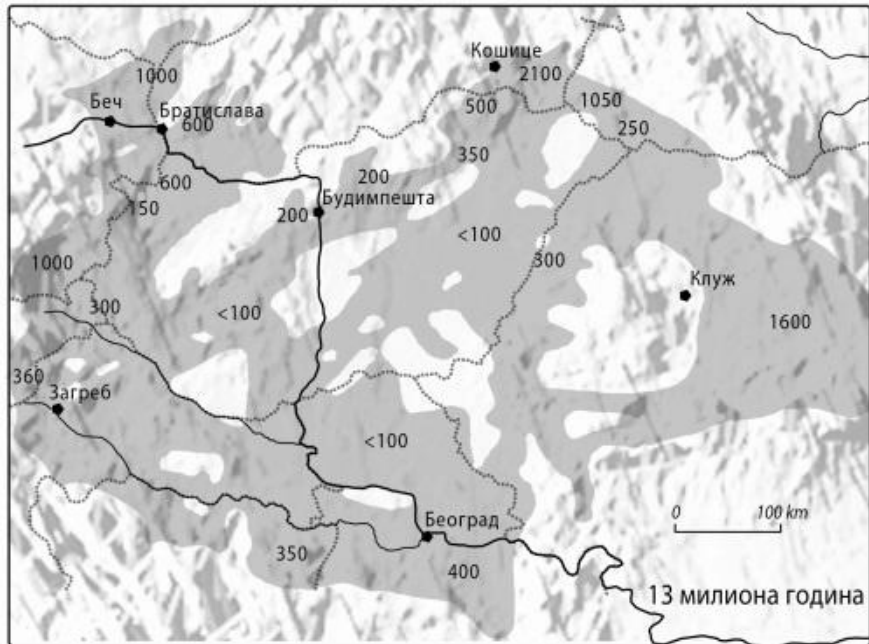
Map 10. Middle - Late Pliocene (PACENTIAN, GELASIAN, Late PLOMANIAN - AKCHAGLIAN)



Time table of the Pannonian basin system

M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Quaternary	Calabrian	Pleistocene
		Pliocene	Romanian
10	Late Miocene	Zanclean	Dacian 5.6
		Messinian	Pontian
		7.1	Pannonian
15	Middle Miocene	11.0	11.5
		Serravallian	Sarmatian 13.0
		14.8	Badenian
		18.4	Langian
20	Early Miocene	18.3	Karpathian
		18.3	Ottományian
		20.5	Eggenburgian
		23.8	Aquitanian
		Egerian	



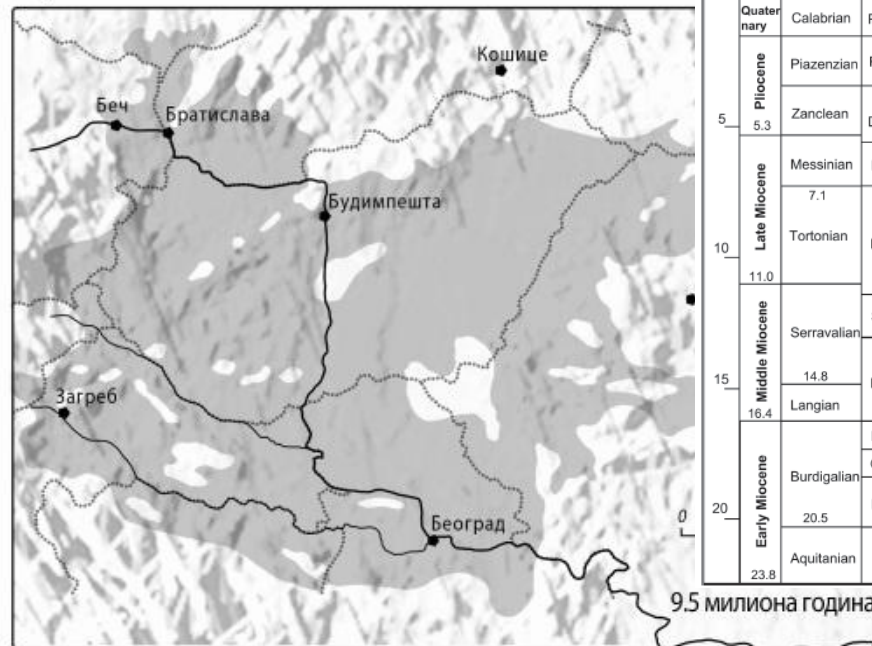
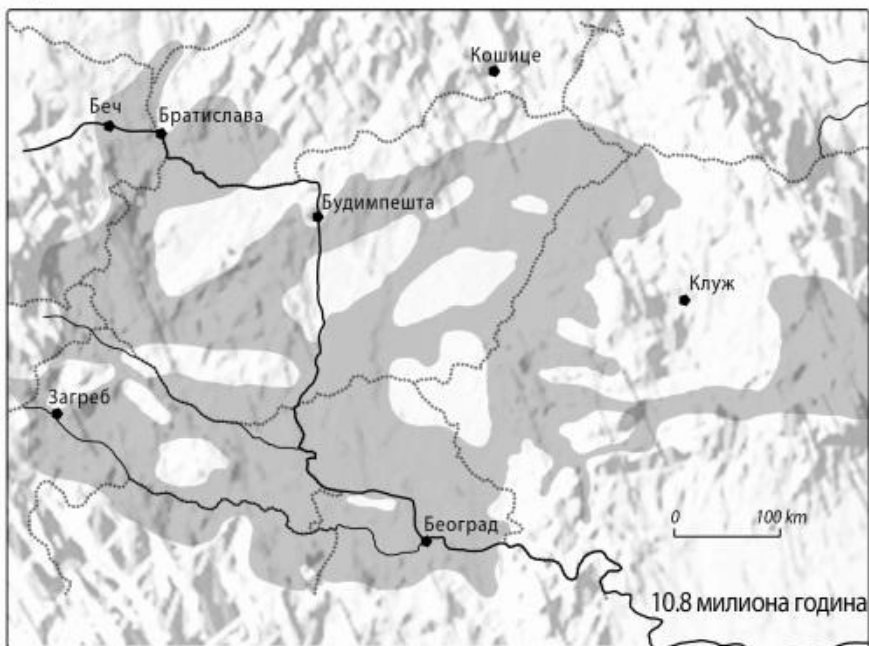


Time table of the Pannonian basin system

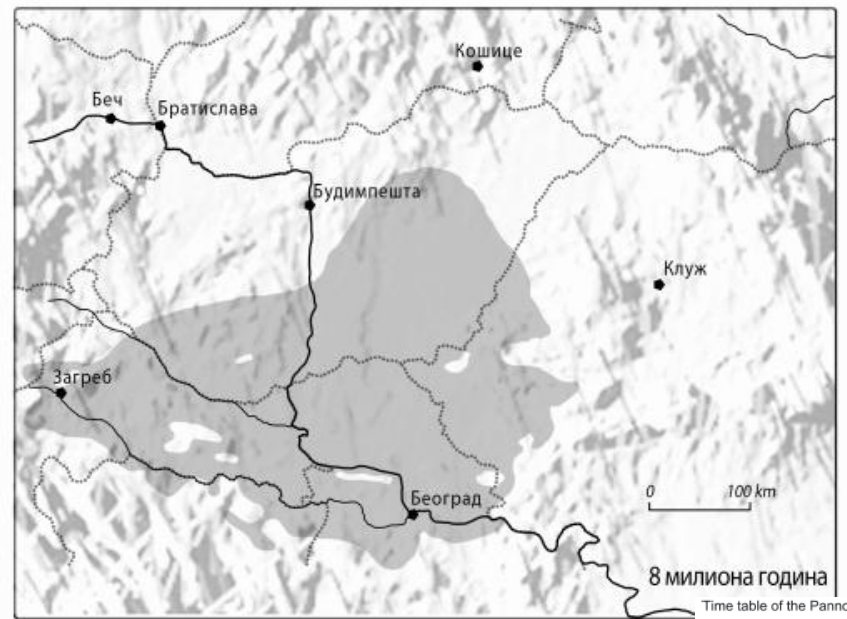
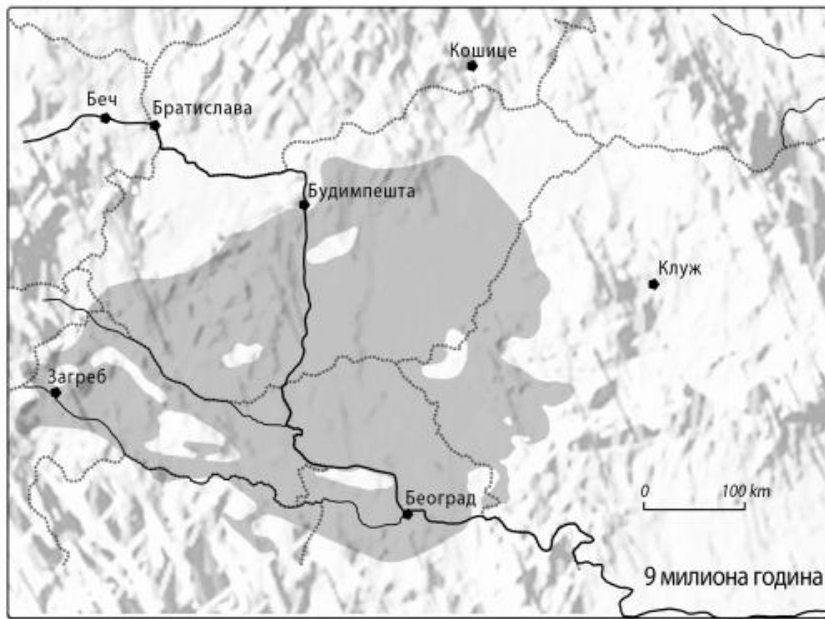
M.A.	EPOCH	AGE	CENTRAL PARATHETYS STAGES
5	Pliocene	Calabrian	Pleistocene
		Piazzian	Romanian
10	Late Miocene	Zanclean	Dacian 5.6
		Messinian	Pontian
		7.1	Pannonian
15	Middle Miocene	11.0	11.5
		Serravalian	Sarmatian 13.0
		14.8	Badenian
		16.4	Langian
20	Early Miocene	17.2	Karpathian
		Burdigalian	Otthangian 18.3
		20.5	Eggenburgian
		23.8	Aquitainian

a)

b)



В) Сл. 5. Палеогеографска еволуција Панонског језера (Magyar et al., 1999) Г)



Time table of the Pannonian basin system

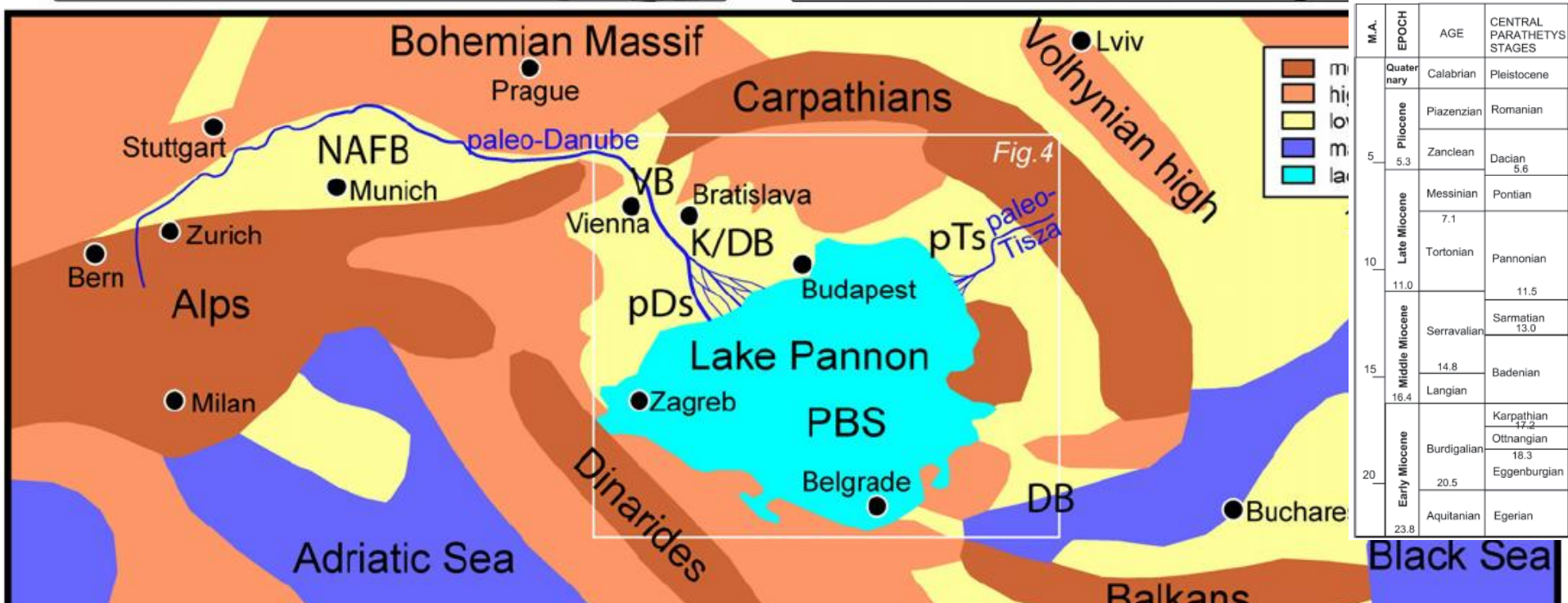
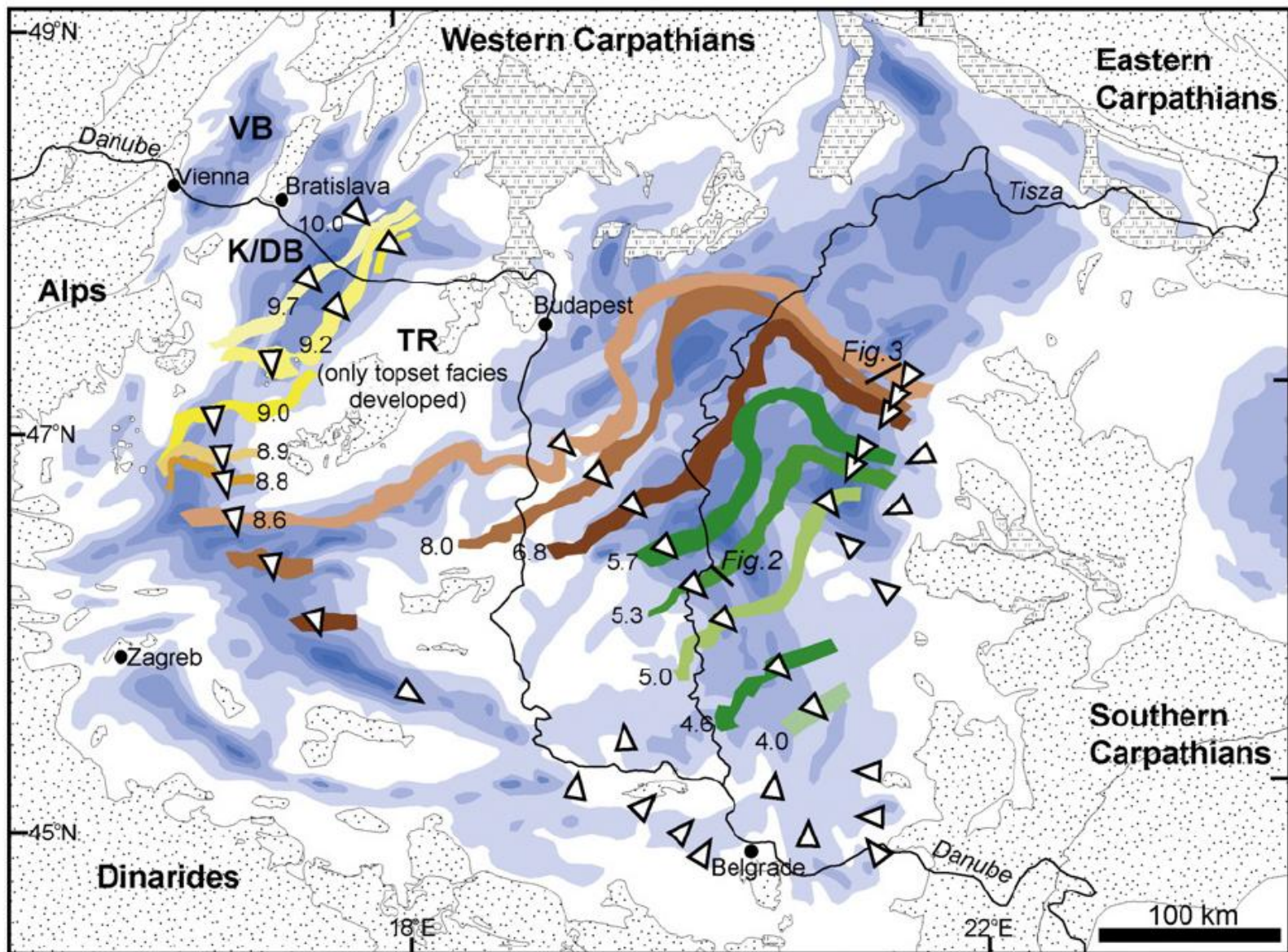




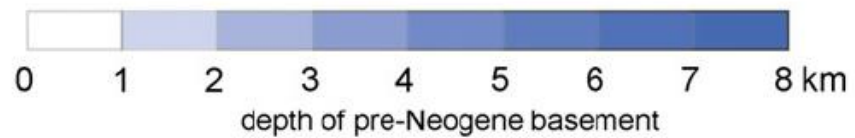


Fig. 1. Paleogeographic sketch of the Pannonian Basin and the Danube catchment area at about 9 Ma

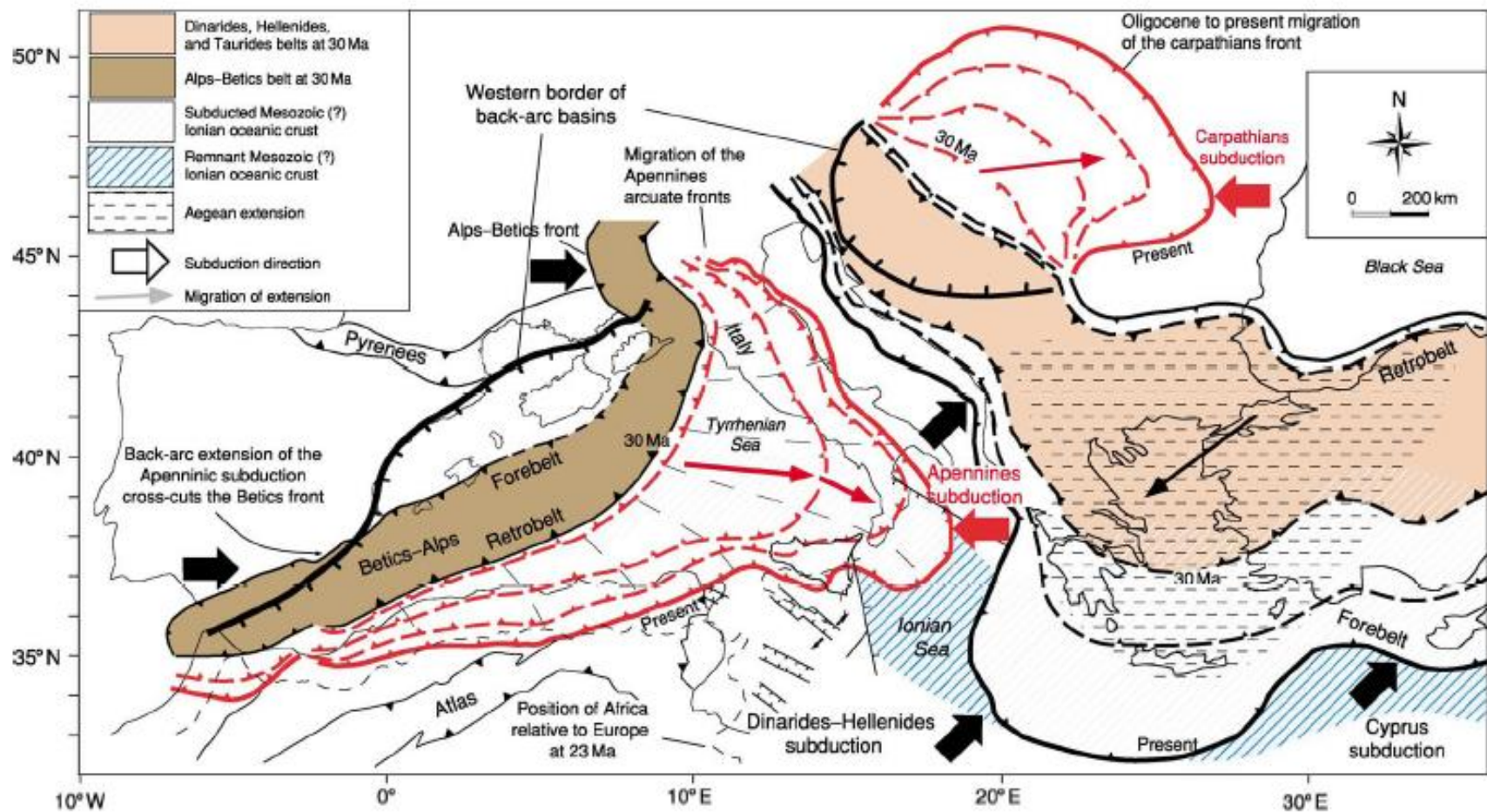




-  pre-Neogene in the surface
-  Neogene volcanics in the surface
-  shelf-margin slope
-  dip of slope







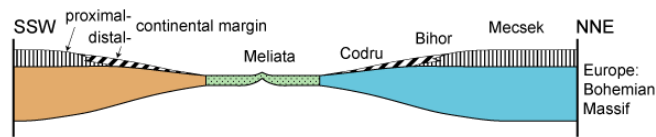
**Figure 6** Main tectonic features of the Mediterranean realm, which has been shaped during the last 45 Ma by a number of subduction zones and related belts: the double-vergent Alps-Betics; the single eastwards-vergent Apennines-Maghrebides and the related western Mediterranean back-arc basin; the double-vergent Dinarides-Hellenides-Taurides and related Aegean extension; the single eastwards-vergent Carpathians and the related Pannonian back-arc basin; and the double-vergent Pyrenees.



# ЕВОЛУЦИЈА ПАЛЕО-ДИНАРИДА

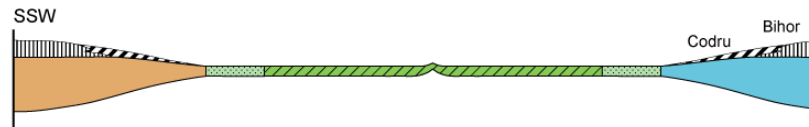
## Triassic - Jurassic boundary

a) NW Dinarides - Tisza - Bohemian massif (I)



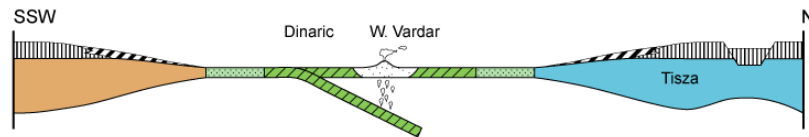
## Early Jurassic

b) NW Dinarides - Tisza - Bohemian massif (I)



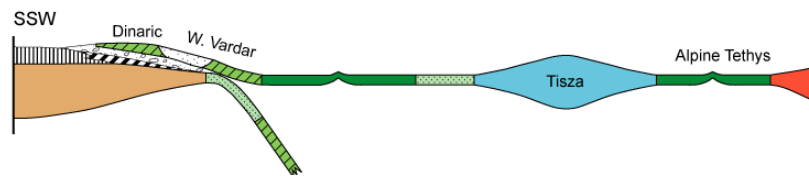
## early Middle Jurassic

c) NW Dinarides - Tisza - Bohemian massif (I)



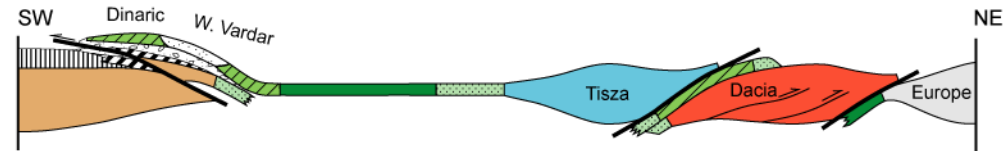
## latest Jurassic

d) NW Dinarides - Tisza - Bohemian massif (I)

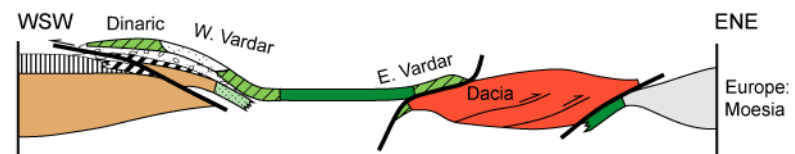


## late Early Cretaceous

f) central Dinarides - Tisza - Dacia - Europe (II)

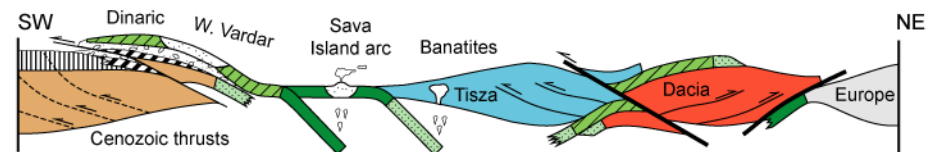


g) SE Dinarides - Dacia - Moesia (III)

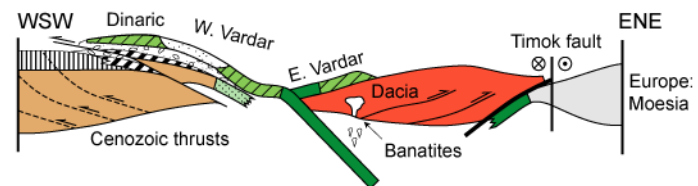


## Late Cretaceous

h) central Dinarides - Tisza - Dacia - Europe (II)



i) SE Dinarides - Dacia - Moesia (III)

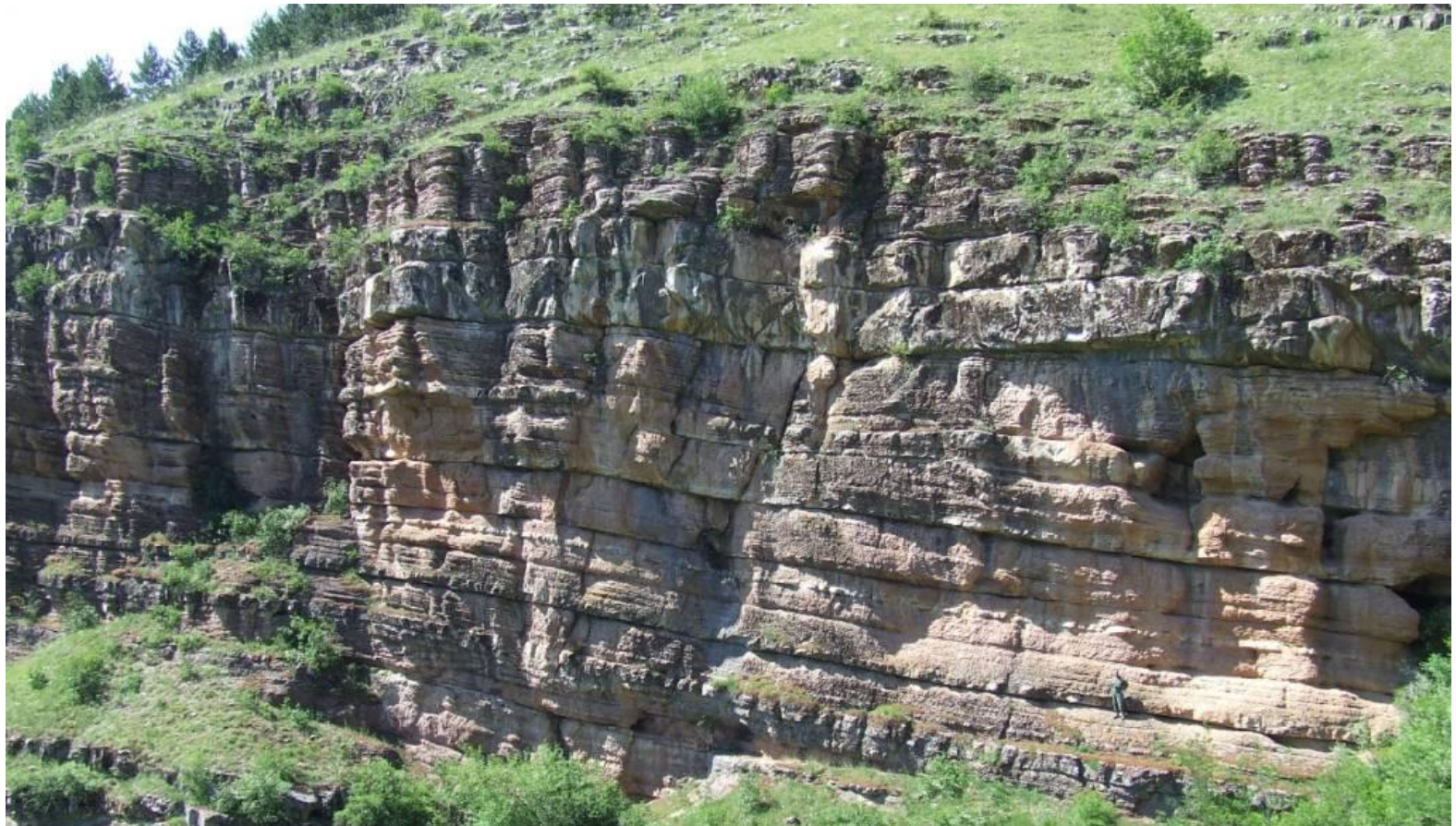




Универзитет у Новом Саду  
Природно-математички факултет  
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**Др Млађен Јовановић**

*Катедра за Физичку географију*



# ГЕОТЕКТОНСКА ПОДЕЛА СРБИЈЕ