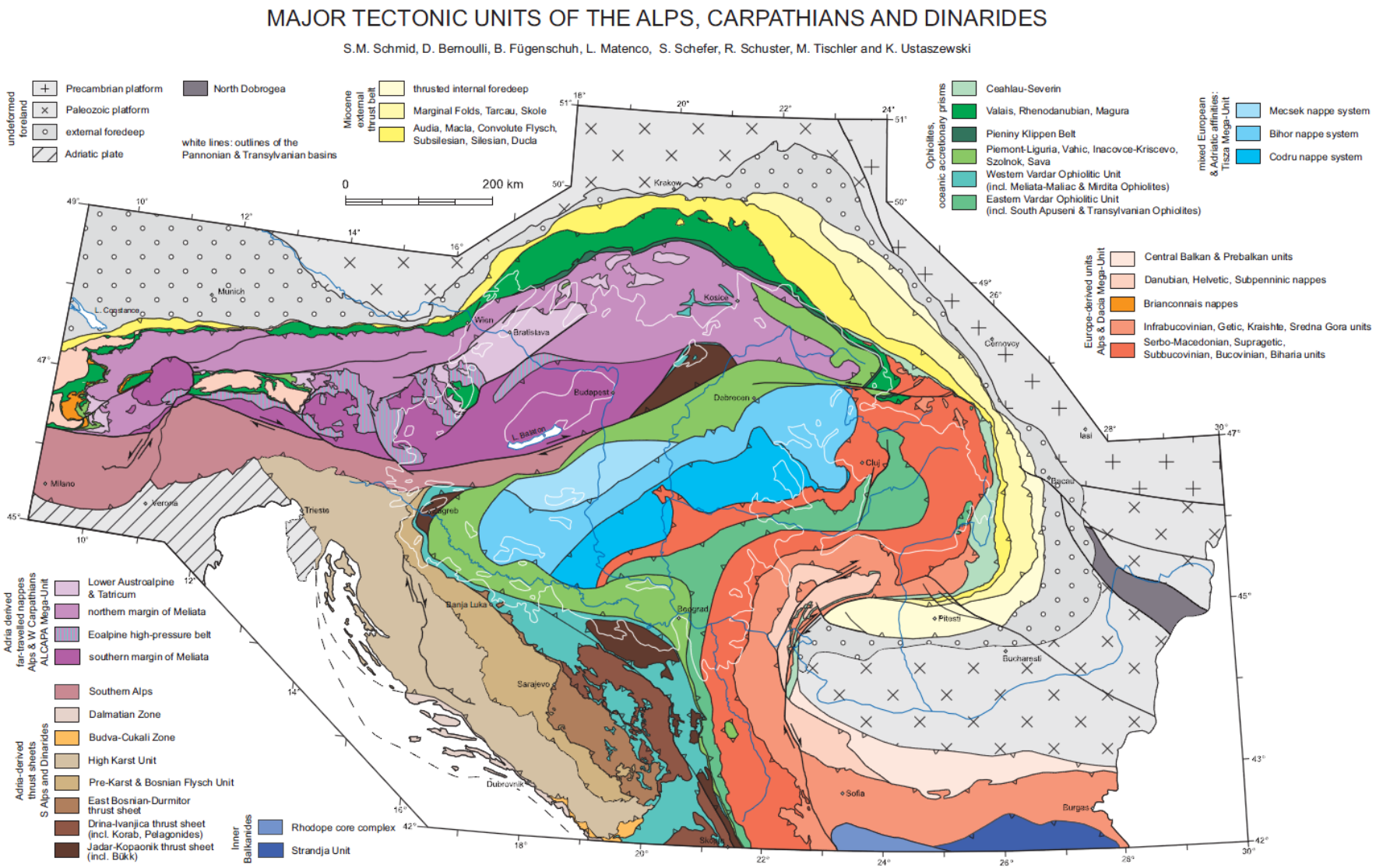
General stratigraphy of the bauxite deposits in the Dinarides

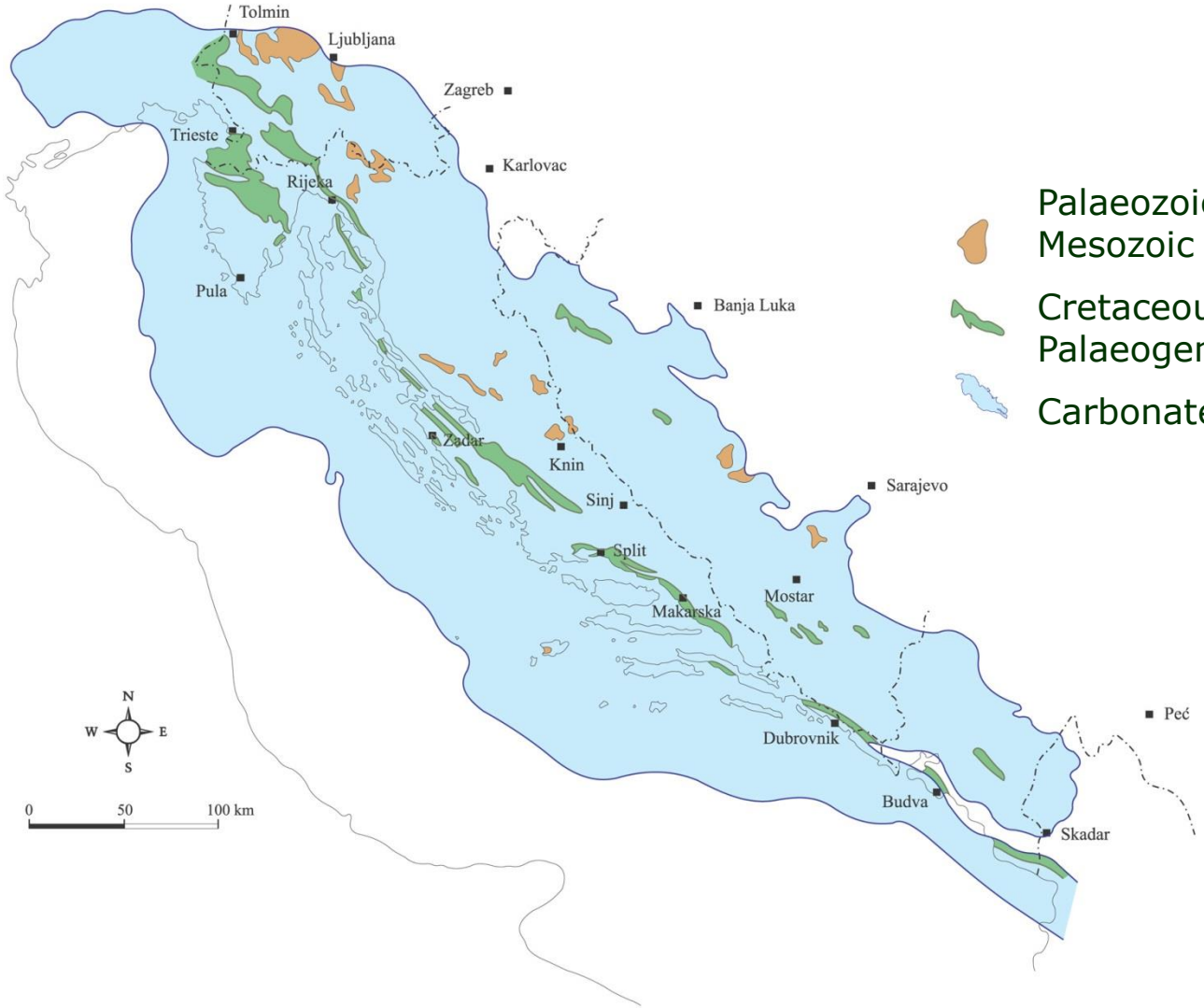
Igor Vlahović

1st REEBAUX Workshop – Ježević, October 14–15, 2019

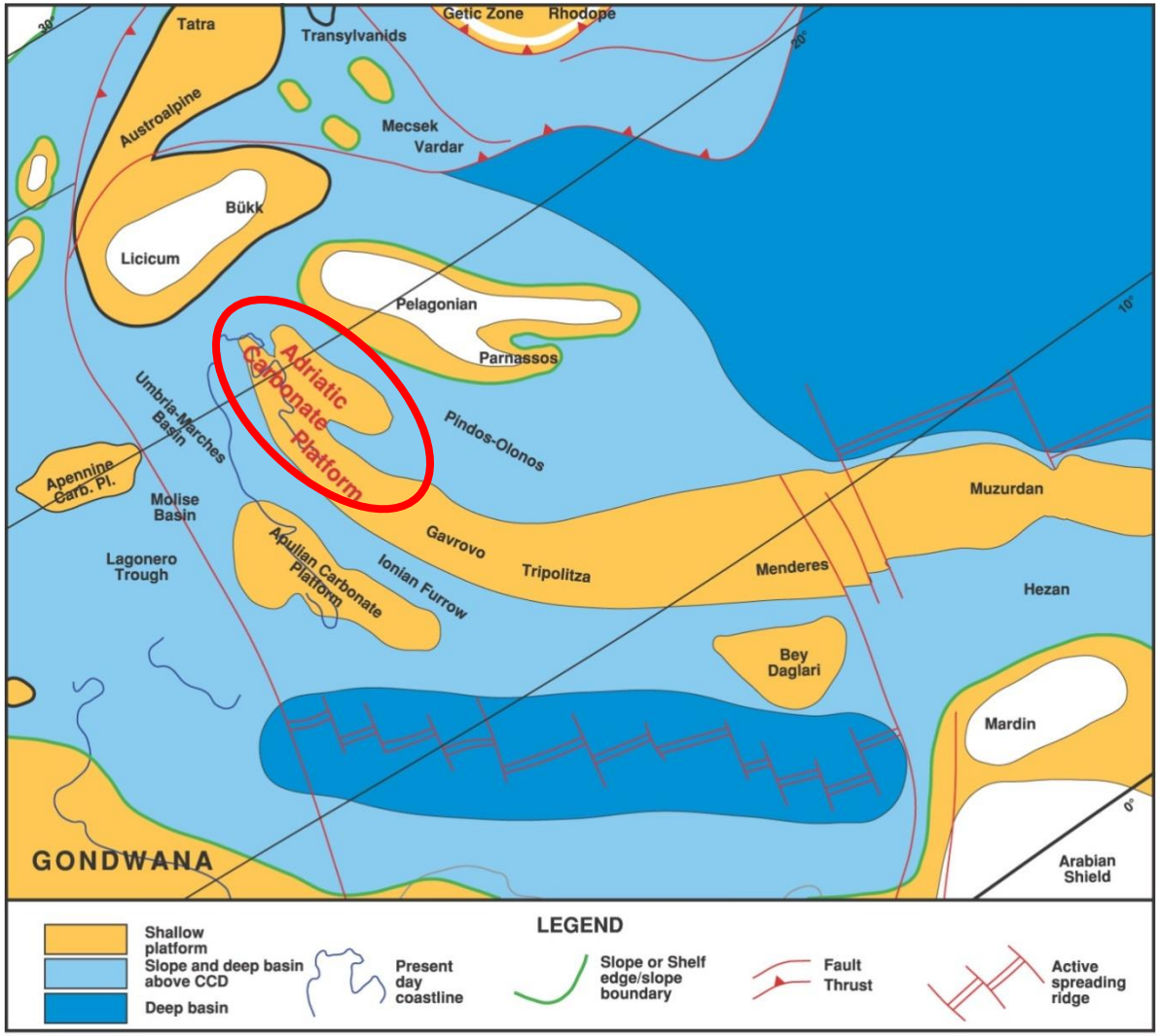


Schmid et al., 2008


Adriatic Carbonate Platform (AdCP)
0
50
100 km
SLOVENIA
Opatija
Gorski Kotar
Karlovac
Istria
Rovinj
Pula
Vel. Kapela Mt.
CROATIA
Velebit Mt.
Banjaluka
Jajce
BOSNIA AND HERCEGOVINA
Ježević
Dinara Mt.
Split
Brač
Hvar
Korčula
Mljet
Dubrovnik
Biokovo Mt.
ITALY
Adriatic sea
SERBIA
MONTENEGRO
ALBANIA
Sava
Kupa
Una
Vrbas
Bosna
Krka
Cetina
Neretva
Drina
Tara
Morača

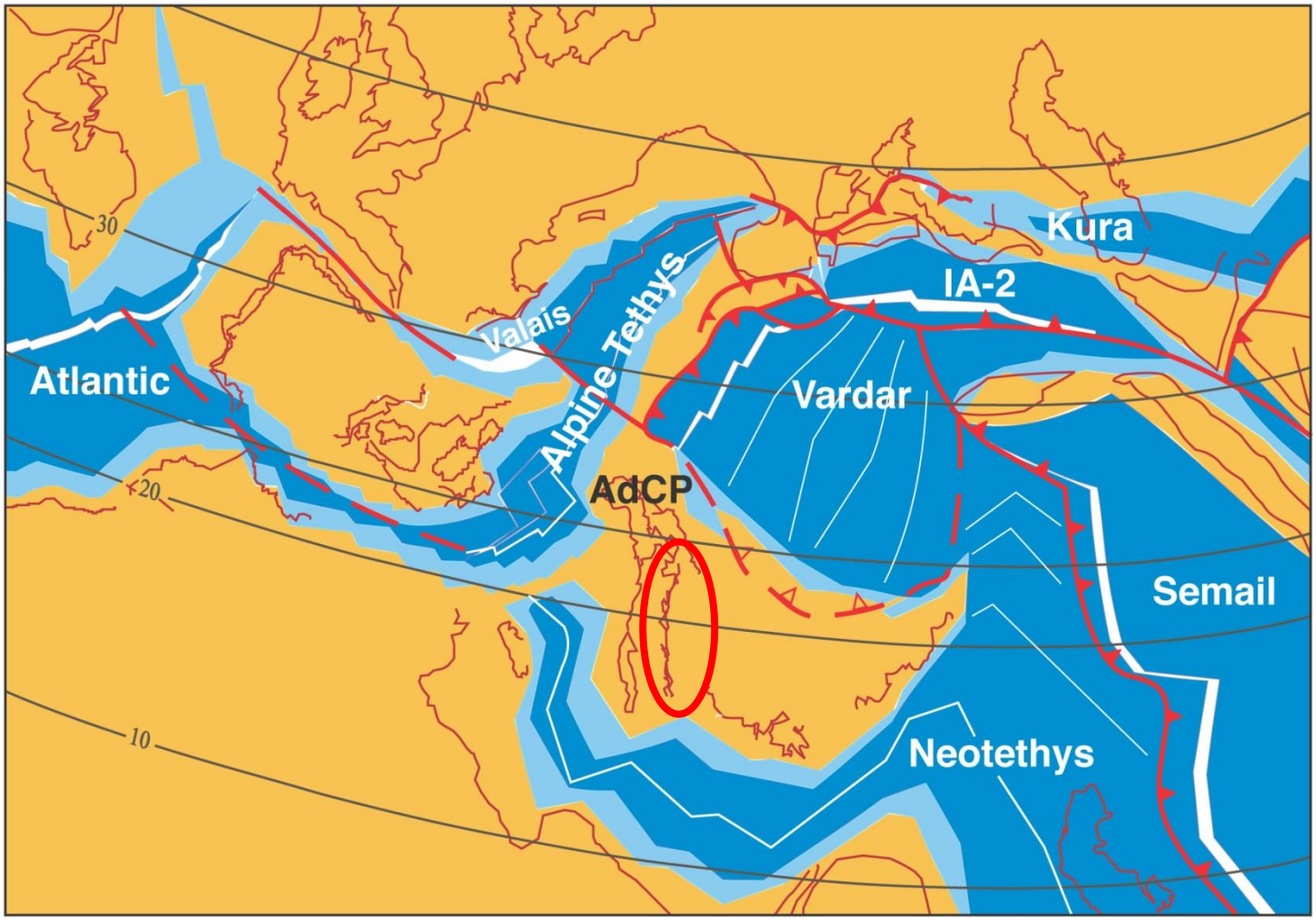

Tolmin
Ljubljana
Zagreb
Trieste
Karlovac
Rijeka
Pula
Banja Luka
Zadar
Knin
Sarajevo
Sinj
Split
Mostar
Makarska
Peć
Dubrovnik
Budva
Skadar
N
W
E
S
0
50
100 km
Palaeozoic and older Mesozoic clastic rocks
Cretaceous and Palaeogene clastic rocks
Carbonates

Aptian Paleogeography 1

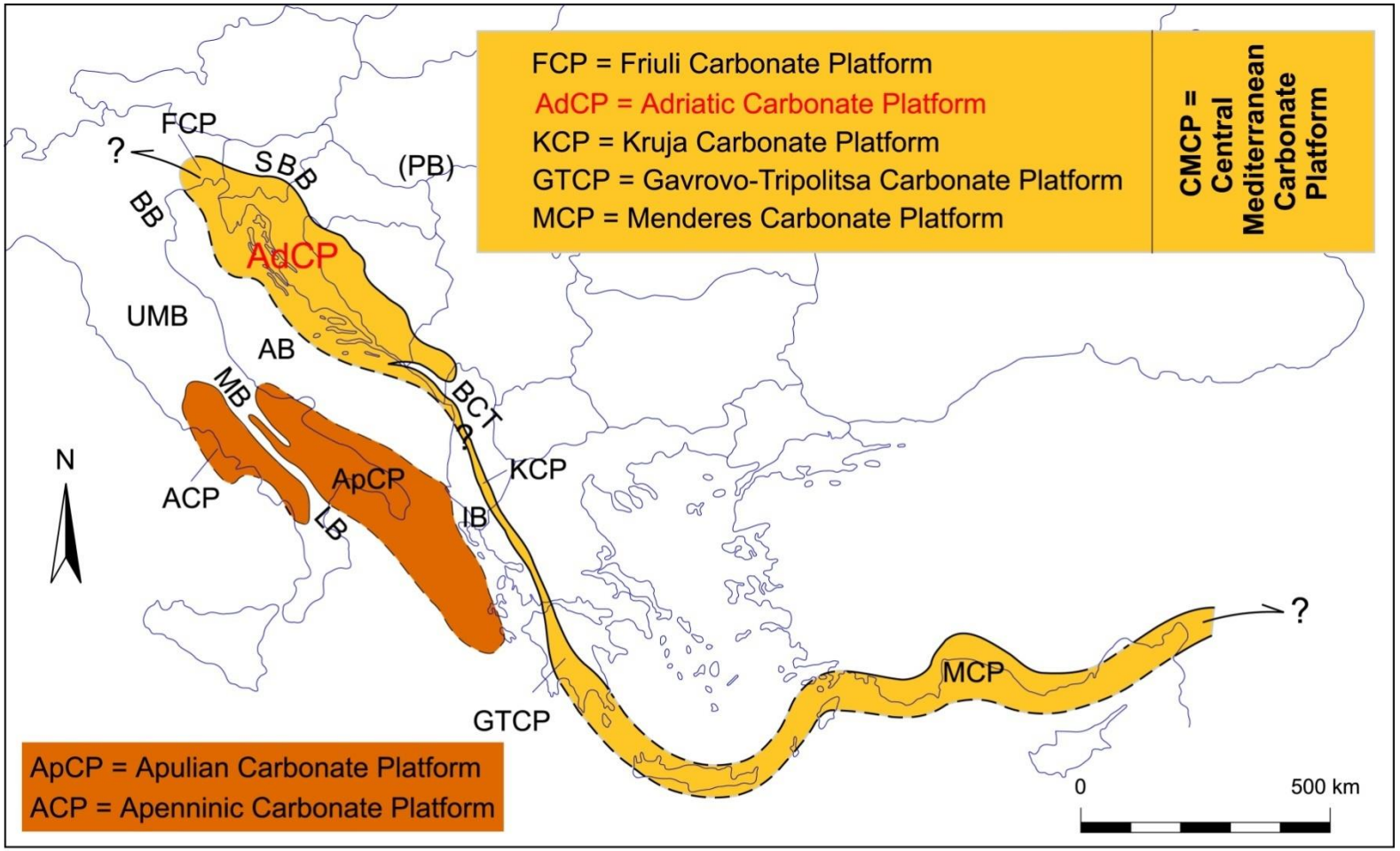


After Masse et al. (1993) in Dercourt et al. (1993)

Aptian Paleogeography 2

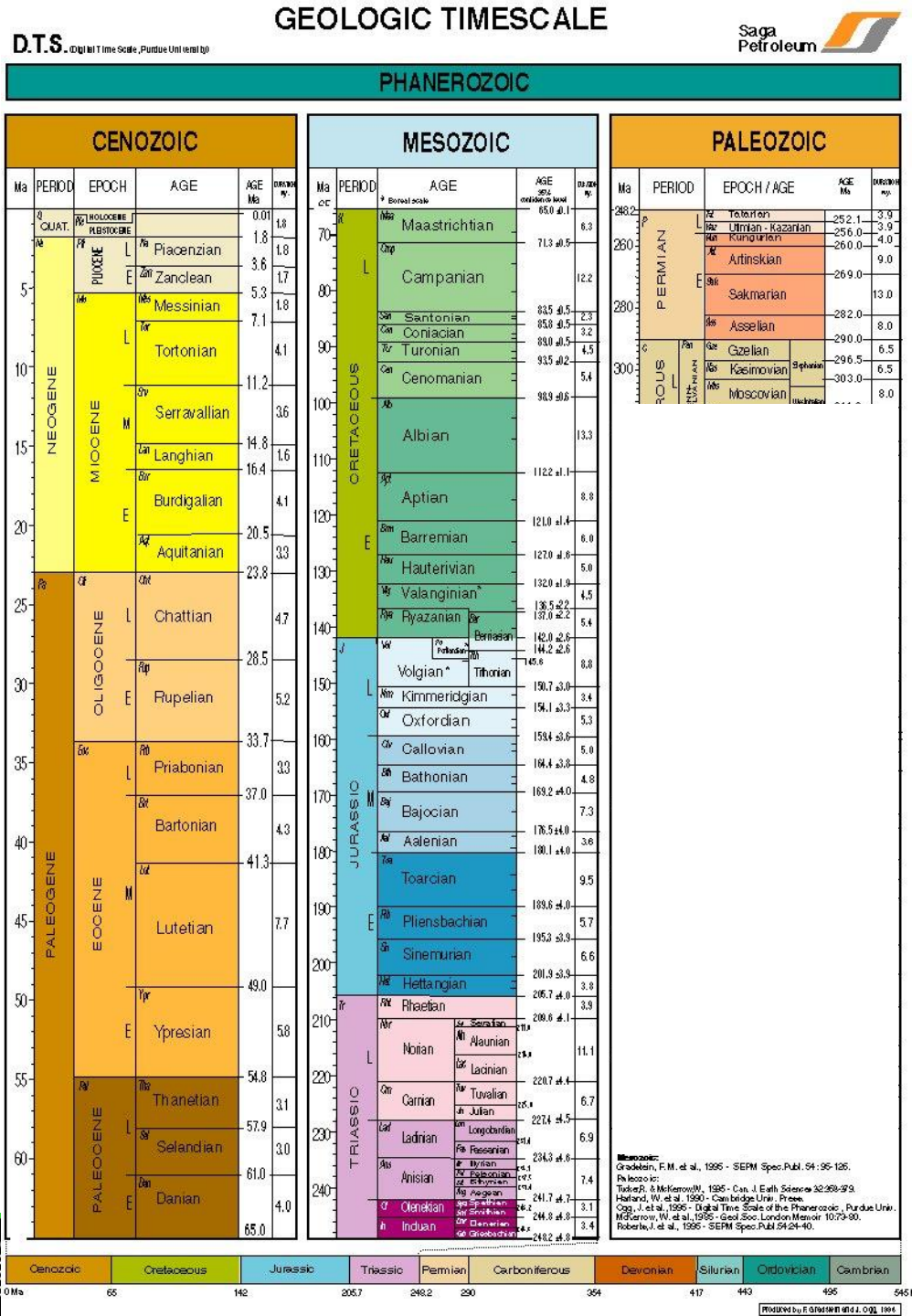


After Stampfli & Mosar (1999)

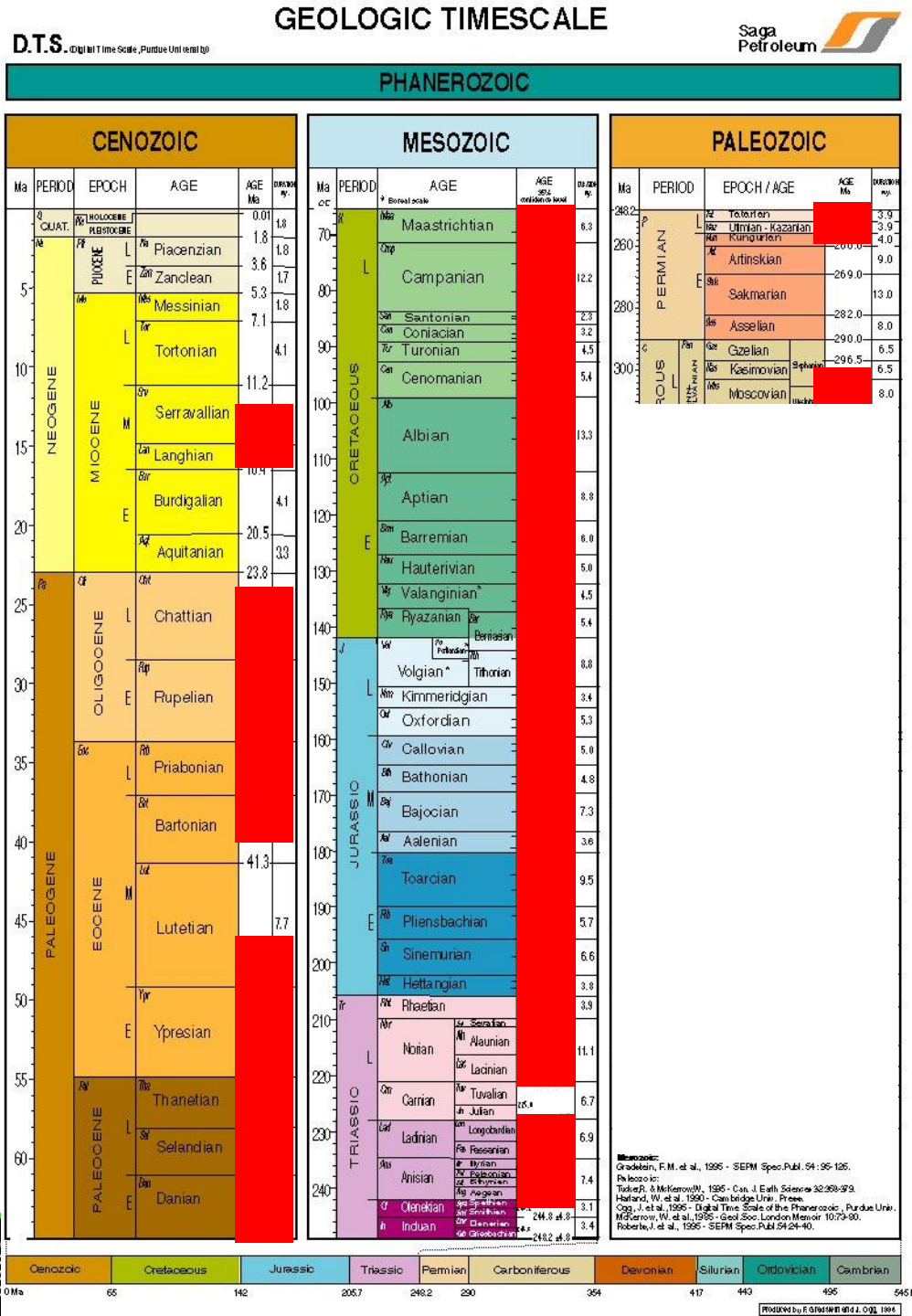


AB = Adriatic Basin
BB = Belluno Basin
IB = Ionian Basin
UMB = Umbria-Marche Basin
MB = Molise Basin
LB = Lagonegro Basin
SBB = Slovenian-Bosnian basin
BCT = Budva-Cukali Trough
PB = Pannonian Basin

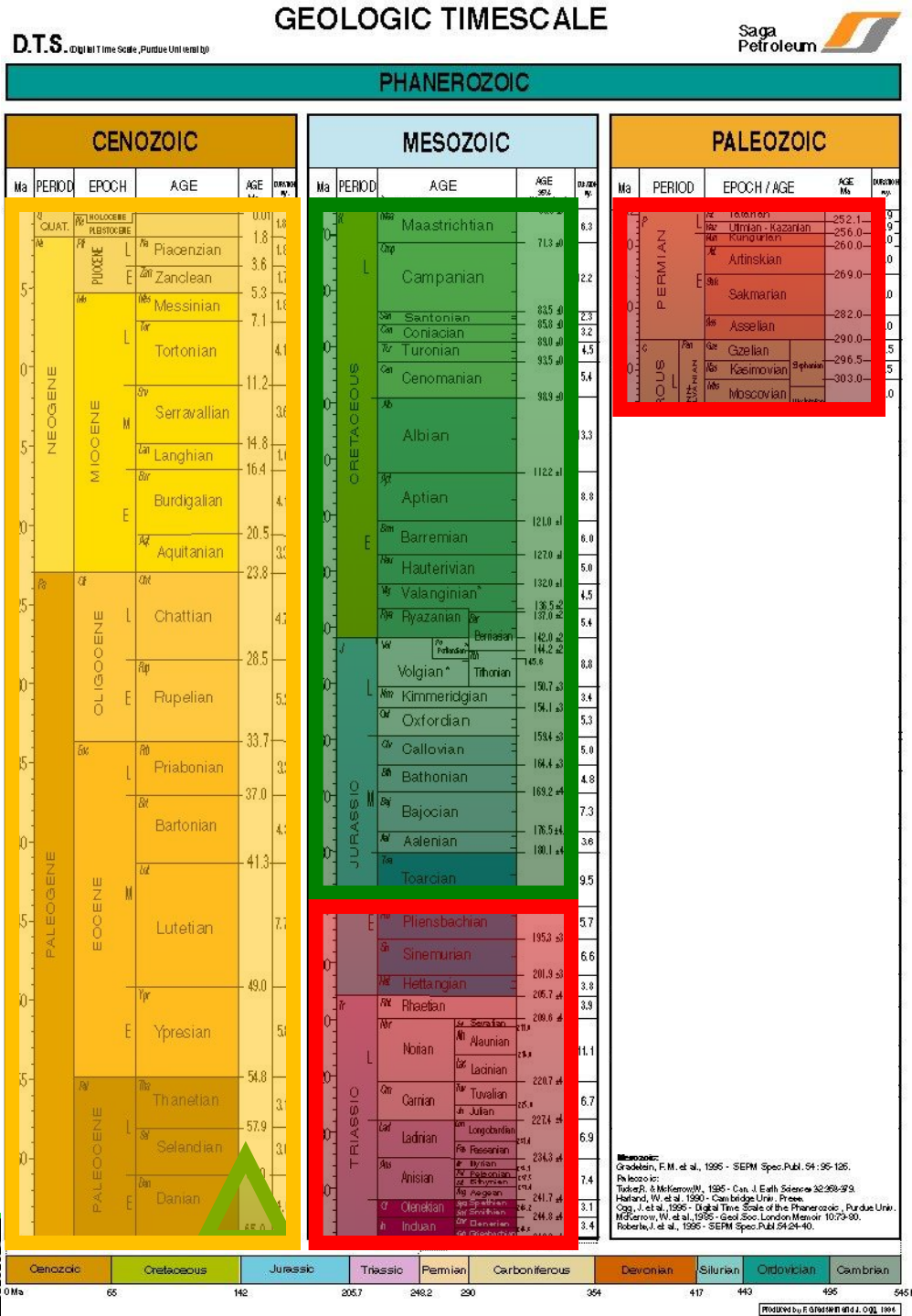
Vlahović et al., 2005



Stratigraphic range of outcrops in the External Dinarides



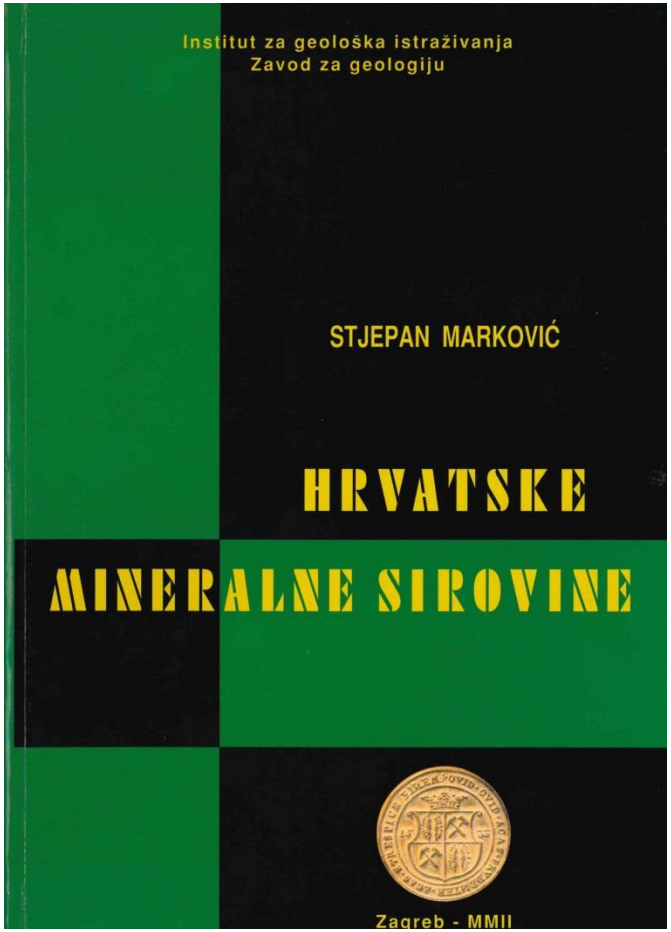
Carbonate deposits (predominantly shallow-marine) in the External Dinarides


GEOLOGIC TIMESCALE
D.T.S. (Digital Time Scale, Purdue University)
Saga Petroleum
PHANEROZOIC
CENOZOIC
MESOZOIC
PALEOZOIC
Ma
PERIOD
EPOCH
AGE
AGE Ma
DURATION my
QUAT.
NEOGENE
PLIOCENE
MIOCENE
PALEOGENE
OLIGOCENE
EOCENE
PALEOCENE
Piacenzian
Zanclean
Messinian
Tortonian
Serravallian
Langhian
Burdigalian
Aquitanian
Chattian
Rupelian
Priabonian
Bartonian
Lutetian
Ypresian
Thanetian
Selandian
Danian
1.8
3.6
5.3
7.1
11.2
14.8
16.4
20.5
23.8
28.5
33.7
37.0
41.3
49.0
54.8
57.9
65.0
CRETACEOUS
JURASSIC
TRIASSIC
Maastrichtian
Campanian
Santonian
Coniacian
Turonian
Cenomanian
Albian
Aptian
Barremian
Hauterivian
Valanginian
Ryazanian
Volgian
Berriasian
Tithonian
Kimmeridgian
Oxfordian
Callovian
Bathonian
Bajocian
Aalenian
Toarcian
Pliensbachian
Sinemurian
Hettangian
Rhaetian
Norian
Carnian
Ladinian
Anisian
Olenekian
Induan
Alaunian
Lacinian
Tuvalian
Julian
Longobardian
Fassanian
Illyrian
Pelsonian
Aegean
Spathian
Smithian
Dienerian
PERMIAN
Ufimian - Kazanian
Kungurian
Artinskian
Sakmarian
Asselian
Gzelian
Kasimovian
Moscovian
Stephanian
Pennsylvanian
Mississippian
252.1
256.0
260.0
269.0
282.0
290.0
296.5
303.0
71.3
83.5
85.8
89.0
93.5
99.9
112.2
121.0
127.0
132.0
136.5
137.0
142.0
144.2
145.6
150.7
156.1
159.4
164.4
169.2
176.5
180.1
195.3
201.9
205.7
209.6
220.7
227.4
234.3
241.7
244.8
Cenozoic
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
0 Ma
65
142
205.7
248.2
290
354
417
443
495
545 Ma
Overlying Deposits
Adriatic Carbonate Platform
AdCP basement

Bauxite deposits in Croatia

1 - Prebukovje (Ravna gora), 2 - Borovik (Krndija), 3 - Kokirevo, 4 - Veljun-most, 5 - Blagaj, 6 - Nikšić, 7 - Marindolsko brdo, 8 - Obajdin, 9 - Bročanac, 10 - Furjan, 11 - Frketići, 12 - Gazibare, Živkovići, 13 - Mejašići, Rebrovići, 14 - Bosiljevo, 15 - Veliki Skočaj, 16 - Grgin brijeg, 17 - Jadovno, 18 - Egeljac, 19 - Vrace, 20 - Rudopolje, 21 - Kijani, 22 - Mazin, 23 - Labusi, 24 - Martići, 25 - Ramljane, 26 - Karenovac, 27 - Kijevo, 28 - Kozjak, 29 - Crvene grede, Lupoglav, 30 - Debelo brdo, 31 - Ogorje, 32 - Funtana, 33 - Gradina, Bralići, 34 - Rovinj, 35 - Momjan, 36 - Grožnjan, 37 - Sovinjak, 38 - Petrovija, 39 - Brtonigla, 40 - Vižinada, 41 - Karojba, 42 - Pazin, 43 - Martinski i Sv. Nedelja, 44 - Duga luka, 45 - Barban, 46 - Glavica, 47 - Šišan (od 35-47 sve su skupine ležišta, osim 46), 48 - Dragozetići, 49 - Beli, 50 - Grabovica, 51 - Martinšćica, 52 - uvala Koromačna, 53 - rt i brdo Osor, 54 - Ćunski, 55 - Gromačina, 56 - Klam, 57 - Negrit, Stara Baška, 58 - Baška, 59 - Sorine, 60 - Kampor, 61 - Lun, 62 - Trimalj, 63 - Novalja, 64 - Caska, 65 - Ugljan, 66 - Pašman, 67 - Čiovo, 68 - Supetar, 69 - Milna, 70 - Polača, 71 - Vinjerac, 72 - Rovanjska, Dračevac, Ćukovac, Jasenica, Kranjčevac, Topla torina, 73 - Selina, V. Gradina, Stari gaj, Juričina, Kruševo, 74 - Crvena zemlja, Kljakovača, 75 - Balići, Komazec, Crvene njive, 76 - Brekića glavica, Subotići, Peslač, Obruč, Graonja, 77 - Kučajska glava, 78 - Laškovica, 79 - Kumanovo, 80 - Mamutovac, 81 - Gluvače, Krstančuša, Marići, Dujići, Tošići, Jukići i dr., 82 - Kalun, 83 - Lukovača, Rajića doci, Galeba, 84 - Suknovci, 85 - "Rezervoar", 86 - Crni vrh, 87 - Sedramić, 88 - Kljaci, 89 - Kunci, Vinovo, 90 - Ramljane, 91 - Prapatnica, 92 - Blaca, 93 - Visoka, 94 - Gljev, 95 - Ovrlje, 96 - Peruča-1 do Peruča-7, 97 - Košute, 98 - Jabuka, Kosmač, Grab, Krkine ograde, Šipića dolac, Šušnjara, 99 - Čaporice, Ivica, Marasovići, Crveni klanac, 100 - Jagodnik, 101 - Mrnjavci, 102 - Svib, 103 - Studenci, 104 - Ričice, 105 - Imotski (od 101 do 105 skupine ležišta), 106 - Zekulići, Majići, 107 - Plana, Lučka, 108 - Glušci, Kolojan.

Marković, 2002



Marković, 2002

PODINA	KROVINA	ORUDNJENJE	LOKALITET	STAROST	NAPOMENA
malm	—	boksitične gline, glinoviti boksiti (?)	Bosanci, Bosiljevo	pleistocen	
baden	plioc. - pleist.	boksitične gline	Borovik (Krndija)	pliocen - pleistocen	
eocen - oligocen senon cenoman - turon malm apt	sr. miocen	glinoviti boksiti	- Krkine ograde, Grab (dio) (Trilj) - Košute, Čaporice, Ivica, Crveni klanac (sve Trilj) - Peruča - Grab (dio) (Trilj) - Meašići, Rebrovići (Tounj)	neogen	**X. horizont**
d. i sr. eocen turon - senon	eocen - oligoc.	glinoviti boksiti	- Košute (SZ od Trilja) - Kosmač (JI od Trilja)	?	krovina: breče neutvrđene starosti
g. eocen - d. oligocen	d. oligocen g. eocen	boksit	Dujići (SZ od Drniša)	g. eocen, d. oligocen	"intraprominski" bx, pretaloženo
sr. eocen d. i sr. eocen paleocen, d. eocen turon - senon cenoman - turon			- Suknovci (Oklaj) Obrovac, Ervenik, Promina (u najširem smislu), Mosec, Sinj	g. eocen	krovina: Promina naslage **IX. horizont**
sr. eocen, g. eocen	g. eocen sr. eocen	boksit, boksitični vapnenac	Mamutovo brdo (Studenci)	sr. eocen, g. eocen	"intraprominski" bx, pretaloženo
d. i sr. eocen paleocen, d. eocen senon		boksit	Studenci - Imotski	sr. eocen	krovina: Promina naslage
cenoman - turon d. i sr. eocen	sr. eocen	glinoviti boksiti	- Kučajska glava (Ervenik) Lukovača (Promina pl.) - Promina pl. (tragovi)	sr. eocen	**VIII. horizont** krovina: Jelar naslage
senon turon - senon cenoman - turon	d. eocen, paleocen	boksit	Istra, Bukovica, Promina - Drniš, Sinj, Studenci - Imotski, Cres, Lošinj, Krk, Rab, Pag i dr.	g. kreda \ paleogen	**VII. horizont** krovina: Kozina naslage i foraminiferski vapnenci
cenoman - turon	senon	boksit	- Gazibare, Živkovići (Krnjak) - Kučevica, Frketići (Z od Duge Rese)	senon	**VI. horizont**
alb	cenoman - turon	glinoviti boksiti	Debelo brdo (Dinara) Ogorje, Zelovo (Svilaja)	d. kreda \ g. kreda	
apt barem	alb	tragovi boksitičnih tvorevina, gline	Baderna, Bale i dr. (Istra), otoci	barem \ alb	**V. horizont**
malm	neokom	glinoviti boksiti	Kijevo, Kozjak (Svilaja), Lupoglav (Dinara), Mljet	malm \ neokom	**IV. horizont**
kimeridž	titon	glinoviti boksiti, boksitične gline, gline	Funtana, Gradine, Bralići, Kloštar, Rovinj (sve Istra)	malm	**III. horizont**
anizik	sr. eocen	boksit	Prebukovje (Ravna gora)	?	
ladinik anizik	lijas	- boksitične gline i dr. glinovite stijene - boksitične stijene	- Martići (ili Marići - Knin), Sutina (JI Svilaja) - Jabuka (Trilj)	sr. trijas \ lijas	
anizik	—	boksit, glinoviti boksiti, boksitične gline	Kokirevo, Veljun, Obajdin (Slunj)	trijas (?)	**II. horizont**
ladinik anizik	karnik	boksit, glinoviti boksiti, boksitične gline	- Bročanac (Slunj), Grgin brijeg, Vrace, ... (Lika) - Veliki Skočaj (Plješivica)	sr. trijas \ g. trijas	
anizik	ladinik	tragovi boksitičnih tvorevina	okolica Gračaca	anizik \ ladinik	**I. horizont**
d. trijas	anizik	boksitično-željezovite breče	Sutina (JI Svilaja)	d. trijas \ anizik	neistraženo, normalno je kontinuitet

10 Stratigraphic horizons:

X – L. Jurassic–E, Ol / M_2

IX – L. Cretaceous–Pc–$E_{1,2}$ / $E_{2,3}$–Ol_1

VIII – L. Cretaceous–$E_{1,2}$ / E_2

VII – L. Cretaceous / Pc, E_1

VI – L. Cretaceous

V – E. Cretaceous

IV – L. Jurassic / E. Cretaceous

III – L. Jurassic

II – M. / L. Triassic

I – M. Triassic

Marković, 2002

PODINA	KROVINA	ORUDNJENJE	LOKALITET	STAROST	NAPOMENA
malm	—	boksitične gline, glinoviti boksiti (?)	Bosanci, Bosiljevo	pleistocen	
baden	plioc. - pleist.	boksitične gline	Borovik (Krndija)	pliocen - pleistocen	
eocen - oligocen senon cenoman - turon malm apt	sr. miocen	glinoviti boksiti	- Krkine ograde, Grab (dio) (Trilj) - Košute, Čaporice, Ivica, Crveni klanac (sve Trilj) - Peruča - Grab (dio) (Trilj) - Meašići, Rebrovići (Tounj)	neogen	**X. horizont**
d. i sr. eocen turon - senon	eocen - oligoc.	glinoviti boksiti	- Košute (SZ od Trilja) - Kosmač (JI od Trilja)	?	krovina: breče neutvrđene starosti
g. eocen - d. oligocen	d. oligocen g. eocen	boksit	Dujići (SZ od Drniša)	g. eocen, d. oligocen	"intraprominski" bx, pretaloženo
sr. eocen d. i sr. eocen paleocen, d. eocen turon - senon cenoman - turon			- Suknovci (Oklaj) Obrovac, Ervenik, Promina (u najširem smislu), Mosec, Sinj	g. eocen	krovina: Promina naslage **IX. horizont**
sr. eocen, g. eocen	g. eocen sr. eocen	boksit, boksitični vapnenac	Mamutovo brdo (Studenci)	sr. eocen, g. eocen	"intraprominski" bx, pretaloženo
d. i sr. eocen paleocen, d. eocen senon		boksit	Studenci - Imotski	sr. eocen	krovina: Promina naslage
cenoman - turon d. i sr. eocen	sr. eocen	glinoviti boksiti	- Kučajska glava (Ervenik) Lukovača (Promina pl.) - Promina pl. (tragovi)	sr. eocen	**VIII. horizont** krovina: Jelar naslage
senon turon - senon cenoman - turon	d. eocen, paleocen	boksit	Istra, Bukovica, Promina - Drniš, Sinj, Studenci - Imotski, Cres, Lošinj, Krk, Rab, Pag i dr.	g. kreda \ paleogen	**VII. horizont** krovina: Kozina naslage i foraminiferski vapnenci
cenoman - turon	senon	boksit	- Gazibare, Živkovići (Krnjak) - Kučevica, Frketići (Z od Duge Rese)	senon	**VI. horizont**
alb	cenoman - turon	glinoviti boksiti	Debelo brdo (Dinara) Ogorje, Zelovo (Svilaja)	d. kreda \ g. kreda	
apt barem	alb	tragovi boksitičnih tvorevina, gline	Baderna, Bale i dr. (Istra), otoci	barem \ alb	**V. horizont**
malm	neokom	glinoviti boksiti	Kijevo, Kozjak (Svilaja), Lupoglav (Dinara), Mljet	malm \ neokom	**IV. horizont**
kimeridž	titon	glinoviti boksiti, boksitične gline, gline	Funtana, Gradine, Bralići, Kloštar, Rovinj (sve Istra)	malm	**III. horizont**
anizik	sr. eocen	boksit	Prebukovje (Ravna gora)	?	
ladinik anizik	lijas	- boksitične gline i dr. glinovite stijene - boksitične stijene	- Martići (ili Marići - Knin), Sutina (JI Svilaja) - Jabuka (Trilj)	sr. trijas \ lijas	
anizik	—	boksit, glinoviti boksiti, boksitične gline	Kokirevo, Veljun, Obajdin (Slunj)	trijas (?)	**II. horizont**
ladinik anizik	karnik	boksit, glinoviti boksiti, boksitične gline	- Bročanac (Slunj), Grgin brijeg, Vrace, ... (Lika) - Veliki Skočaj (Plješivica)	sr. trijas \ g. trijas	
anizik	ladinik	tragovi boksitičnih tvorevina	okolica Gračaca	anizik \ ladinik	**I. horizont**
d. trijas	anizik	boksitično-željezovite breče	Sutina (JI Svilaja)	d. trijas \ anizik	neistraženo, normalno je kontinuitet

10 Stratigraphic horizons:

X – L. Jurassic–E, Ol / M_2

IX – L. Cretaceous–Pc–$E_{1,2}$ / $E_{2,3}$–Ol_1

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VII – L. Cretaceous / Pc, E_1

VI – L. Cretaceous

V – E. Cretaceous

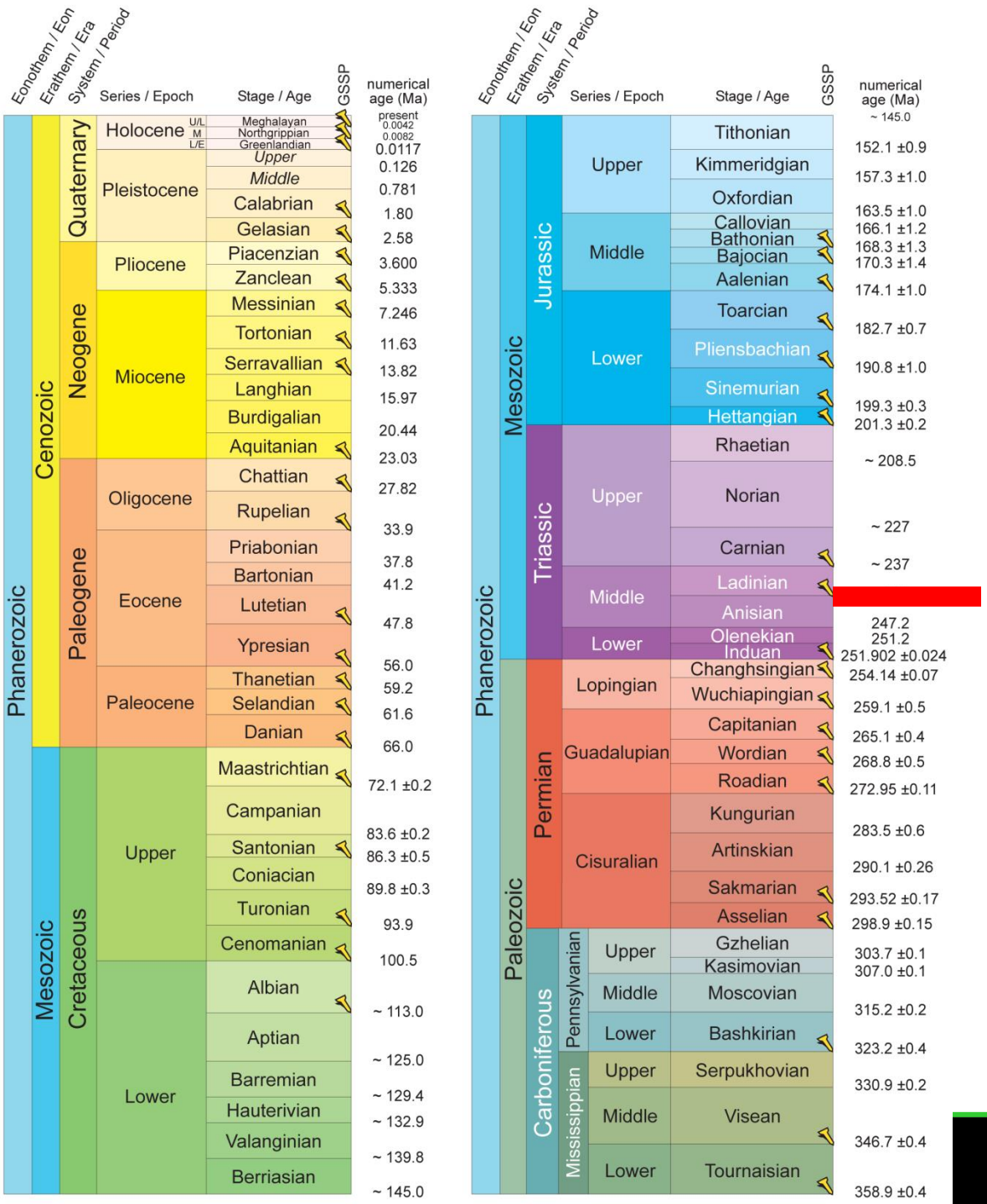
IV – L. Jurassic / E. Cretaceous

III – L. Jurassic

II – M. / L. Triassic

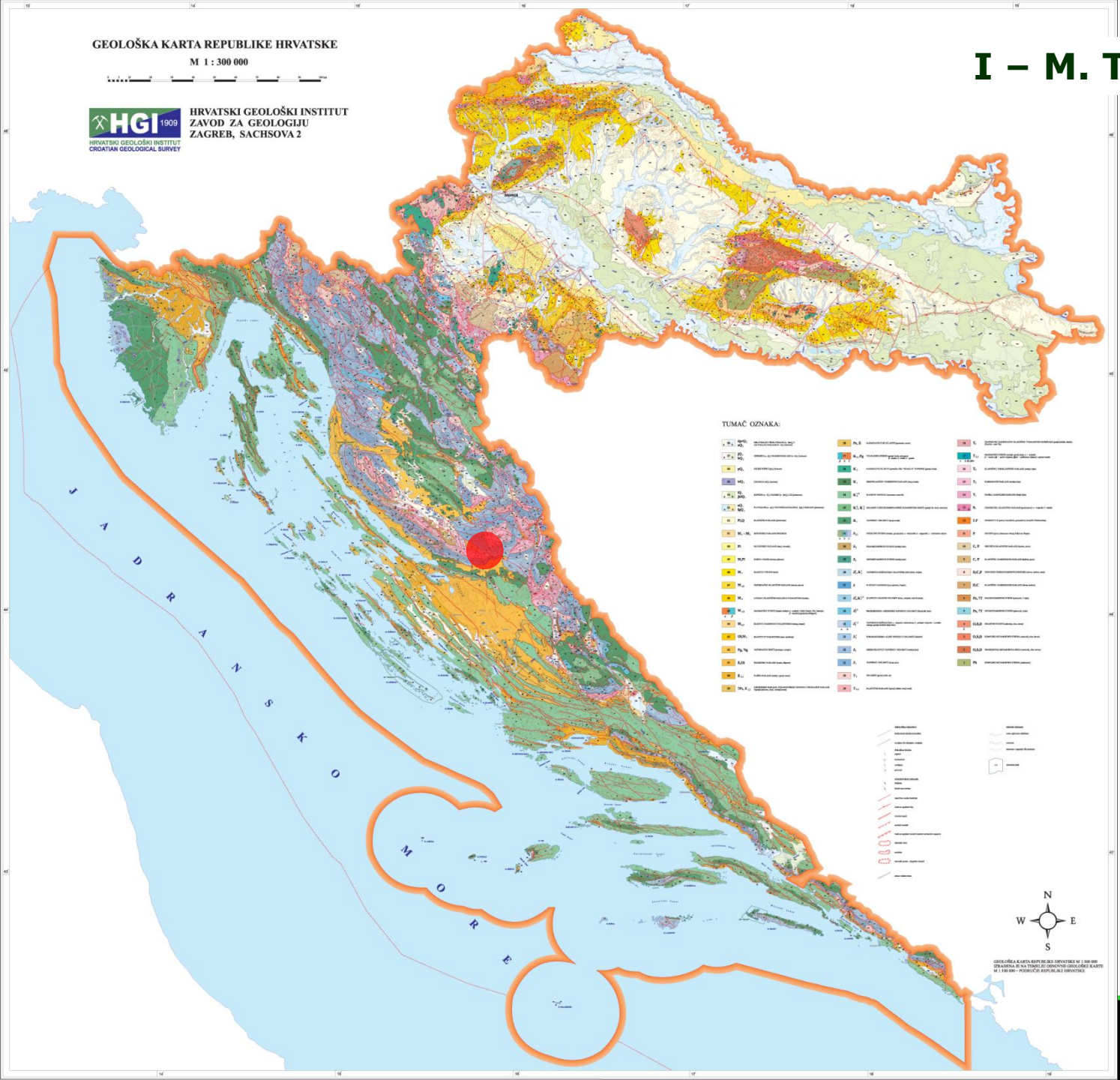
I – M. Triassic

Marković, 2002



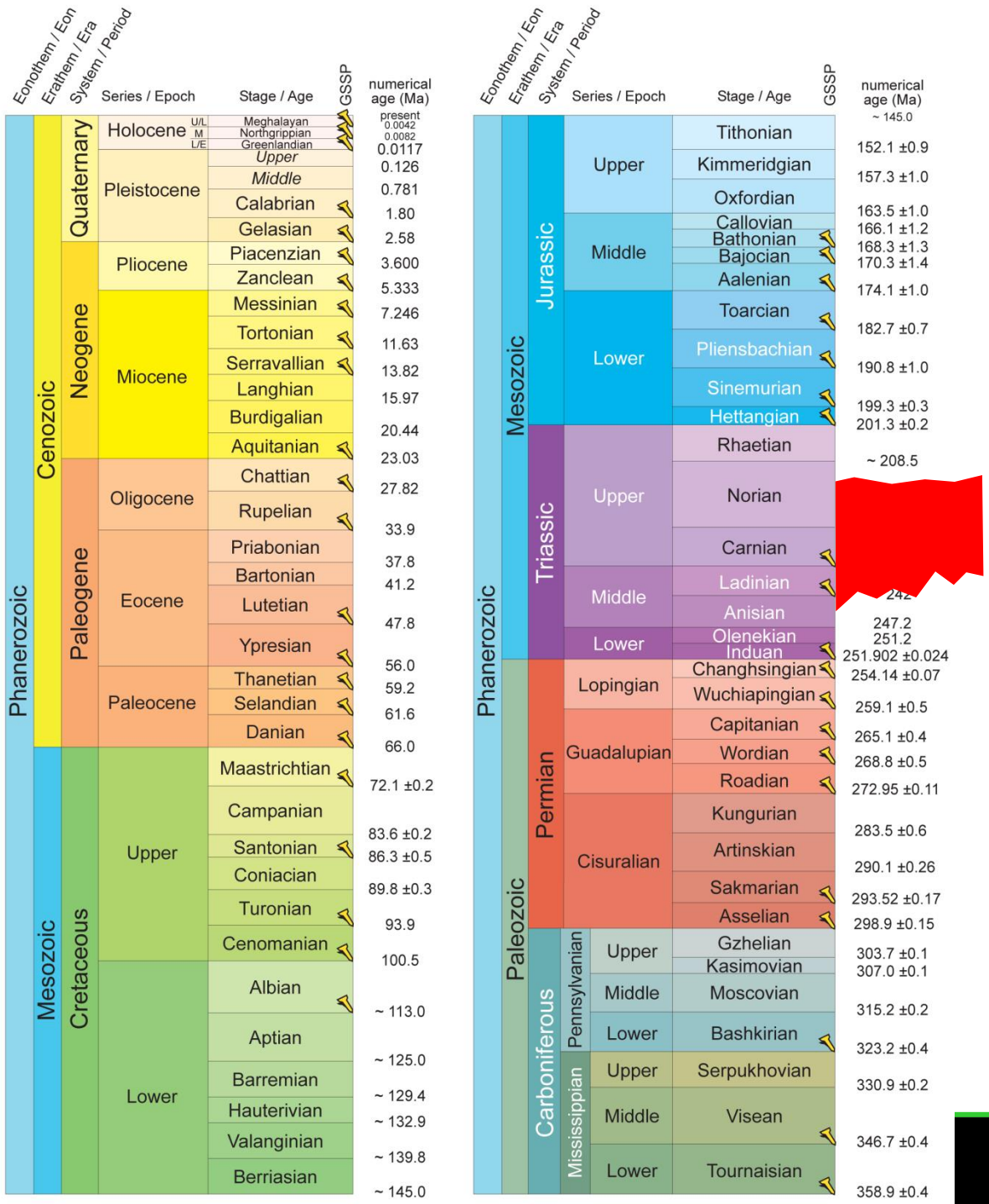
I – M. Triassic

Anisian / Ladinian



I – M. Triassic

Gračac Area



II – M. / L. Triassic

Anisian–Ladinian / Norian

II – M. / L. Triassic

Slunj

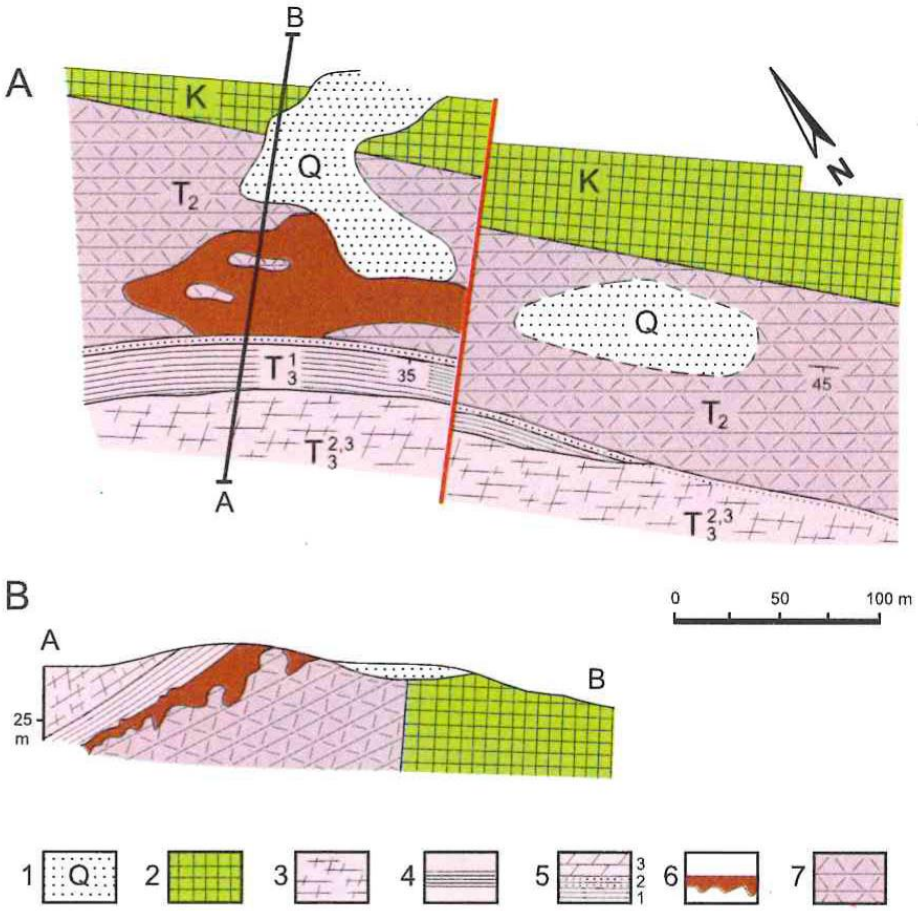
Lika

Velebit

Plješevica

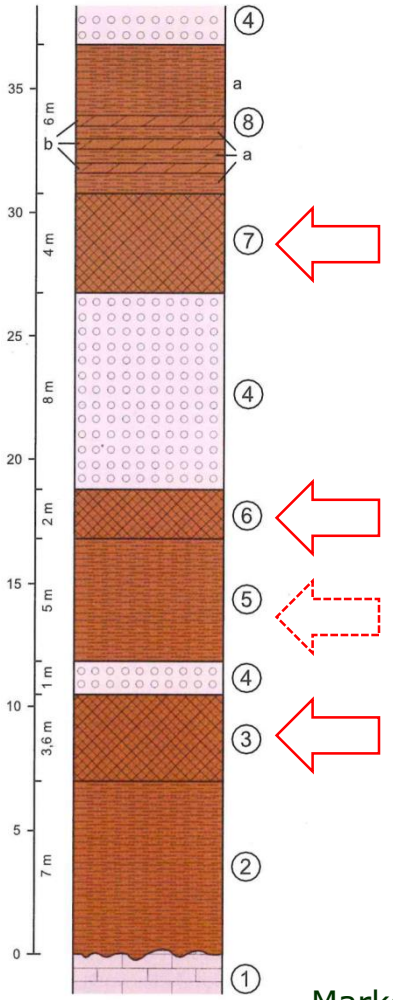
Montenegro

Bročanac deposit near Slunj

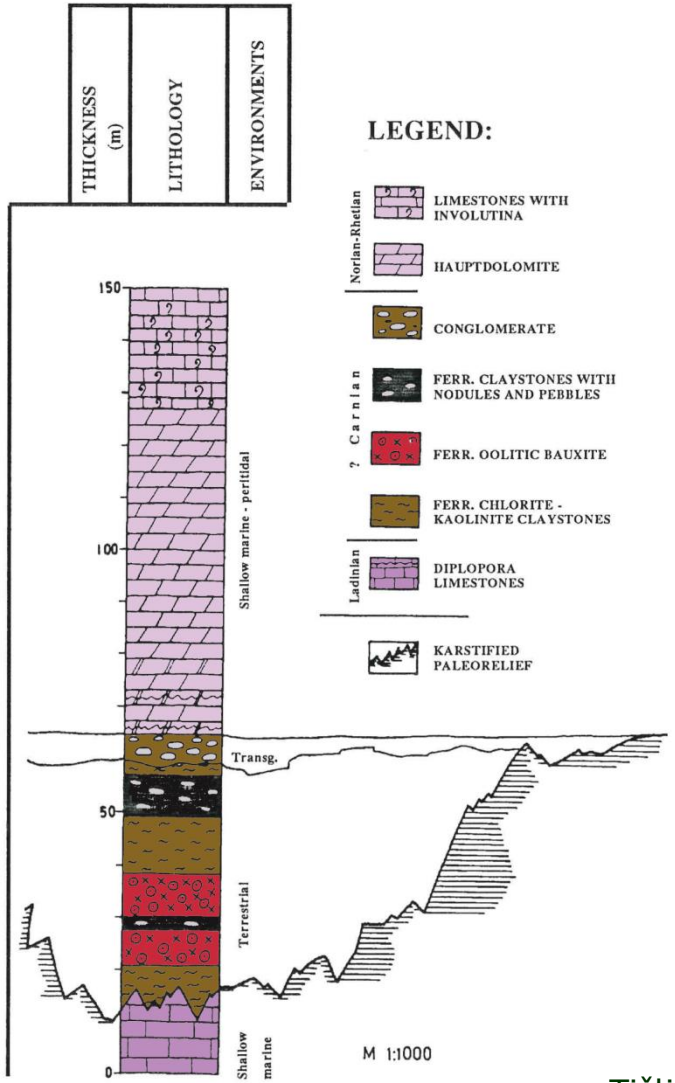


Marković, 2002

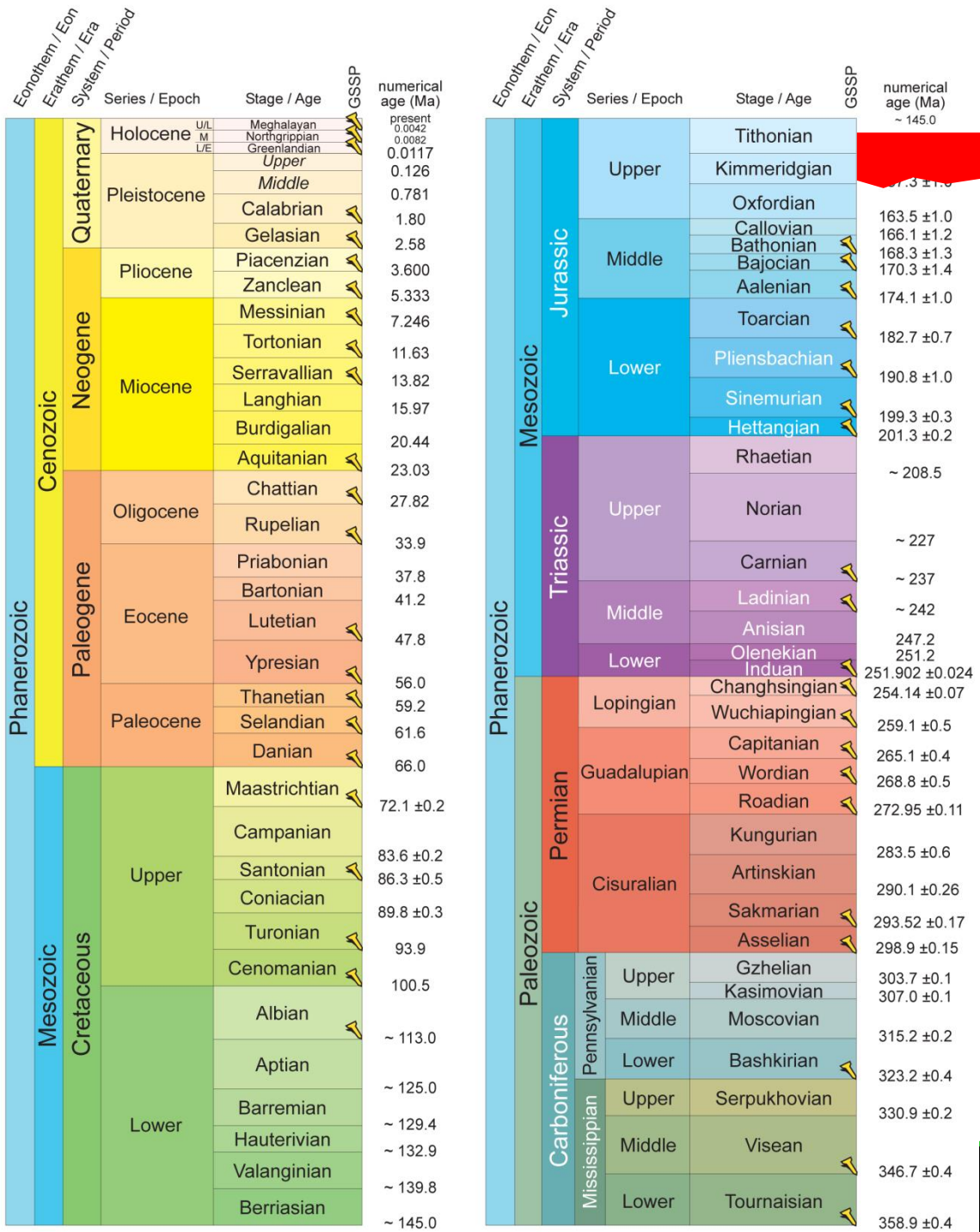
Vrace deposit near Gračac



Marković, 2002

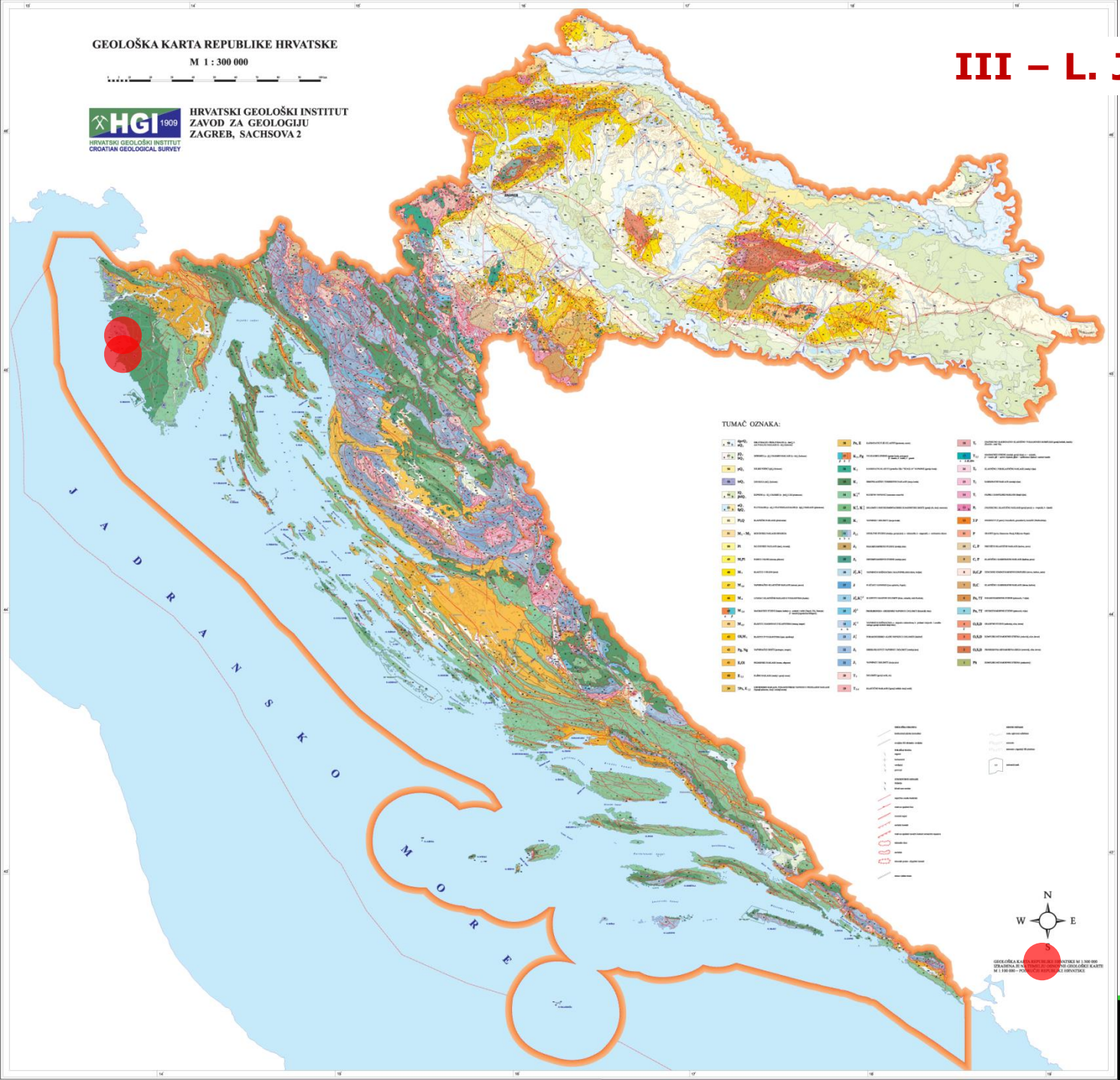


Tišljar et al., 1991



III – L. Jurassic

E. Kimmeridgian / L. Tithonian



III – L. Jurassic

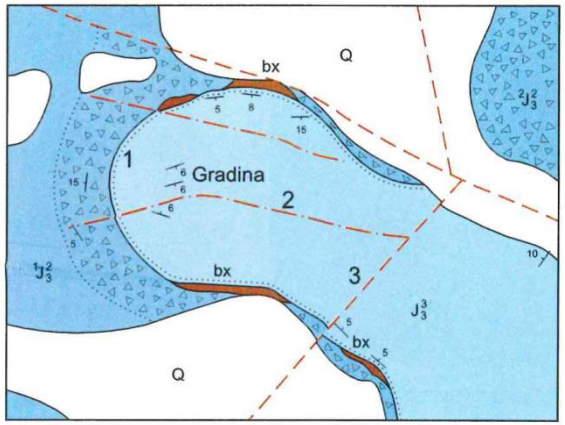
Funtana

Gradine

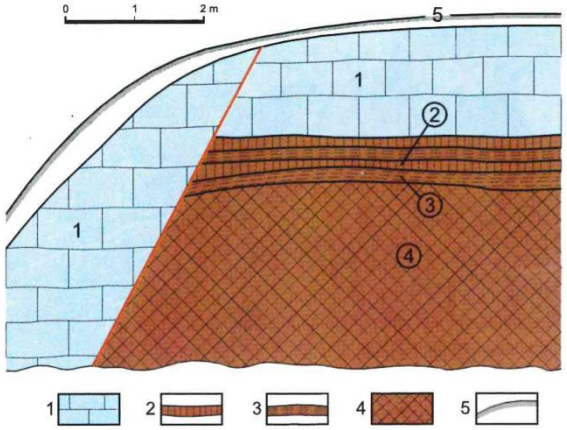
Rovinj

Montenegro

Gradina deposit near Vrsar



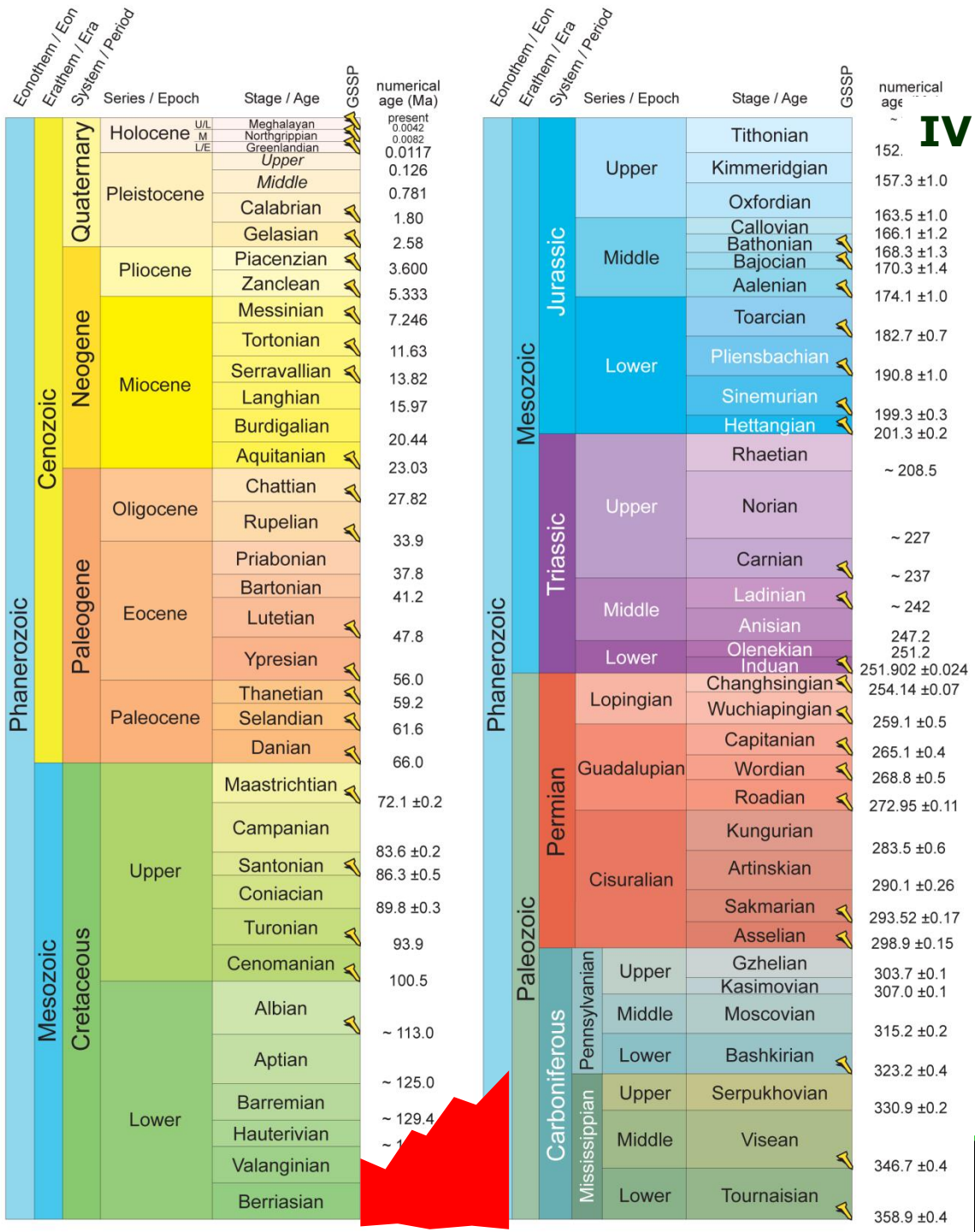
Rovinj I deposit



Marković, 2002

Rovinj I deposit

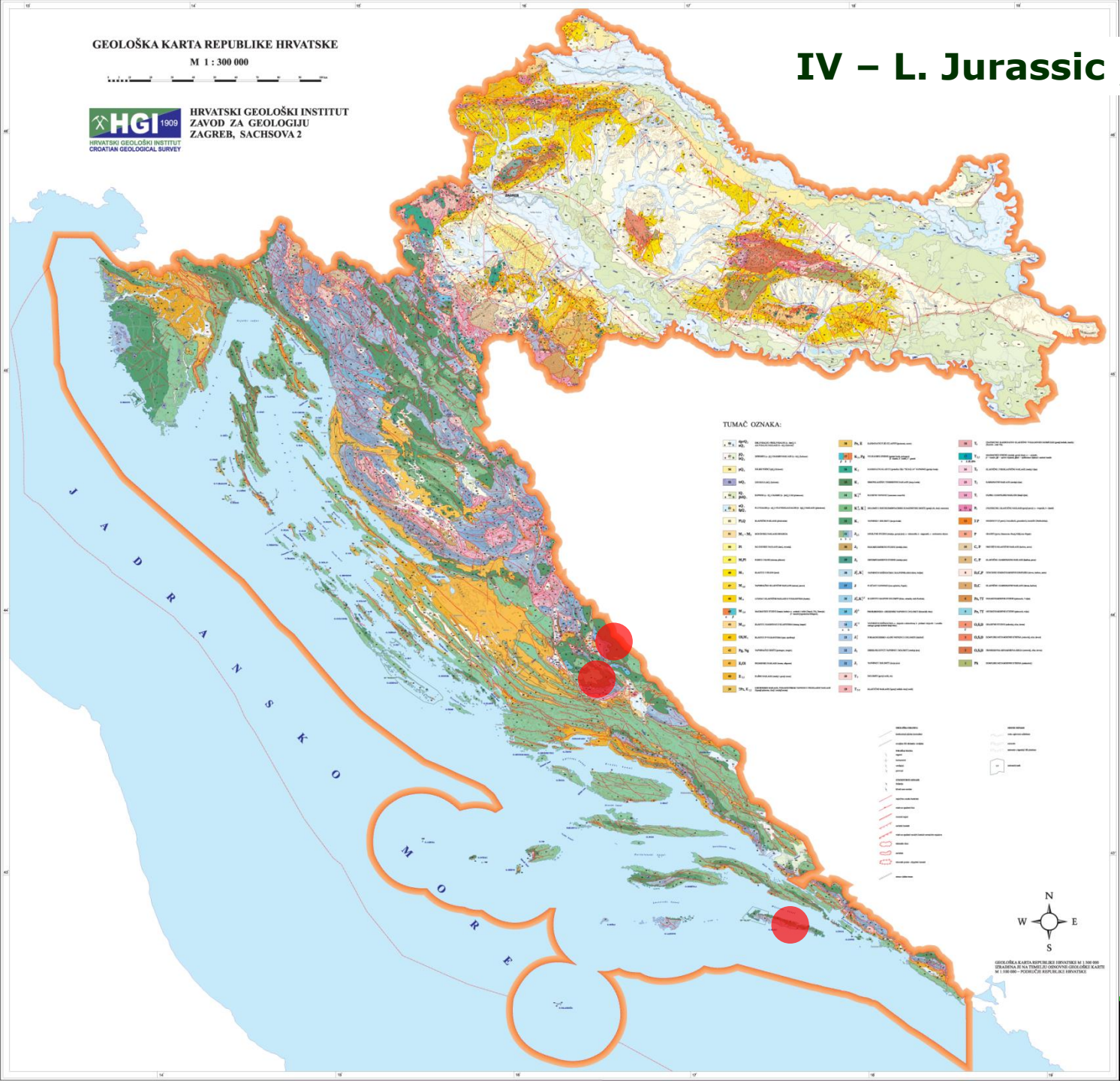
Rovinj I deposit



IV – L. Jurassic / E. Cretaceous

L. Tithonian / Valanginian–Hauterivian–Barremian–Aptian

IV – L. Jurassic / E. Cretaceous

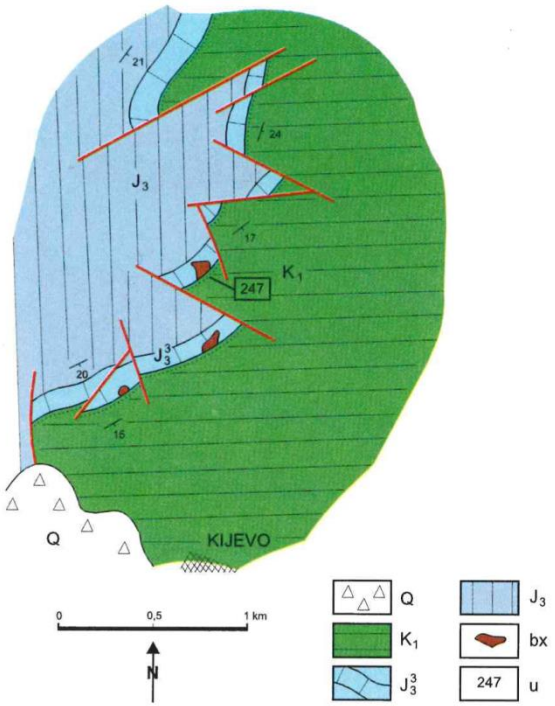


Svilaja

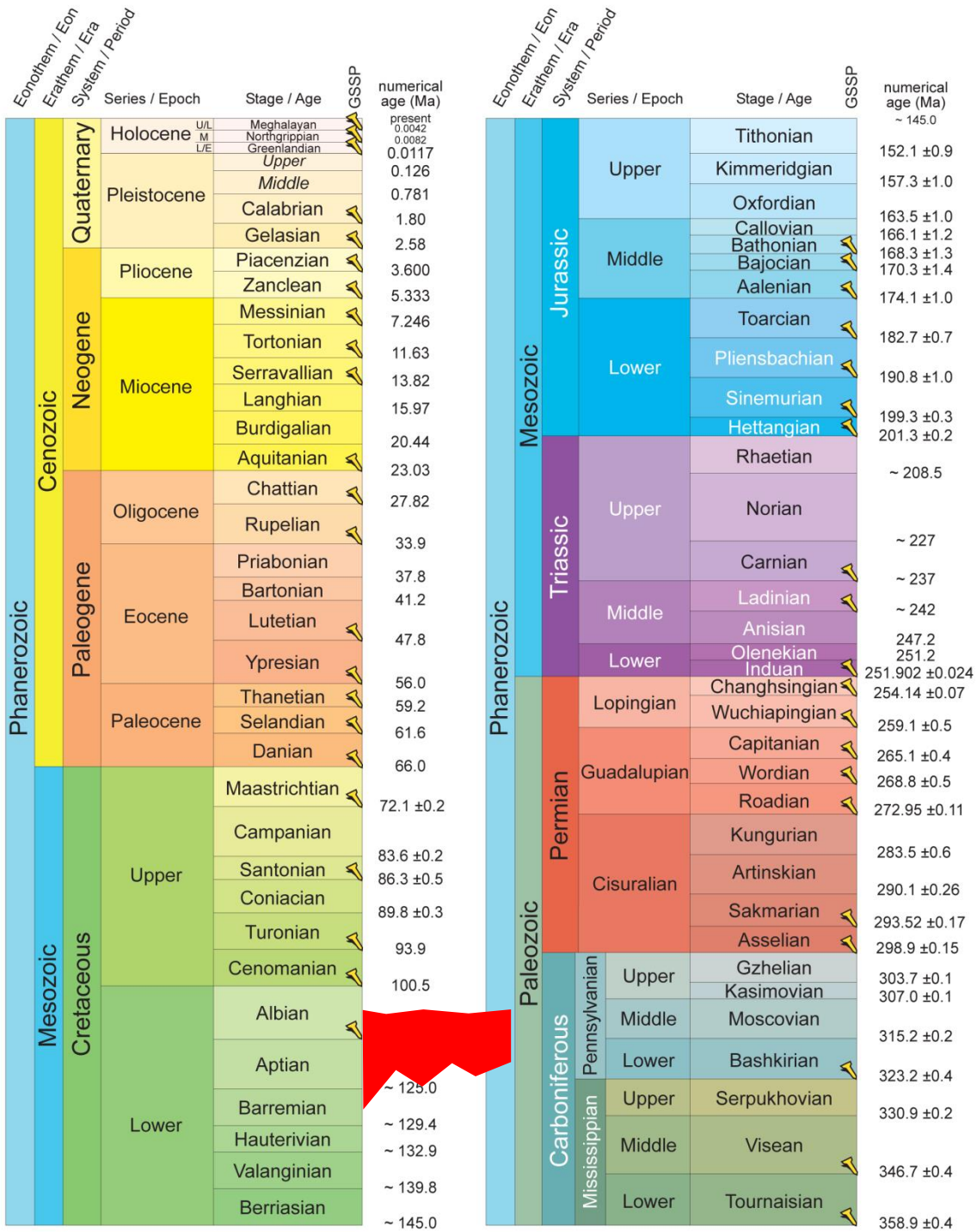
Dinara

Mljet

Kijevo deposit

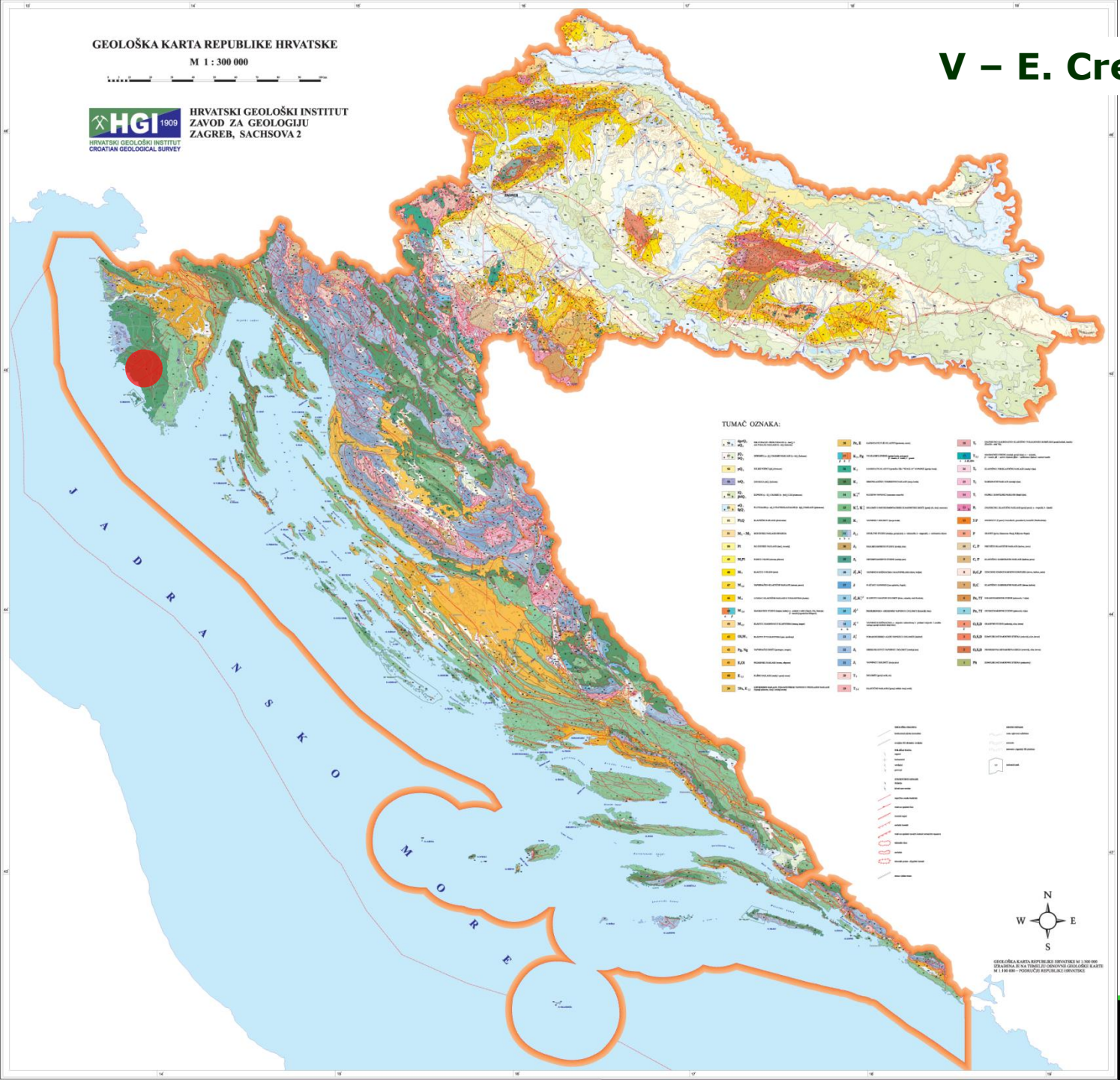


Marković, 2002



V – E. Cretaceous

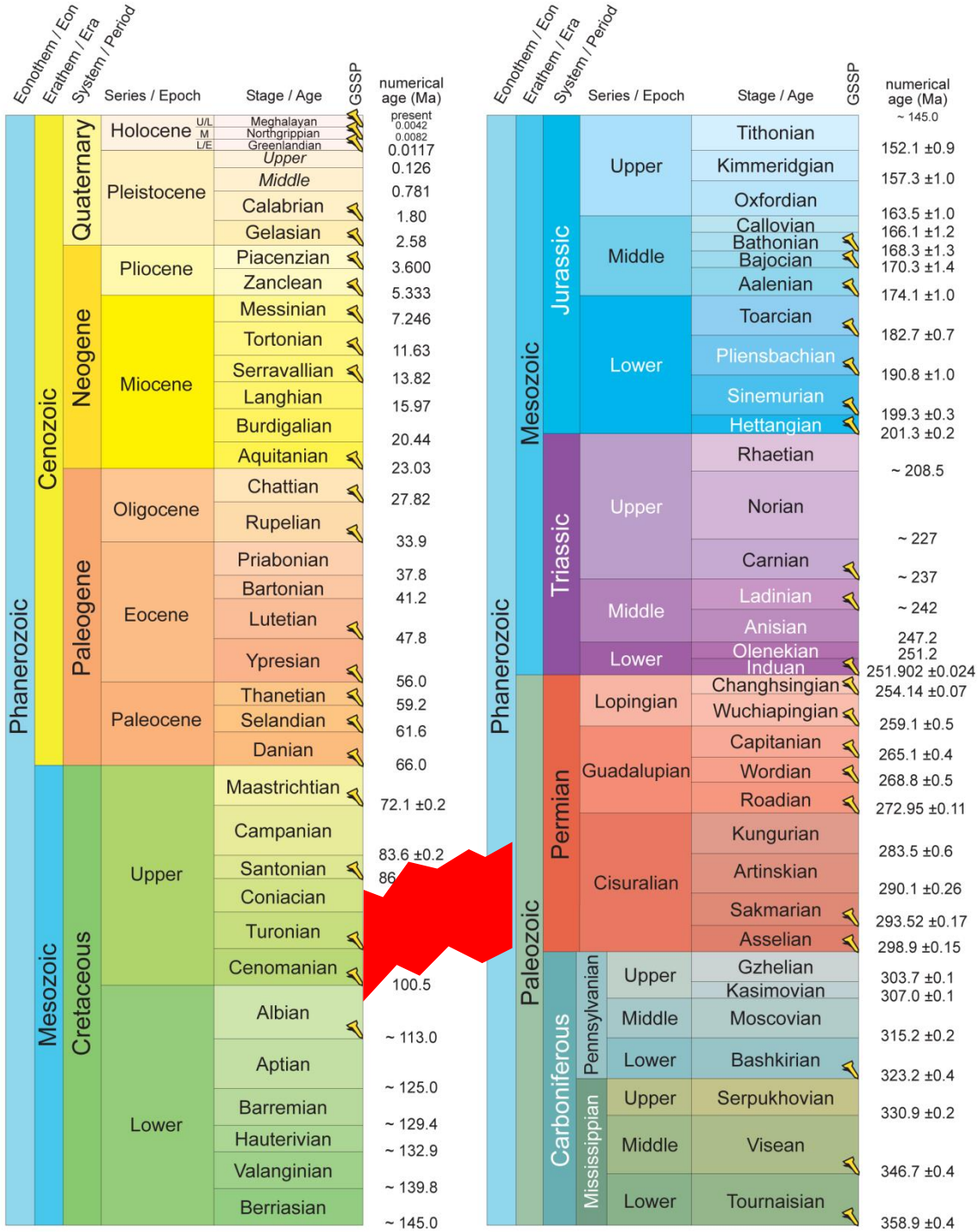
Barremian–E. Aptian / L. Albian



V – E. Cretaceous

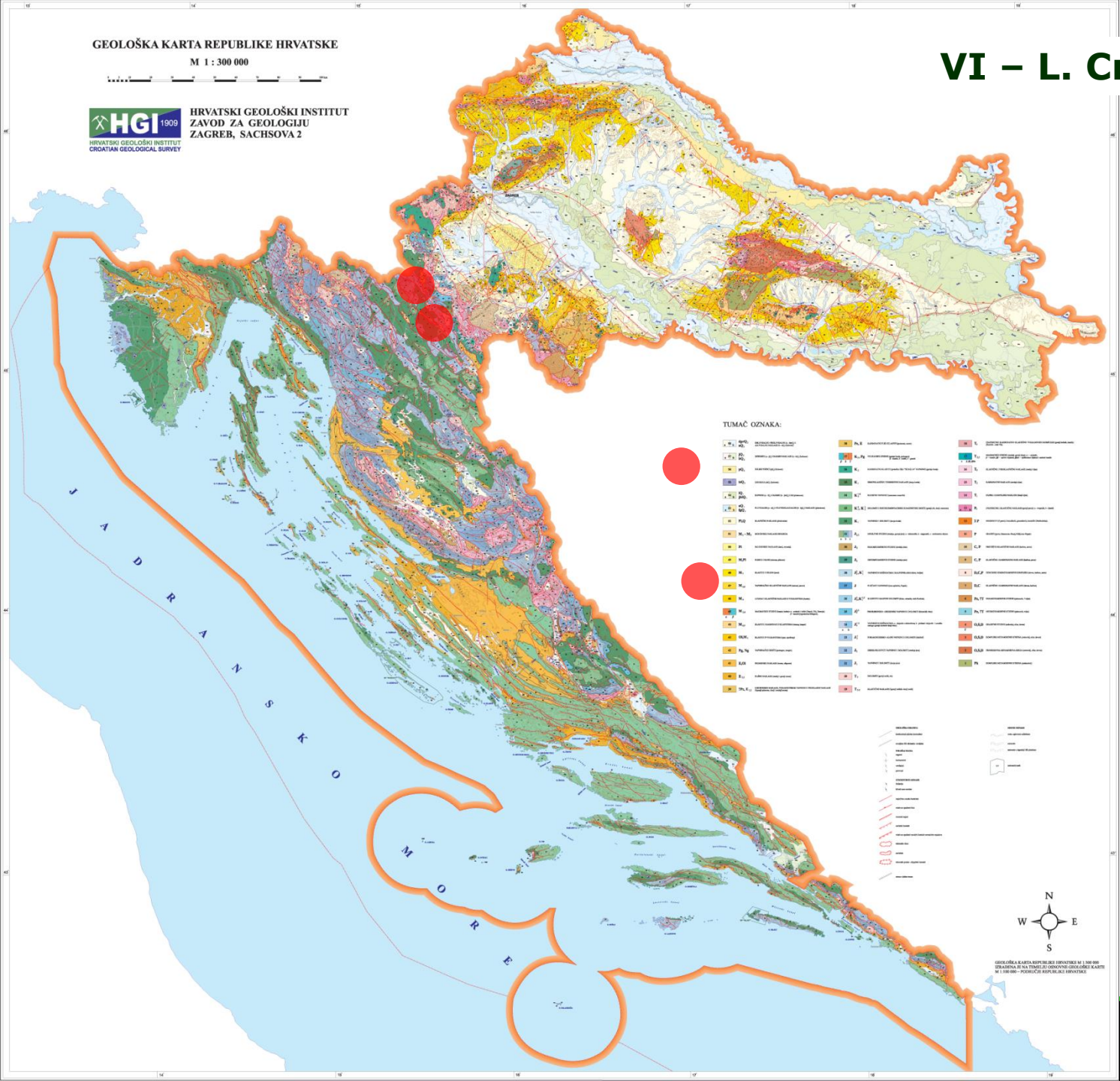
Baderna

Bale



VI – L. Cretaceous

Cenomanian–Turonian / ‘Senonian’



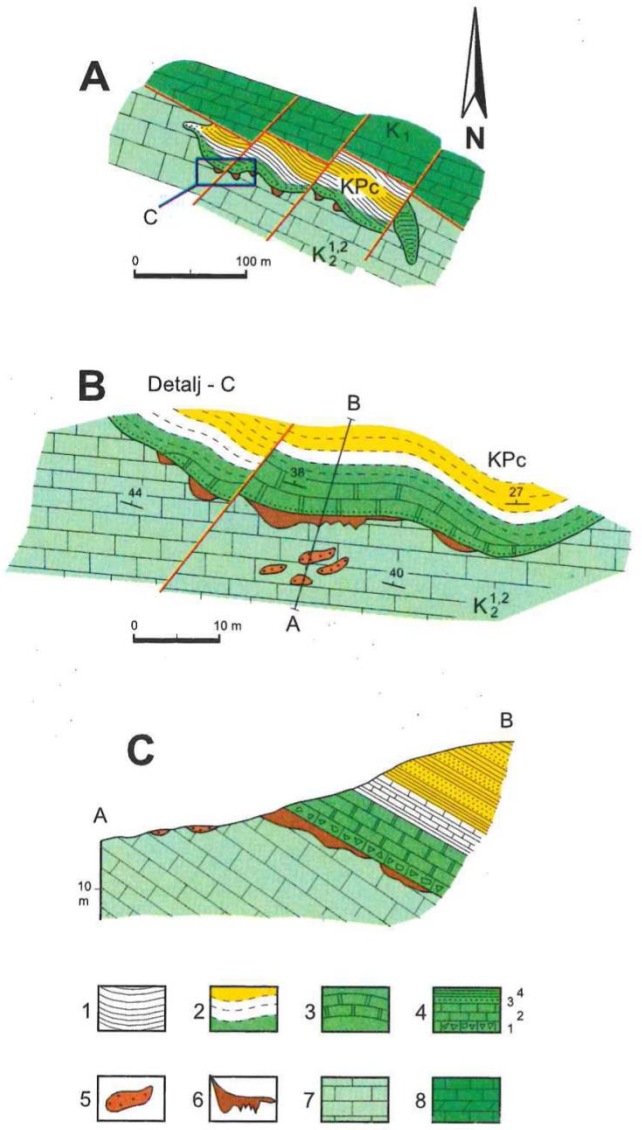
VI – L. Cretaceous

Kordun

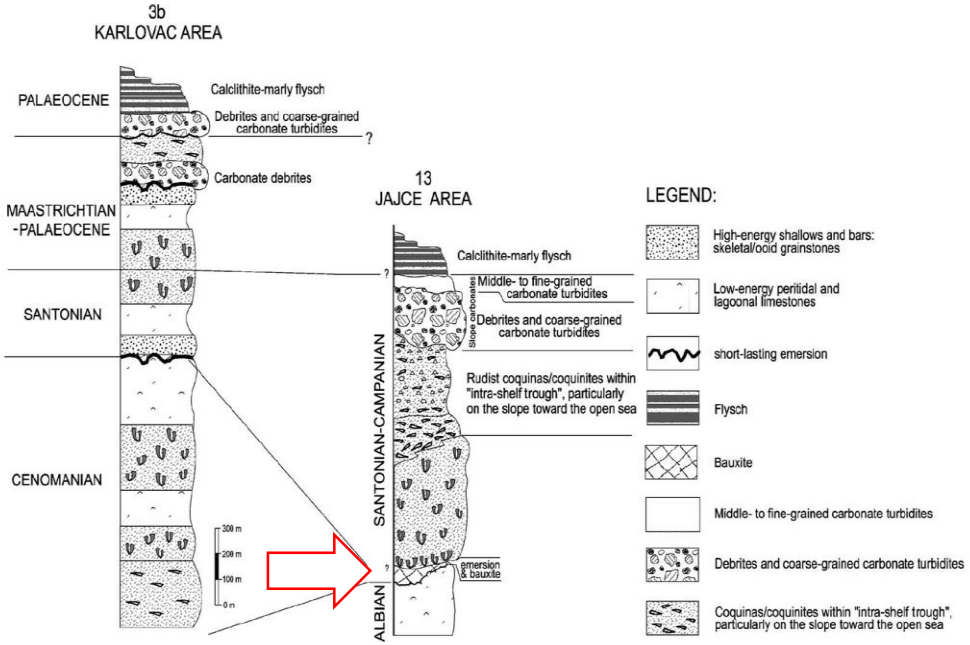
Jajce (BH)

Čardak (BH)

Gazibare–Živkovići deposit

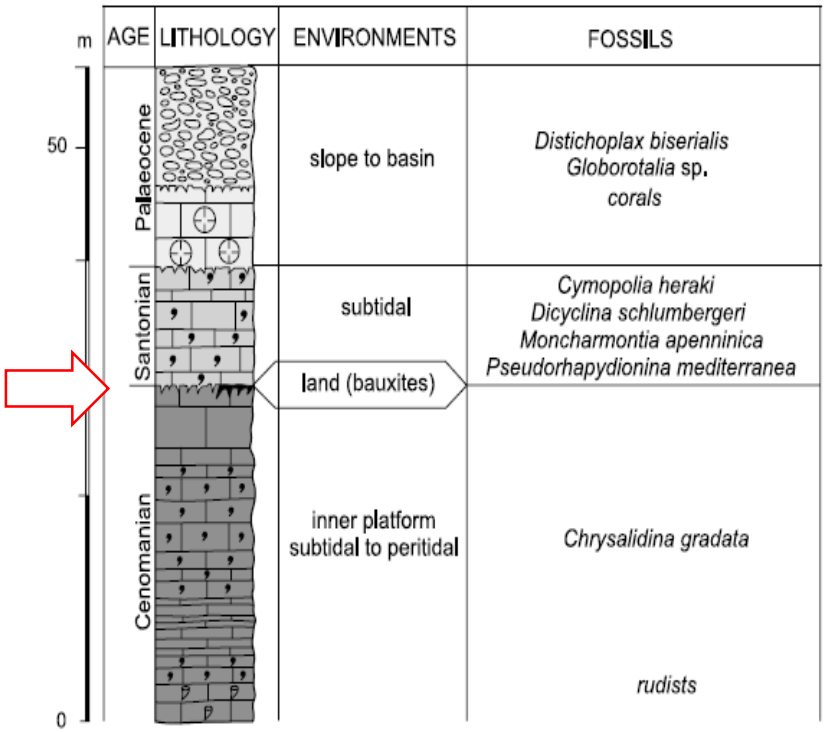


Marković, 2002

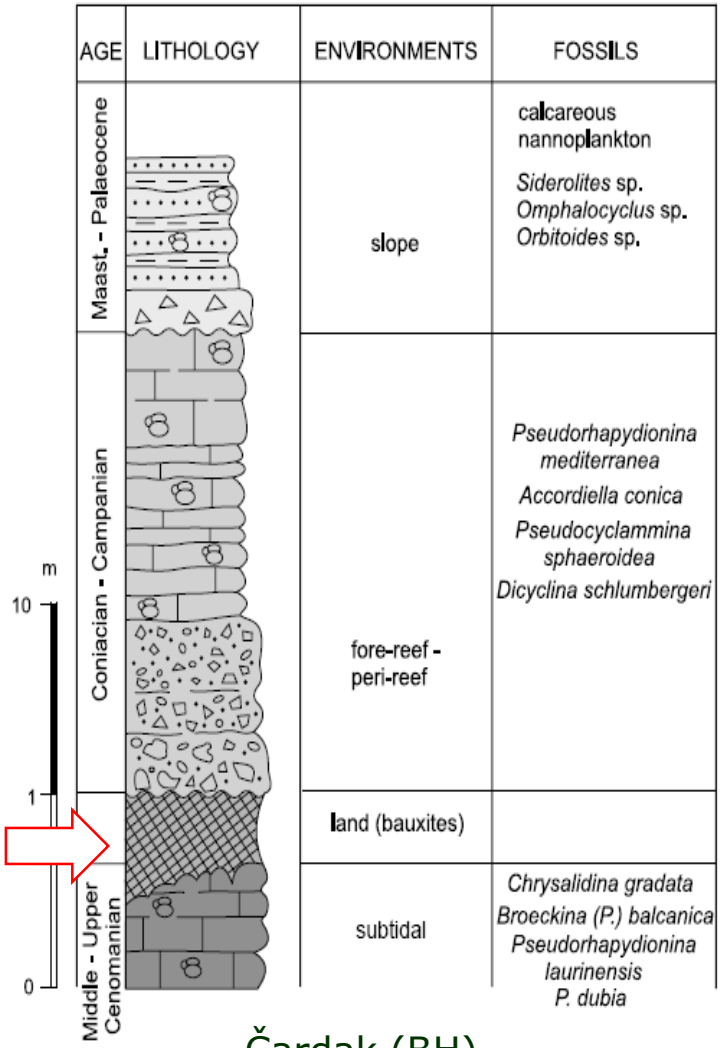


Jajce (BH)

Vlahović et al., 2005

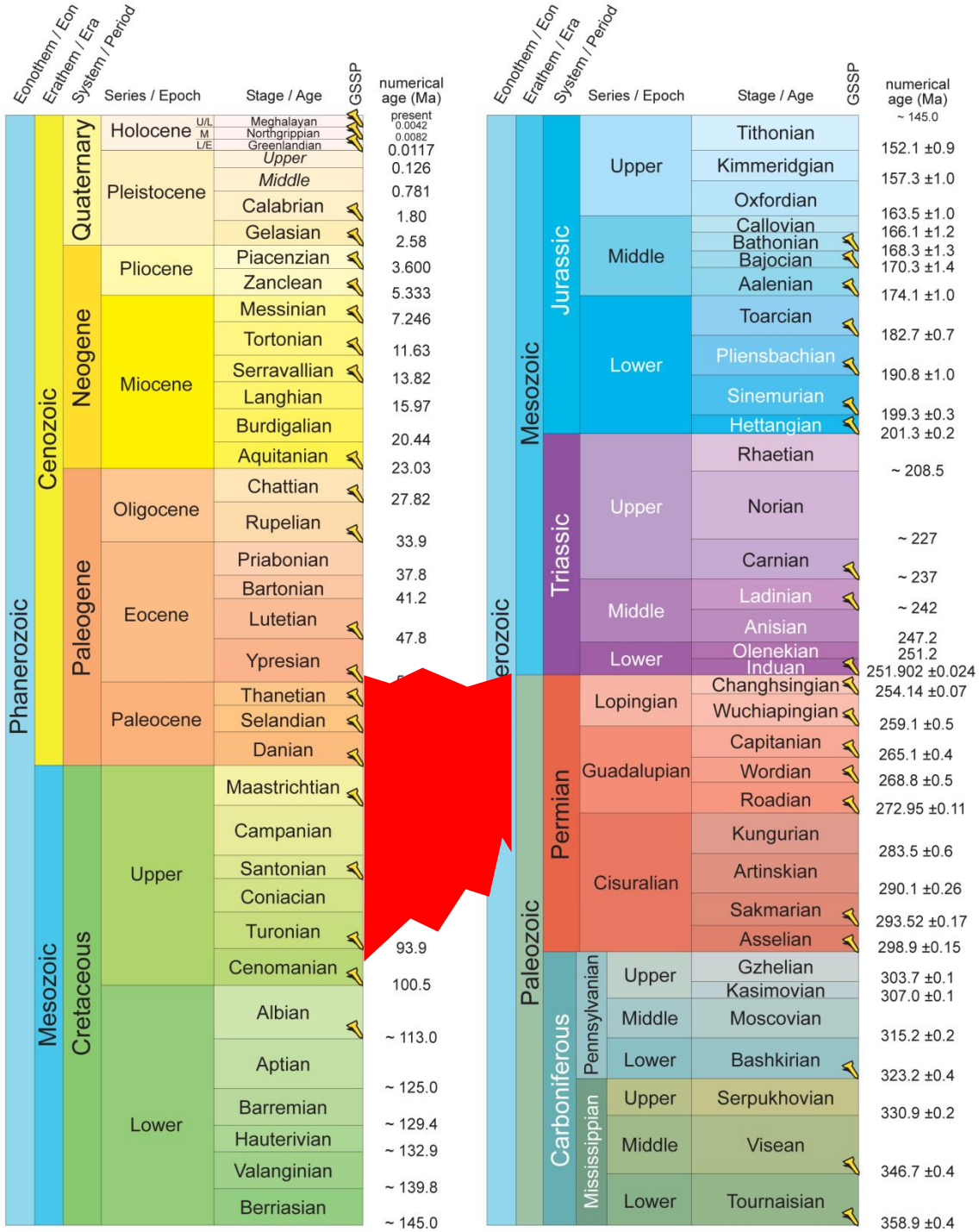


Dubravčani



Čardak (BH)

Dragičević & Velić, 2002



VII – L. Cretaceous / Pc, E_1

Cenomanian–Turonian–
'Senonian' /
Palaeocene(?)–E. Eocene

VII – L. Cretaceous / Pc, E_1

Istra

Bukovica

Promina

Sinj

Imotski

Cres

Lošinj

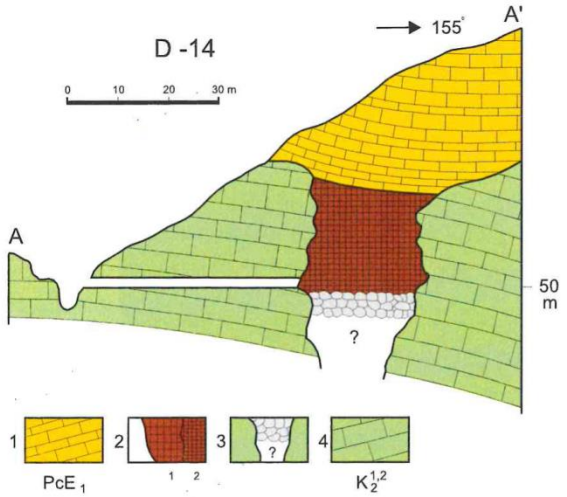
Krk

Rab

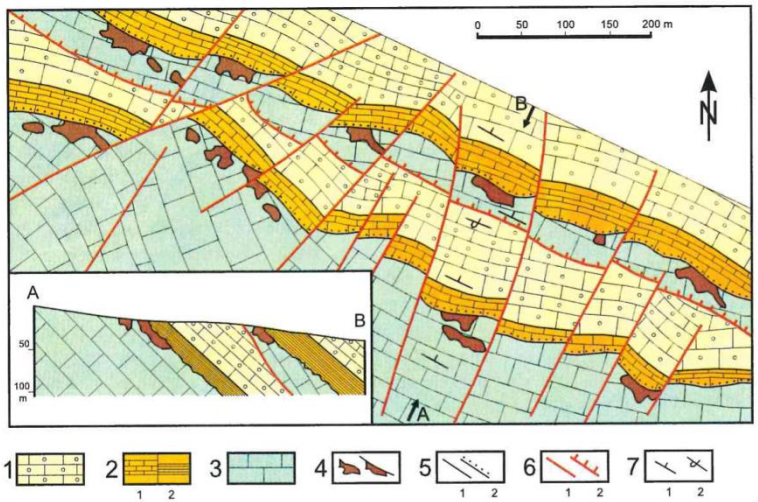
Pag

...

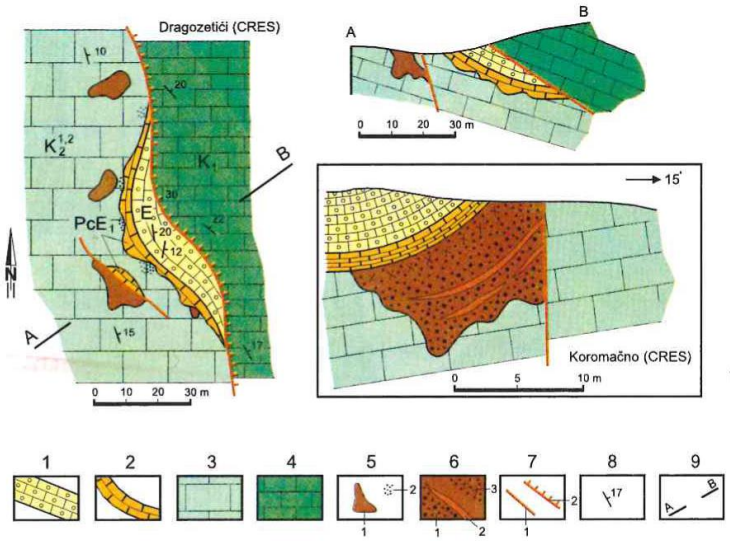
Mirna Valley (Istria)



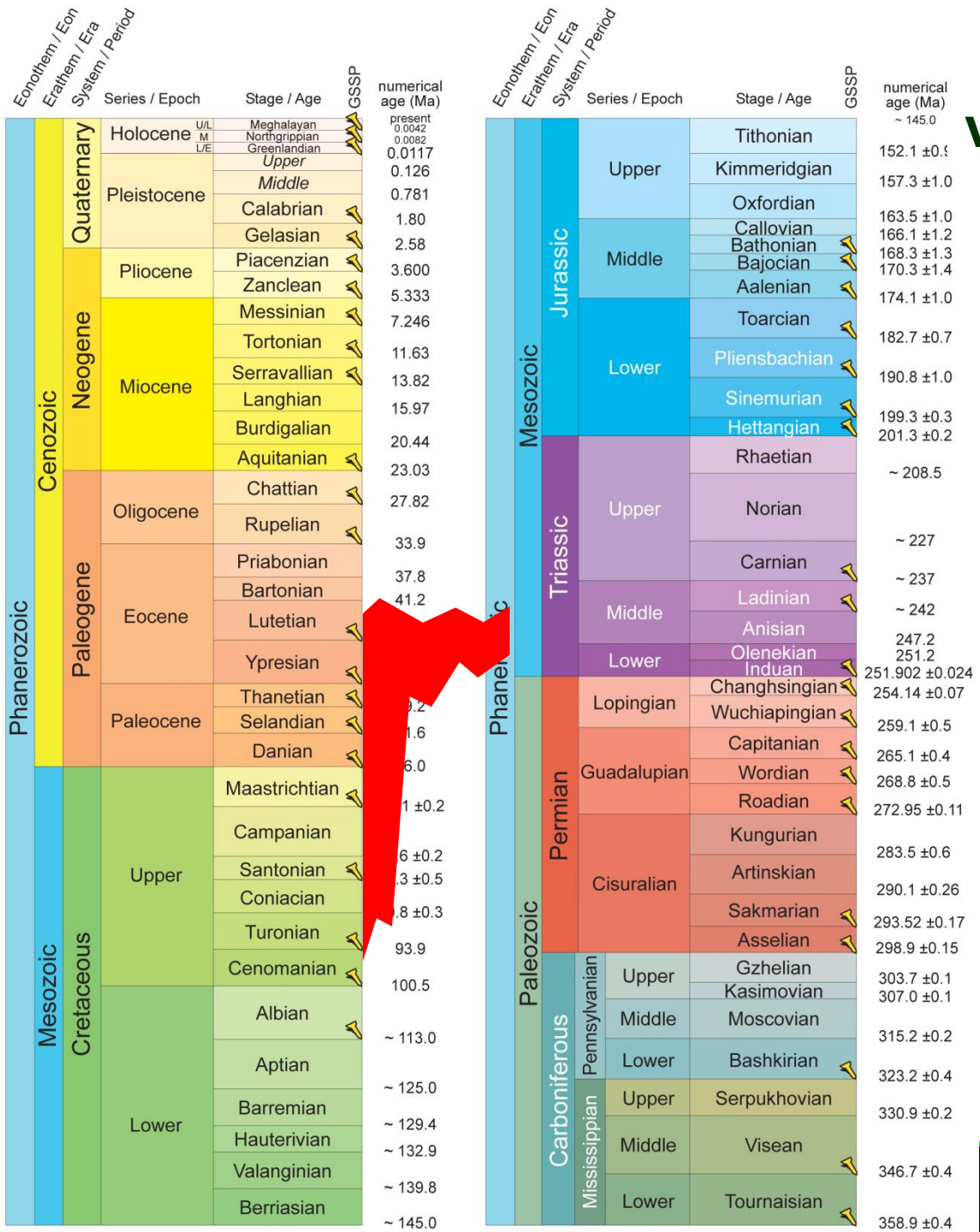
Ričice (Imotski)



Cres Island



Marković, 2002



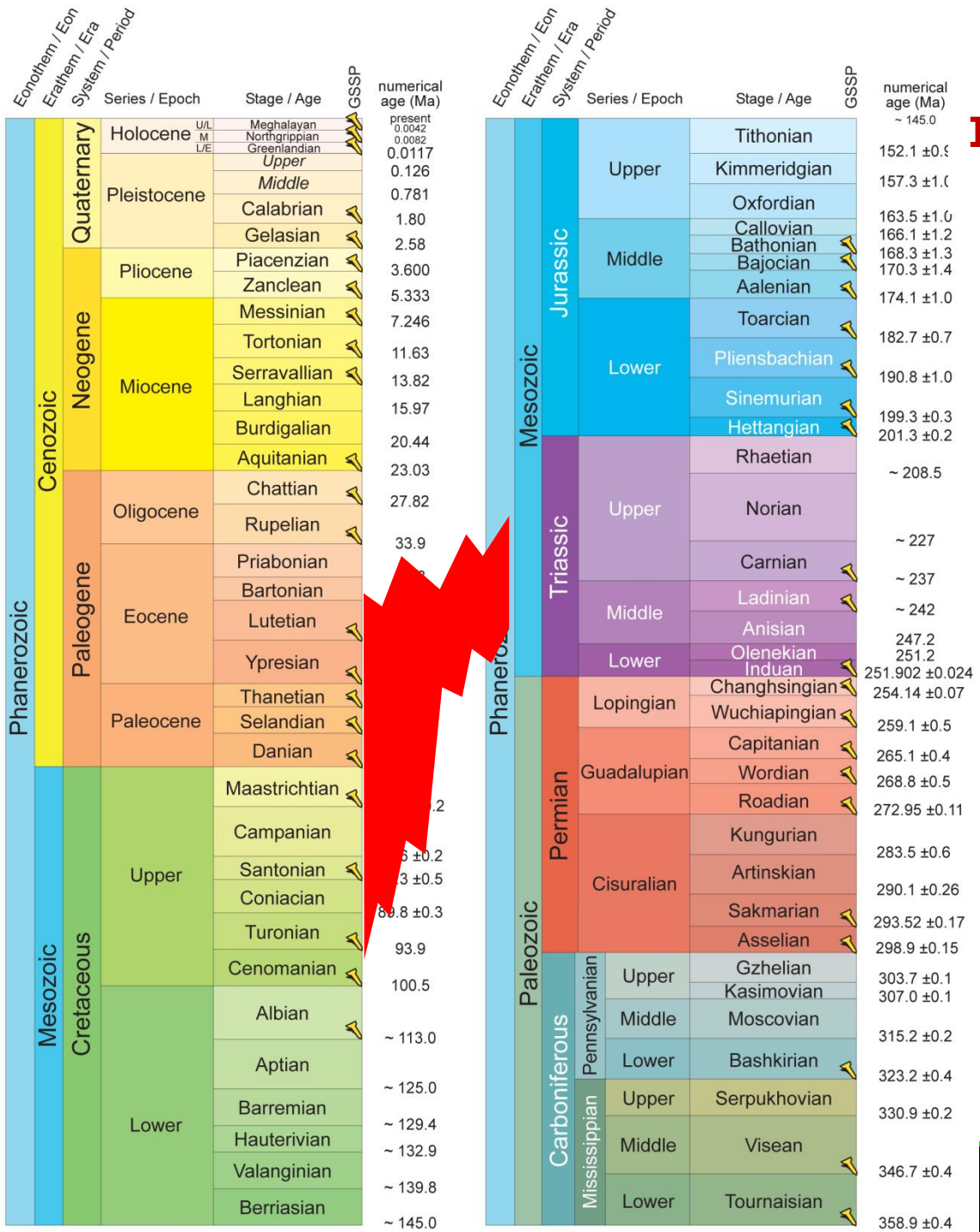
VIII – L. Cretaceous–$E_{1,2}$ / E_2

Cenomanian–Turonian–
E. to M. Eocene /
M. Eocene

VIII – L. Cretaceous–$E_{1,2}$ / E_2

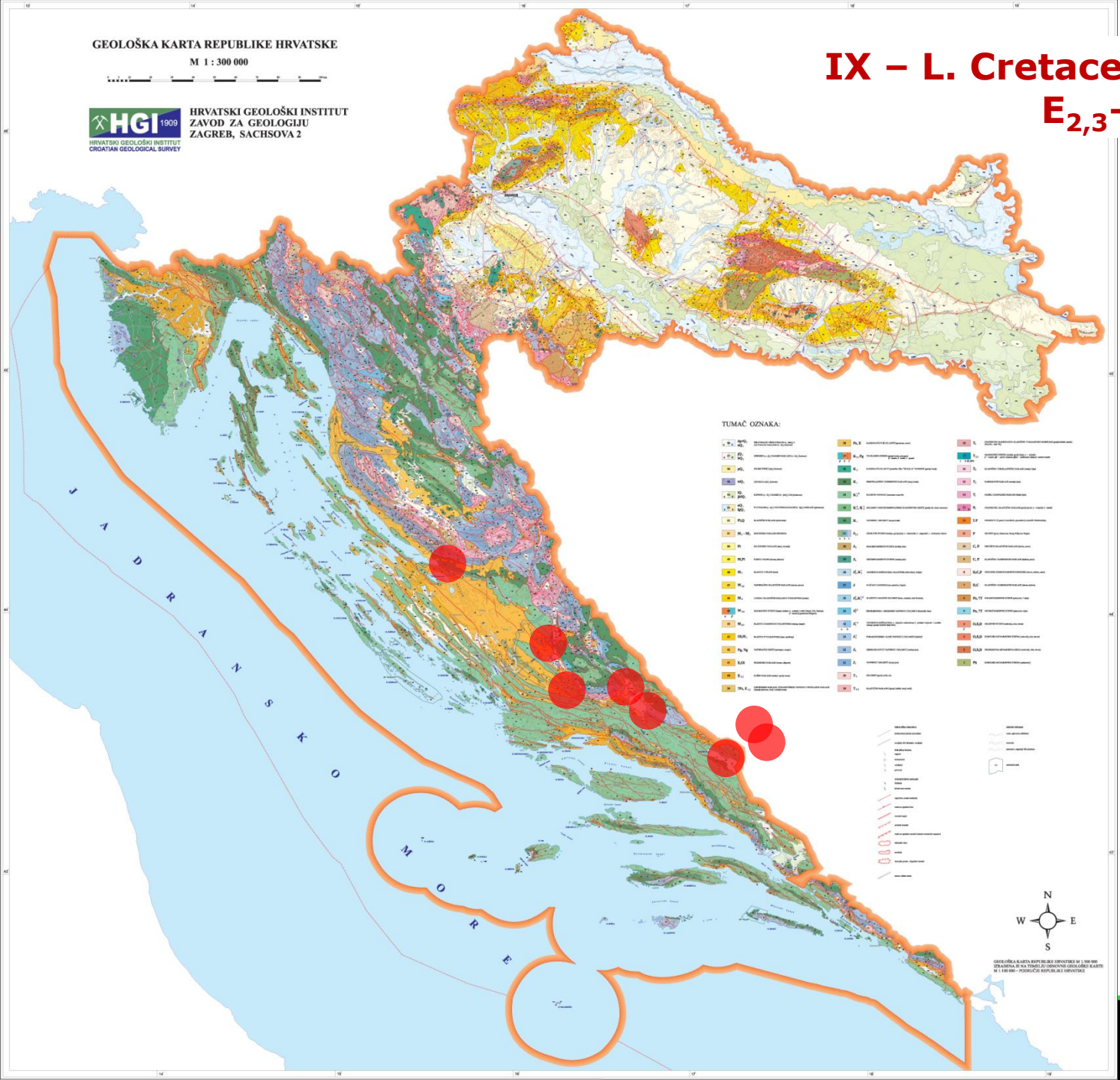
Ervenik

Promina



IX – L. Cretaceous–Pc–$E_{1,2}$ / $E_{2,3}$–Ol_1

Cenomanian–Turonian–
'Senonian'–E. to M. Eocene /
M. to L. Eocene–E. Oligocene



IX – L. Cretaceous–Pc–$E_{1,2}$ / $E_{2,3}$–Ol_1

Obrovac

Drniš

Promina

Moseć

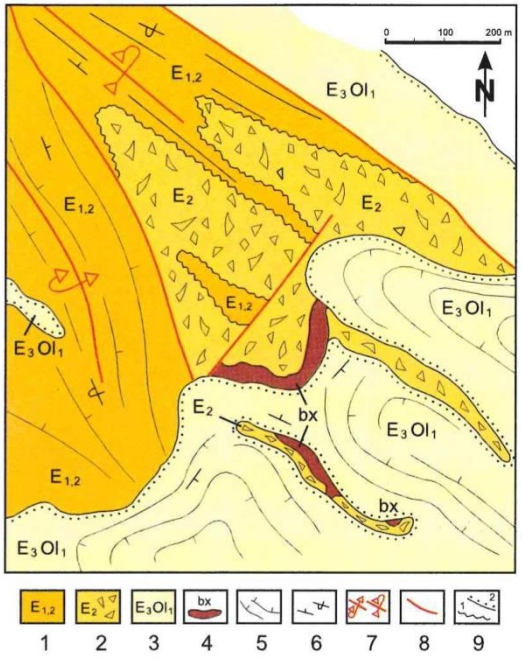
Sinj

Trilj

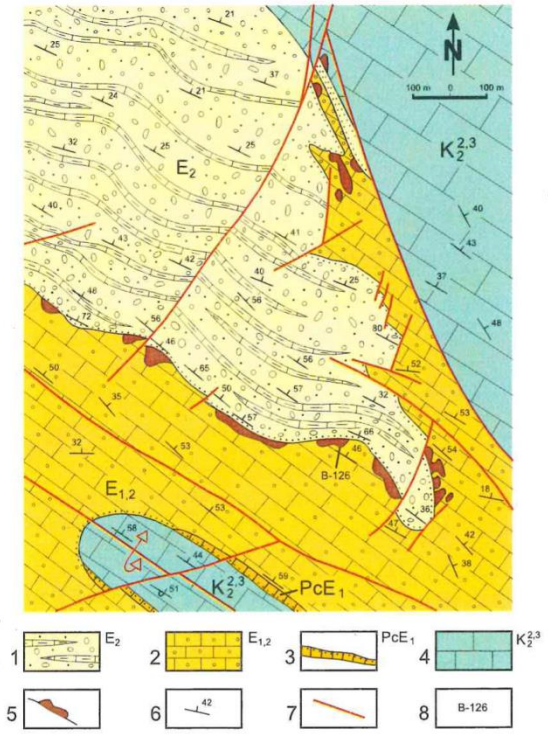
Imotski

Posušje (BH)

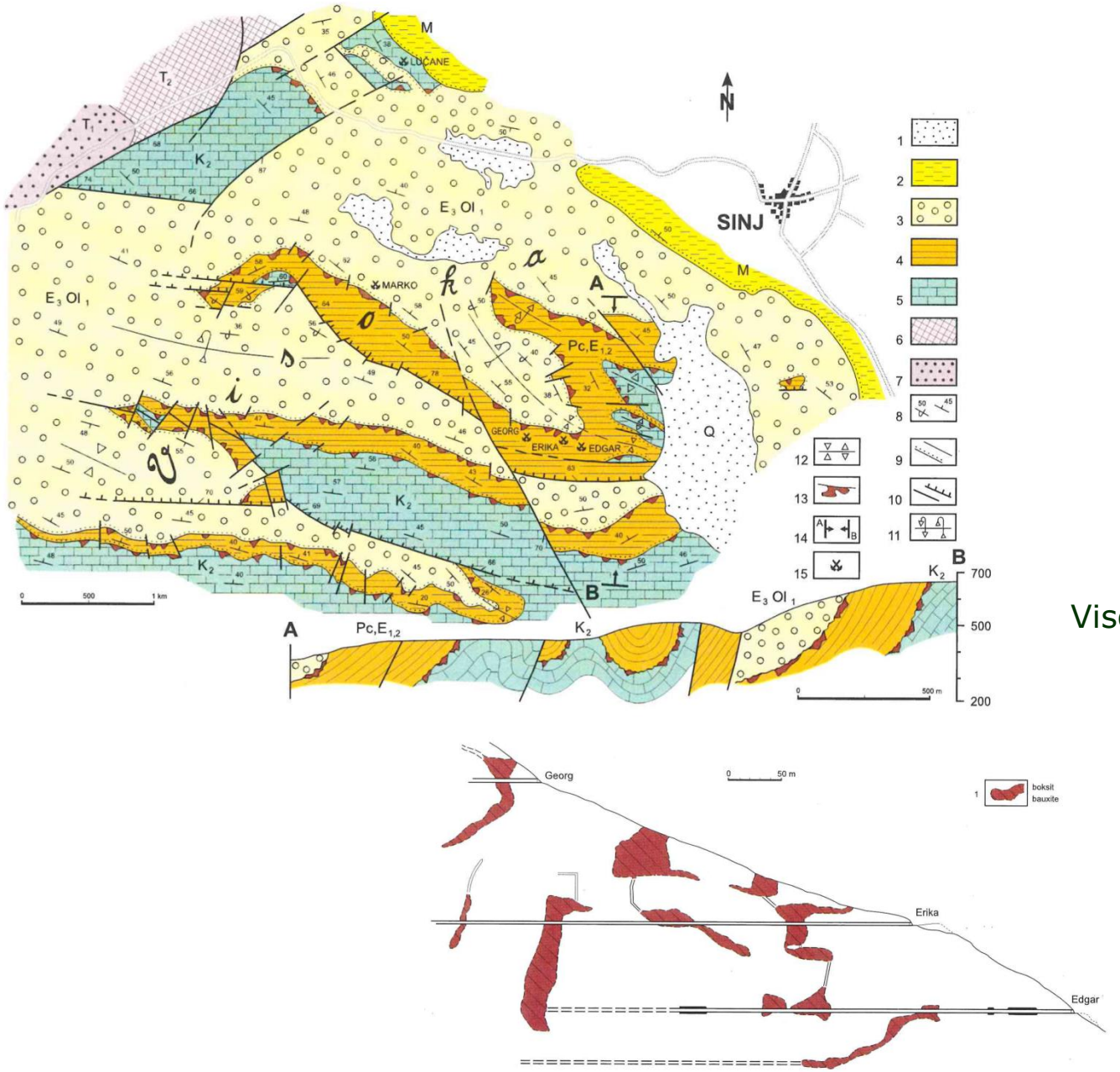
Suknovac Deposit (Drniš)



Kljaka Deposit (Moseć)

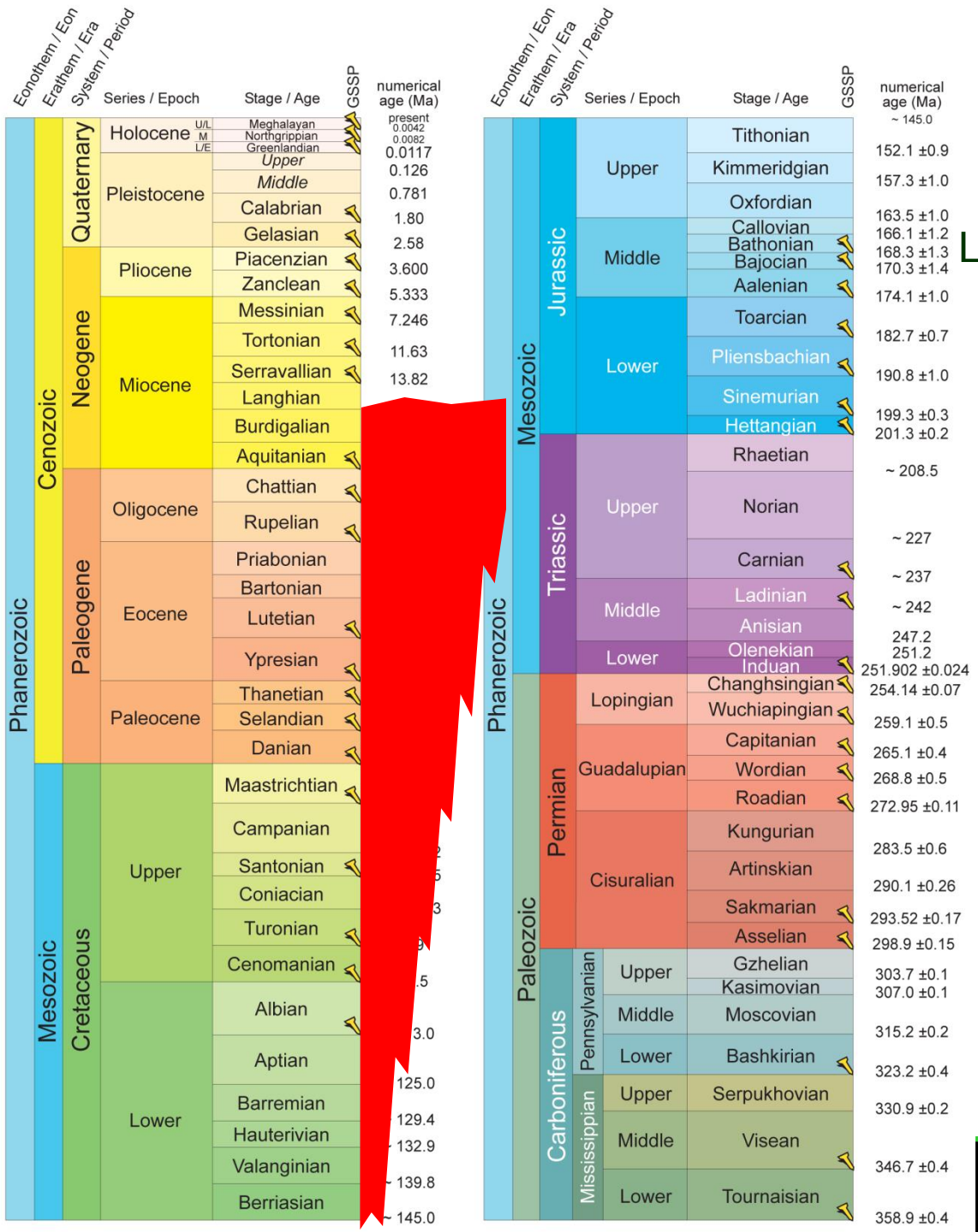


Marković, 2002



Visoka Deposit (Sinj)

Marković, 2002



X – L. Jurassic–E, Ol / M_2

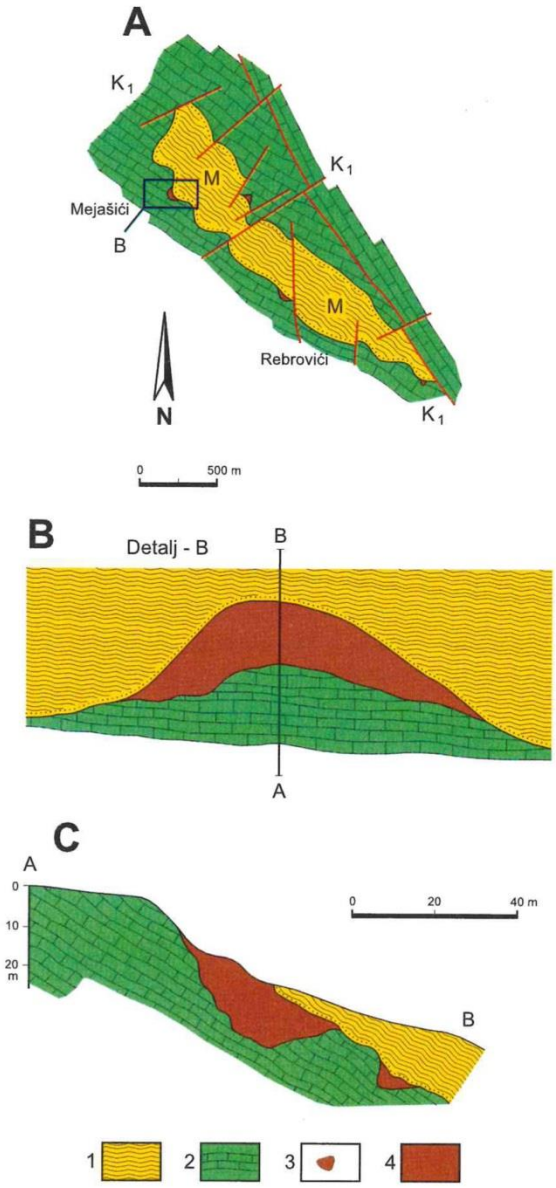
L. Jurassic–Aptian–Cenomanian–Turonian–'Senonian'–Eocene–Oligocene / M. Miocene

X – L. Jurassic–E, Ol / M_2

Tounj

Peruča

Trilj



Mejašići Deposit
(Tounj)

Marković, 2002

Instead of conclusion

In the Croatian part of the External Dinarides bauxite occurrences and deposits may be generally divided into ten horizons, and four of them had economical value.

Several small bauxite occurrences have also been found in the Northern Croatia.

The first bauxite mine in Europe was opened in the Mirna river valley in Istria almost 400 years ago, with the first written record from 1780 and the first scientific discussion published in 1808. Those K/Pg pyritic bauxites were excavated for production of sulphuric acid and later for production of alum used for tanning in the leather industry.

German mineralogist August Breithaupt described in 1847 ***cliachite*** as previously unknown mineral from the Kljaka bauxite deposit near Drniš – this term is still used as a synonym for bauxite (which was described from Le Baux in 1821).

Bauxite was often unofficially cited as the '**Croatian national mineral**'.


Thank you!