THE 8TH SYMPOSIUM OF IGCP 506

MARINE AND NON-MARINE JURASSIC: GLOBAL CORRELATION AND MAJOR GEOLOGICAL EVENTS

University of Bucharest, 28 August - 3 September 2009

ABSTRACTS AND FIELD GUIDE

8th IGCP 506 meeting in Bucharest

Marine and non-marine Jurassic: global correlation and major geological events

28 August – 3 September 2009

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University of Bucharest
Babeş-Bolyai University

8th IGCP 506 meeting in Bucharest
28 August – 3 September 2009

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Organizing Committee
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CONTENTS

8th IGCP 506 meeting in Bucharest
PROGRAMME

28 August 2009:
Location: University of Bucharest, Faculty of Geology and Geophysics, Laboratory of Palaeontology, 1, N. Bălcescu Ave., second floor (see Map 1):

- **12.00-20.00: Registration.**

29 August 2009:
Location: University of Bucharest, Faculty of Geology and Geophysics, Laboratory of Palaeontology, 1, N. Bălcescu Ave., second floor, Amphitheater 2A:

- **09.00-10.15: Salutatio and key lecture**:
  - 09.00-09.45: Salutatio: addresses of organizers and of project leaders;
  - 09.45-10.15: Acad. Mircea Săndulescu, *General outlook of Romanian Geology*;

- **10.15-10.55: Key lecture and scientific talk.** Convenor: Prof. Ioan I. Bucur.
  - 10.15-10.35: Palfy, J., *The Triassic-Jurassic boundary after the votes: prospects and problems of GSSP-based correlation*;
  - 10.35-10.55: Pienkowski, G., Niedzwiedzki, G., Marynowski, L., Waksmundzka, M., *T/J boundary in Poland – global events and biotic turnovers in continental environments*;

- **10.55-11.30: Coffee break**;

- **11.30-12.50: Scientific talks**. Convenor: Dr. Jozsef Palfy.
  - 11.30-11.50: Ishida, K., Yoshioka, M., Hirsch, F., Kozai, T., *The Tsunomine Complex: from oceanic plate to latest Jurassic recycle of accreted materials in southernmost Chichibu Superbelt, SW Japan*;
  - 11.50-12.10: Ishida, K., Tsujino· Y., Kozai, K., Sato, T., Hirsch, F., *The age of radiolarian Kilinora Spiralis Zone: direct correlation with Late Jurassic ammonite faunal succession in the Todoro Section of the Kurisaka Formation, SW Japan*;
  - 12.10-12.30: Meesook, A., *Marine Jurassic rocks of peninsular Thailand: updated lithostratigraphy and paleontology*;
  - 12.30-12.50: Bacon, K., McElwain, J., *Investigation of fossil leaf widths across the Triassic-Jurassic boundary (200 million years ago) and implication for climate*;

- **12.50-14.00: Visiting the Laboratory of Palaeontology.** Guide: Acad. Theodor Neagu**;**

- **14.00-15.00: Lunch break**;
- **15.00-16.20: Scientific talks**. Convenor: Prof. Michal Krobicki.
  - 15.00-15.20: Wierzbowski, A., Schlogl, J., Krobicki, M., *Ammonite stratigraphy of the Jurassic deposits in the Veliky Kamenets section of the Pieniny Klippen Belt (Transcarpathian Ukraine)*

- 15.20-15.40: Bucur, I., Săsăran, E., Iacob, R., Ichim, C., Turi, V., *Upper Jurassic shallow-water carbonate deposits from some Carpathian areas: new micropaleontological results*;
- 15.40-16.00: Lakova, I., Petrova, S., Rabrenovic, D., *Calpionellid biostratigraphy across the Jurassic-Cretaceous boundary in the Western Balkan Mountains (Bulgaria and Serbia)*;
- 16.00-16.20: Skupien, P., *Palynology and palynofacies of Uppermost Jurassic – Lower Cretaceous sediments*

- **16.20-17.10: Coffee break**;

- **17.10-17.50: Scientific talks**. Convenor: Prof. Andrzej Wierzbowski.
  - 17.10-17.30: Lazăr, I., Grădinaru, M., *Fossil assemblages associated with Jurassic hardgrounds from Bucegi Mountains (Eastern Carpathians, Romania)*;
  - 17.30-17.50: Popa, M.E., Kedzior, A., *Lower Jurassic continental formations of the South Carpathians, Romania.*

- **17.50-19.00: Downtown walk in Bucharest**. Guide: Assoc.Prof. Mihai E. Popa**;**

Location: University of Bucharest, University House Restaurant ("Casa Universitarilor"), 14, Dionisie Lupu Str.:

- **19.00-22.00: Dinner.**

30 August 2009
Location: University of Bucharest, Faculty of Geology and Geophysics, Laboratory of Palaeontology, 1, N. Bălcescu Ave., second floor, Amphitheater 2A:

- **09.00-10.20: Scientific talks.** Convenor: Prof. Keisuke Ishida.
  - 09.00-09.20: Lazăr, I., Sandy, M., Grigore, D. Panaiotu, C. *Taxonomy, paleoecology and paleobiogeographical significance of the Lacunosella brachiopod assemblage from Upper Jurassic of Hasmas Mountains (Eastern Carpathians, Romania)*;
  - 09.20-09.40: Tomas, R., Palfy, J., *Early Jurassic ammonites from the Persani Mountains (Eastern Carpathians, Romania)*;
  - 09.40-10.00: Grigore, D., Stoica, M., Lazăr, I., Sandy, M., Gheuca, I., *Late Jurassic fossil assemblages from the Ghilcoş Mountains (Eastern Carpathians, Romania) an exquisite paleontological site*;
  - 10.00-10.20: Chellai, E.H., *The central High Atlas, Morocco Jurassic system: a new data*;

- **10.20-10.40: Coffee break;**

- **10.40-12.00: Conclusions**. Convenor: Prof. Grzegorz Pienkowski
  - 10.40-12.00: Conclusions and free discussions.

12.00-14.00: Lunch break;

- 14.00-14.30: Trip to the National Museum of Geology, by subway.

Location: National Museum of Geology, Geological Institute of Romania, 2, Kisseleff Ave.

- **14.30-16.30: Visiting the National Museum of Geology.**

31 August 2009
First day of the fieldtrip: driving to the South Carpathians. Gathering point: University of Bucharest, Faculty of Geology and Geophysics, in the inner court of the University. Itinerary: Bucharest – Piteşti – Craiova – Beharca – Turnu-Severin (see Map 2).

- 08.00-08.30: Gathering
- 08.30: Departure for Turnu-Severin;
- 12.00-13.00: Romanian lunch in Beharca, "Carul cu stele" Restaurant, trip to Dubova;
- 19.00: Arrival in Turnu Severin (Gura Văii), at the Continental Motel;
- 20.00-22.00: Dinner at the Continental Motel Restaurant.

1 September 2009
Second day of the fieldtrip: the Danube Gorges. Gathering point: front of the Cotinental Motel. Itinerary along the Danube Gorges: Turnu-Severin – Orşova – Dubova – Svinița – Cozla – Moldova Nouă- Oravița.

- 08.00-08.45: Breakfast, Continental Motel Restaurant;
- 08.45-09.00: Gathering in front of the Continental Motel;
- 09.00-12.00: Fieldtrip;
- 12.00-13.00: Lunch in the field (lunch bag);
- 13.00-20.00: Fieldtrip.
- 20.00: Arrival in Oravița, 7 Fir Trees Chalet.
- 21.00-22.00: Dinner, 7 Fir Trees Chalet Restaurant.

2 September 2009
Third day of the fieldtrip: the Reşița Basin. Gathering point: front of the 7 Fir Trees Chalet. Itinerary: Oravița – Anina – Caraşova – Anina – Miniş Gorges – Oravița.

- 07.30-08.30: Breakfast, 7 Fir Trees Chalet Restaurant;
- 08.30-08.45: Gathering in front of 7 Fir Trees Chalet;
- 08.45-09.30: Driving to Anina (Steierdorf)
- 09.30-10.00: Meeting with officials in Anina (Steierdorf);
- 10.00-12.00: Fieldtrip;
- 12.00-13.00: Lunch in the field (lunch bag);
- 13.00-20.00: Fieldtrip.
- 20.00: Arrival in Oravița, Arrival in Oravița, 7 Fir Trees Chalet.
- 21.00-22.00: Dinner, 7 Fir Trees Chalet Restaurant.

3 September 2009

Fourth day of the fieldtrip: driving back to Bucharest. Gathering point: front of the 7 Fir Trees Chalet. Itinerary: Oravița – Anina – Bozovici – Orşova – Turnu-Severin – Craiova – Bucharest.

- 07.30-08.30: Breakfast, 7 Fir Trees Chalet Restaurant;
- 08.30-08.45: Gathering in front of 7 Fir Trees Chalet;
- 08.45-12.00: Driving to Bucharest;
- 12.00-13.00: Lunch in the field (lunch bag);
- 13.00-18.30: Driving to Bucharest.
- 18.30: Arrival in Bucharest, inner court of the University of Bucharest.

Brief schedule (Bucharest)

29 August 2009

Interval	Range	Talks	Authors	Conveners
09.00-10.15	75 min	- salutatio - 1 key lecture	- group address - Săndulescu	
10.15-10.55	40 min	- 1 key lecture - 1 talk	- Palfy - Pienkowski	Bucur
10.55-11.30	35 min	Coffee break		
11.30-12.50	80 min	- 4 talks	- Ishida 1 - Ishida 2 - Meesook - Bacon	Palfy
12.50-14.00	70 min	Laboratory visit		
14.00-15.00	60 min	Lunch		
15.00-16.20	80 min	- 4 talks	- Wierzbowski - Bucur - Lakova - Skupien	Krobicki
16.20-17.10	30 min	Coffee break		
17.10-17.50	40 min	- 2 talks	- Lazăr 1 - Popa	Wierzbowski
17.50-19.00	70 min	Downtown walk		
19.00-22.00	120 min	Dinner		

30 August 2009

Interval	Range	Talks	Authors	Conveners
09.00-10.20	80 min	- 4 talks	- Lazăr 2 - Tomas - Grigore - Chellai	Ishida
10.20-10.40	20 min	Coffee break		
10.40-12.00	60 min	- discussions - conclusions	- Free discussions and conclusions	Pienkowski
12.00-14.00	120 min	Lunch		
14.00-14.30	30 min	Trip to Museum		
14.30-16.30	120 min	Museum visit		

List of participants to the 8th IGCP 506 meeting in Bucharest

No	Last name	First name	Affiliation	Abstract
1	Bacon	Karen	University College Dublin, Ireland	Bacon, K., McElwain, J., *Investigation of fossil leaf widths across the Triassic-Jurassic boundary (200 million years ago) and implication for climate*
2	Bucur	Ioan	Babes-Bolyai University, Cluj-Napoca, Romania	Bucur, I., Săsăran, E., Iacob, R., Ichim, C., Turi, V., *Upper Jurassic shallow-water carbonate deposits from some Carpathian areas: new micropaleontological results*
3	Chellai	El-Hassane	Cadi Ayyad University, Marrakech	Chellai, E.H., *The central High Atlas, Morocco Jurassic system: a new data*
4	Grigore	Dan	Geological institute of Romania	Grigore, D., Stoica, M., Lazăr, I., Sandy, M., Gheuca, I., *Late Jurassic fossil assemblages from the Ghilcoş Mountains (Eastern Carpathians, Romania) an exquisite paleontological site*
5	Ishida	Keisuke	Tokushima University, Tokushima, Japan	Ishida, K., Yoshioka, M., Hirsch, F., Kozai, T., *The Tsunomine Complex: from oceanic plate to latest Jurassic recycle of accreted materials in southernmost Chichibu Superbelt, SW Japan* Ishida, K., Tsujino, Y., Kozai, K., Sato, T., Hirsch, F., *The age of radiolarian Kilinora Spiralis Zone: direct correlation with Late Jurassic ammonite faunal succession in the Todoro Section of the Kurisaka Formation, SW Japan*
6	Ishida	Akira	Tokushima University, Tokushima, Japan	Student
7	Kedzior	Artur	Institute of Geological Sciences, Polish Academy of Sciences, Krakow, Poland	Popa, M.E., Kedzior, A., *Lower Jurassic continental formations of the South Carpathians, Romania*
8	Krobicki	Michal	AGH University of Science and Technology, Krakow, Poland	Wierbowski, A., Schlogl, J., Krobicki, M., *Ammonite stratigraphy of the Jurassic deposits in the Veliky Kamenets section of the Pieniny Klippen Belt (Transcarpathian Ukraine)*
9	Lakova	Iskra	Geological Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria	Lakova, I., Petrova, S., Rabrenovic, D., *Calpionellid biostratigraphy across the Jurassic-Cretaceous boundary in the Western Balkan Mountains (Bulgaria and Serbia)*

10	Lazăr	Iulia	University of Bucharest, Bucharest, Romania	Lazăr, I., Grădinaru, M., *Fossil assemblages associated the Jurassic hardgrounds from Bucegi Mountains (Eastern Carpathians, Romania)* Lazăr, I., Sandy, M., Grigore, Panaiotu, C. *Taxonomy, paleoecology and paleobiogeographical significance of the Lacunosella brachiopod assemblage from Upper Jurassic of Hasmas Mountains (Eastern Carpathians, Romania)*
11	Meesook	Assanee	Bureau of Geological Survey, Bangkok, Thailand	Meesook, A., *Marine Jurassic rocks of peninsular Thailand: updated lithostratigraphy and paleontology*
12	Palfy	Jozsef	Hungarian Museum of Natural History, Budapest, Hungary	Palfy, J., *The Triassic-Jurassic boundary after the votes: prospects and problems of GSSP-based correlation* Tomas, R., Palfy, J., *Early Jurassic ammonites from the Persani Mountains (Eastern Carpathians, Romania)*
13	Pienkowski	Gregory	Polish Geological Institue, Warsawa, Poland	Pienkowski, G., Niedzwiedzki, G., Marynowski, L., Waksmundzka, M., *T/J boundary in Poland – global events and biotic turnovers in continental environment*
14	Popa	Mihai	University of Bucharest, Bucharest, Romania	Popa, M.E., Kedzior, A., *Lower Jurassic continental formations of the South Carpathians, Romania*;
15	Sandulescu	Mircea	University of Bucharest, Bucharest, Romania	Săndulescu, M., *General outlook of Romanian Geology*
15	Skupien	Petr	Institute of Geological Engineering, Technical University Ostrava, Ostrava, Czech Republic	Skupien, P., *Palynology and palynofacies of Uppermost Jurassic – Lower Cretaceous sediments*
16	Tomas	Robert	Upstreamers Energy Ltd., Sfantu Gheorghe, Romania	Tomas, R., Palfy, J., *Early Jurassic ammonites from the Perşani Mountains (Eastern Carpathians, Romania)*
17	Wierzbowski	Andrzej	University of Warsaw, Warsaw, Poland	Wierzbowski, A., Schlogl, J., Krobicki, M., *Ammonite stratigraphy of the Jurassic deposits in the Veliky Kamenets section of the Pieniny Klippen Belt (Transcarpathian Ukraine)*

ABSTRACTS

INVESTIGATION OF FOSSIL LEAF WIDTHS ACROSS THE TRIASSIC–JURASSIC BOUNDARY (200 MILLION YEARS AGO) AND IMPLICATIONS FOR CLIMATE

Bacon, K.L.[1] and McElwain, J.C.[1]

[1]University College Dublin, School of Biology and Environmental Sciences, Science Education and Research Centre West, Belfield, Dublin 4, Ireland, karenl.bacon@gmail.com

Leaf widths provide a useful method for determining the maximum temperature regime that a plant was exposed to during its life. Plant widths have been shown to express a relationship to climatic conditions because with increasing temperatures, plants tend to either increase leaf dissection or decrease leaf area to compensate for near-lethal internal temperatures. This investigation focuses on determining the variation in leaf widths for a range of plant taxa from Jameson Land East Greenland across the Triassic–Jurassic boundary (TJB) and on how such variations may reflect changes in climate at the time. Previous work found that plants decreased in leaf area and increased in leaf width, in line with this thermal leaf damage hypothesis, across the TJB, which represents a period of significant global warming in Earth history. The current analysis represents a much higher resolution study from census-collected fossil plants from Astartekløft, East Greenland. Over 4,500 measurements of bennettites, conifers, ferns and ginkophytes were taken, and the findings from this investigation will be presented. The focus of this investigation will be the canopy and sub-canopy taxa as these are the plants most likely to have to cope with rising temperatures and increased potential heat damage.

UPPER JURASSIC SHALLOW-WATER CARBONATE DEPOSITS FROM SOME CARPATHIAN AREAS: NEW MICROPALEONTOLOGICAL RESULTS

Bucur, I.I.[1], Săsăran, E. [1], Iacob, R. [1], Ichim, C. [1] and Turi, V. [1]

[1]Babeş-Bolyai University, Department of Geology, str. M. Kogălniceanu nr.1, 400084, Cluj-Napoca; ibucur@bioge.ubbcluj.ro

The researche carried out during the last years on the shallow-water carbonate deposits from some Romanian Carpathian areas resulted in new paleontological, biostratigraphical and carrtographical data. We present here two of these areas: Piatra Craiului massif, belonging to the eastern end of the Getic carbonate platform from the South Carpathians, and Hodobana area in Bihor Mountains, part of the Jurassic carbonate platform of the Bihor-Pădurea Craiului unit.

In the Piatra Craiului massif several sections were sampled on the north-western flank of the mountain, through the so called “white massif” limestones: 1. Padinile Frumoase-Varful Ascuțit – Brâul Ciorânga Mare; 2. Padina Popii; 3. Curmătura-Varful Turnu; 4. Lanțuri-Vârful La Om

These limestones are set in a shallowing upward megasequence, starting with slope deposits, followed by reffal limestone (mainly microbialites and diverse encrusting facies, and less coral and sponge boundstones), peritidal limestone (mainly subtidal-intertidal, including large fenestral successions), and ending with intertidal-supratidal deposits. The age

of this succession was, and still remains, in debate. Our reserche in the last years brings several developments in this respect. The micropaleontological assemblage identified in thin sections is represented by:

1. Calcareous algae and rivulariacean-typecyanobacteria (*Campbelliella striata*, *Clypeina sulcata*, *Clypeina parasolkani*, *Salpingoporella annulata*, *Salpingoporella pygmaea*, *Selliporella neocomiensis*, *Nipponophycus ramosus*, *Thaumatoporella parvovesiculifera*, *Diversocallis dianae*).
2. Foraminifera (*Anchispirociclyna lusitanica*, *Andersenolina alpina*, *Mohlerina basiliensis*, *Pfenderina neocomiensis, Protopeneroplis striata*, *Protopeneroplis ultragranulata*, *Belorisiella* sp., *Charentia* sp., *Coscinophragma* sp., *Everticyclammina* sp., *Haplophragmoides* sp, *Lenticulina* sp., *Montsalevia/Vercorsella* sp., *Nautiloculina* sp.
3. Microprobelatica (*Bacinella irregularis*, *Crescentiella morronensis*, *Lithocodium aggregatum*, *Mercierella dacica*, *Radiomura cautica*, *Terebella* sp.).

Some of the microfossils from this assemblage are important biostratigraphically and represent arguments fro the presence of the Berriasian (and even the Lower Valanginian) in the upper part of the succession.

Anchispirocyclina lusitanica is characteristic for Upper Tithonian – Lower Berriasian. *Clypeina parasolkani*, *Selliporella neocomiensis*, *Pfenderina neocomiensis*, *Protopeneroplis ultragranulata*, *Montsalevia/Vercorsella* sp. are also microfossils characteristic for Berriasian-Lower Valanginian, and constitute new arguments that in the northen part of the Piatra Craiului massif the carbonate platform sedimentation was continue at least until the Lower Valanginian.

In the Bihor Mountains the investigations were made near Hodobana locality. The limestone in this region contain a micropaleontological assemblage represented by:

1. Calcareous algae (*Campbelliella striata*, *Clypeina sulcata*, S*alpingoporella annulata*, *Salpingoporella pygmaea*, *Salpingoporella* sp., *Nipponophycus ramosus, Thaumatoporella parvovesiculifera*, "*Solenopora*" sp., and rivulariacean-type cyanobacteria).
2. Foraminifera (*Andersenolina alpina*, *Kurnubia palastiniensis, Labyrinthina mirabilis, Mohlerina basiliensis, Neokilianina rahonensis, Parurgonina caelinensis, Pseudocyclammina lituus, Redmondoides lugeoni,* ?*Alveosepta* sp., *Charentia* sp., *Coscinophragma* sp., *Everticyclammina* sp.
3. Microproblematica (*Bacinella irregularis, Crescentiella morronensis, Lithocodium aggregatum*).

The whole assemblage is typical for the Upper Jurassic carbonate platform deposits in the Tethyan realm. Some foraminifera (*Kurnubia palastiniensis, Labyrinthina mirabilis, Neokilianina rahonensis* and *Parurgonina caelinensis*) point mainly on Kimmeridgian-Early Tithonian time interval.

We also have to note that the correct age determination of some outcropping areas with Jurassic limestones made some corrections on the geological map of the region.

LATE JURASSIC FOSSIL ASSEMBLAGES FROM THE GHILCOŞ MOUNTAINS (EASTERN CARPATHIANS, ROMANIA) AN EXQUISITE PALEONTOLOGICAL SITE

Grigore, D.[1], Stoica, M.[2], Lazăr, I.[2], Sandy, M.[3] and Gheucă, I.[1]

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[2]Department of Geology and Paleontology, Faculty of Geology and Geophysics, University of Bucharest, 1 N. Balcescu Street, 010041 Bucharest, Romania;
[3]Department of Geology, University of Dayton, Dayton, Ohio 45469-2364.

The famous site from the Ghilcoş Mts. discovered by Franz Herbich in 1866 and well studied by M. Neumayr (1873) and later by other scientists (Vadasz, 1915, Jekelius, 1921, Patrulius, 1969, Preda, 1973, Turculet, 1980) was named in "The Jurassic of the World" by Arkell (1956) as an important location for the Kimmeridgian Stage.

Strangely this site is not declared paleontological reservation until these days.

In the last 20 years this site was studied more systematically (Grigore, 1996, 2000, 2002) and in a complex way (integrated studies) in the GEOBIOHAS Project (founded by CNMP, Romania) by a working group including the authors.

Some of the results of this research established a distribution of outcrops which contain a very rich ammonite fauna and other faunas. Many detailed profiles consisting of different lithologies with the same faunal content, confirm the entire Kimmeridgian and the Lower Tithonianin part for these deposits.

The exposures of these deposits are located in the western and north-western side of the Ghilcoş Mts. Here are two types of outcrops: one, represented by the western walls of Ghilcoş, where the Upper Jurassic deposits are affected by transversal faults with some lateral differences in lithology the second, represented by an area with big blocks possibly slipped on the north-western slope of this mountain. These blocks seem to be relicts of a destroyed second lithofacies of the same age, which doesn't comprise red nodular limestones in the lower part of the suite as there are in the walls. Here, there are presented many studied profiles of this area and a detailed map of outcrops.

The ammonite assemblages confirm the following zones: *Platynota, Hypselocyclum/Strombecki* and *Divisum* for the Lower Kimmeridgian; *Acanthicum, Eudoxus* and *Beckeri* for the Upper Kimmeridgian and *Hybonotum, Vimineus, Semiforme* and *Fallauxi* for the Lower Tithonian (Grigore, 2000, 2002 Ph.D. thesis and 2009 in press). At this time there are 175 ammonite taxa counted (from 113 evaluated in 1980 by Turculeț) in this site; besides the ammonites we recently evaluated the other fossils present in these deposits and their biostratigraphic distribution which are presented here.

The terebratulid *Pygope janitor* (Pictet) is very frequent from the top of the Eudoxus zone to the Vimineus zone (i.e. on the Kimmeridgian-Tithonian boundary); from the same fossil assemblage are recorded *Nucleata nucleata* (Schlotheim), bivalves (*Entolium, Ostrea, Cuspidaria, Pleurmya* species), gastropods (*Trochotoma*), regular and irregular echinoids (*Cidaris, Collyrites*), crinoids, sponges (*Chenendropora herbichi* Neumayr), belemnites (*Conobelus benekei* Neumayr, species of *Neohibolites*), apthychi (*Lamellaptychus* and *Laevaptychus* taxa) and micro-fossils (some agglutinated). Also, in the Lower Tithonian siliciclastic layers are discovered plants debris (Zamitidae).

Now, more than 230 taxa of invertebrates from this site are known.

THE TSUNOMINE COMPLEX: FORM OCEANIC-PLATE TO LATEST JURASSIC RECYCLE OF ACCRETED MATERIALS IN SOUTHERNMOST CHICHIBU SUPERBELT, SW JAPAN

Ishida[1], K., Yoshioka, M.[1], Hirsch, F.[2] and Kozai, T.[2]

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Rock-fragments of the same origin were dispersed over many hundreds of kilometers, as in the case of the Jurassic-Early Cretaceous accretionary complex (AC) of Japan in Honshu, Shikoku and Kyushu. The Late Jurassic AC of the southernmost South Chichibu Belt in the Outer Zone encompasses the Sambosan Terrane (Matsuoka and Yao, 1990) or Tsunomine Subbelt (Ishida and Kozai, 2003). It is characterized by oceanic submarine basalts, atoll-type limestones, pelagic-limestones and bedded cherts of the Panthalassan low paleo-latitude origin. It also represents a remnant of distal edge of the Izanami Plateau (Hirsch and Ishida, 2002), a kind of seamount swarm on the Izanagi Plate (Isozaki, 1997). The generality and particularity are witnessed in the Tsunomine Complex.

The Tsunomine Complex has an episode that the Triassic limestones were quarried as “marbles” in East Shikoku. Its polished slabs decorate the inside of the Japanese National Diet Building in Tokyo, exhibiting facies and fauna of the carbonates characteristic of the complex (Ishida et al., 2004, 2008). The Tsunomine Complex of its lower part encompasses typical oceanic-plate sequences (OPS) as blocks in the accretionary tectonic mélange, whereas the recycles of accreted materials are characteristic in Late Jurassic-earliest Cretaceous fore-arc basin deposits as an olistostrome.

The fore-arc basin olistostrome also contains latest Jurassic- earliest Cretaceous continental-shelf bituminous limestones (Torinosu-type). The meaning of this limestone unit together with the blocks of pelagic origin is that the accretion and successive recycle of pelagic material took place in the vicinity of a Tethyan low paleo-latitude continental shelf around the south-eastern margin of the Yangtze block along the continental side of the trench-slope.

The episodes in history of the Tsunomine Complex are: 1) Deposition of bedded chert on the oceanic-floor once interrupted by a Carnian volcanic sea-mount eruption followed by a deposition of pelagic limestone during Late Carnian to Middle Norian with condensed conodont faunas as an event across CCD, that were succeeded by Late Norian to early Late Jurassic bedded chert; 2) Deposition of shallow-marine carbonates on seamount-tops with megalodonts and hexacorals continued in several parts of the plateau during Late Triassic; 3) Limestone breccia including different conodont zones of Early Norian to Rhaetian suggests the collapse or erosion of seamount-tops and flanks just after the end-Triassic; 4) Olistostromes, being derived from the accreted materials, filled the Late Jurassic-earliest Cretaceous fore-arc basin.

THE AGE OF RADIOLARIAN *KILINORA SPIRALIS* ZONE: DIRECT CORRELATION WITH LATE JURASSIC AMMONITE FAUNAL SUCCESSION IN THE TODORO SECTION OF THE KURISAKA FORMATION, SW JAPAN

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The *Kilinora spiralis* Zone (JR6) (Matsuoka, 1995) is recognized widely in various kinds of facies such as pelagic cherts and hemipelagic shales in the oceanic plate succession of the accretionary complexes, fine tuffs and mudstones in fore-arc basin deposits, and continental shelf-type reef limestones in Japan and NW Pacific Region. The FAD of *Kilinora spiralis* and the LAD of *Tricolocapsa conexa* clearly define the JR6 (Matsuoka, 1995).

The LAD of the radiolarian *Kilinora spiralis* is found to concur with the FAD of the ammonite *Ataxioceras* (*A*.) *kurisakense* in the Todoro Section of the Kurisaka Formation, Southern Kurosegawa Terrane (Sakashu Belt), Shikoku, SW Japan. Providing a clue to the still pending chronological differences of radiolarian ranges and zones between Europe and North America (ex. Hull, 1997; O'Dogherty et al., 2006), the constraint by ammonite age prolongs the range of the *Kilinora spiralis* Zone (JR6) into the Lower Kimmeridgian.

The Todoro Section, fine epiclastic shallow-marine facies with calcareous nodules, totally 80 m thick, is subdivided into the Lower, Middle and Upper members. *Kilinora spiralis* occur through the Lower Member of the section. The lowermost horizon (3A), already belongs to the Upper part of the *Kilinora spiralis* Zone, is characterized by the association of a few primitive forms of the species occurring in common with *Stichocapsa naradaniensis* and *Tricolocapsa conexa*. In summary, the Todoro Section comprises the following radiolarian zones, ammonite assemblages and horizons in ascending order:

Pseudodictyomitra carpatica Zone (KR1: Uppermost Tithonian - Berriasian)
Loopus primitivus Zone (JR8: Tithonian)
Neochetoceras mizunoi - *Lytogyroceras* sp. - *Simoceras* sp. sub-assemblage (C1: Lower Tithonian)
Ataxioceras (*A.*) *kurisakense* - *Orthosphinctes* (*Ardescia*) sp. sub-assemblage (C1: Kimmeridgian)
Uppermost part of *Kilinora spiralis* Zone (JR6: TIC3: Lower Kimmeridgian)
Ataxioceras (*A.*) *kurisakense* FAD horizon (AK1: Lower Kimmeridgian)
Upper part of *Kilinora spiralis* Zone (JR6: 3A - C2: Oxfordian)

The radiolarian biostratigraphy in the Todoro Section of the Kurisaka Formation basically corroborates the Late Jurassic radiolarian zonation by Matsuoka and Yao (1986) and Matsuoka (1995). With the age constraint by the FAD of ammonite *Ataxioceras* (*A.*) *kurisakense*, the upper limit of the *Kilinora spiralis* Zone in Japan and NW Pacific region should be placed in early Kimmeridgian.

CALPIONELLID BIOSTRATIGRAPHY ACROSS THE JURASSIC-CRETACEOUS BOUNDARY IN THE WESTERN BALKAN MOUNTAINS (BULGARIA AND SERBIA)

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According to the working status of IUGS (Gradstein *et al.*, 2004) the Jurassic/Cretaceous boundary is the base of Berriasian defined at the base of *Berriasella jacobi* ammonite zone. The absolute age is 145.5 Ma. Additional criterion is the base of *Calpionella* Zone (*C. alpina* Subzone). Almost coeval to this is the first occurrence of the nannofossil *Nannoconus steinmanni minor*. Alternative candidate for the base of Berriasian is the base of the magnetic chron M18r.

This study represents calpionelid biostaratigraphy across the Tithonian/Berriassian boundary in five sections of pelagic micritic limestones in the Western Balkan Mountain in the border area between Bulgaria and Serbia. These are: Gintsi 1, Gintsi 2, Komshtitsa and Barlya section in western Bulgaria and Rosomach section in eastern Serbia. Successive calpionellid bioevents (first and last occurrences, abundance dymanics) are documented within *Crassicolaria* Zone (Upper Tithonian) and *Calpionella* Zone (Lower Berriasian). It W Bulgaria the studied sections are assigned to the Glozhene Formation and in E Serbia – to the Rosomach Limestone Formation.

The base of *Calpionella* Zone is clearly defined by the explosion of the spherical form of *Calpionella alpina*. This bioevent coincides exactly with the rapid decline of *Calpionella grandalpina* and the last occurrences of *Crassicollaria massutiniana, Crassicollaria brevis* and *Calpionella elliptalpina.* This level is related to significant decrease in the total abundance of calpionellid. The base of *Calpionella* zone is thus traced at the first sample in which *C. alpina* predominates over *C. grandalpina* and represents more than 50% of all specimens (Lakova, 1994). Higher in *Calpionella alpina* Subzone, the calpionellid association consists almost enterily of the index-species with some *Tintinnopsella carpathica* and *Crassicollaria parvula*. An acme of *Crassicollaria parvula* together with the restricted occurrence of *Crassicollaria colomi* is documented in the lower third of the subzone. *Calpionella minuta* first occurs in the upper third of the subzone. Calpionellid zonation of the Tithonian and Berriasian across the Bulgaria-Serbian border provide precise chrostratigraphic correlation.

The second level of interest, the base of *Ferasini* Subzones, is defined at the first occurrence of *Remaniella ferasini* or other *Remaniella* species. The subzonal association consists of *Calpionella alpina, Calpionella minuta, Calpionella sp., Tintinnopsella carpathica, Remaniella ferasini* and *Remaniella duranddelgai*. Below the base of *Ferasini* Subzone there is a significant decrease in the total calpionellid abundance.

There is no direct correlation between Berriasian ammonite and calpionellid zonations of the Western Balkan Mountains in Bulgaria and Serbia so far. It is accepted that *Calpionella* Zone corresponds to the sum of *Malbosiceras chaperi* Subzone (equivalent of *B. jacobi* Zone), *Berriasella grandis* and *Tirnovella occitanica* Zones. Moreover, in Bulgaria the Jurassic-Cretaceous boundary was often placed on ammonites at the base *Barriasella grandis* Zone/Subzone which is within *Calpionella alpina* Subzone on calpionellids. Further joint ammonite and calpionellid work will reveale a succession of macro- and microfossil correlative bioevents across the Tithonian-Berriasian boundary strata.

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FOSSIL ASSAMBLAGES ASSOCIATED WITH THE JURASSIC HARDGROUNDS FROM THE BUCEGI MOUNTAINS (EASTERN CARPATHIANS, ROMANIA)

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Within the lithostratigraphic Jurassic successions which belong to different geotectonic units from the Romanian territory, have been mentioned, few hardgrounds levels corresponding to important stratigraphical unconformities. These hardgrounds, in the meaning that today we consider for this term, were mentioned in fewer places in Romania, being associated with intervals of stratigrafic condensation. The present study represent the preliminary results of an extensive project founded by CNCSIS, Romania (Project 1922 / 2009-2011) to Lazăr, project concerning Jurassic hardgrounds from Romania – biostratigraphy, genesis and the palaleoecology of the associated faunas. The researchers are focused on the Jurassic succession where hardgrounds levels have been previously mentioned (Bucegi Mts., Rucăr-Bran area, Piatra Craiului Mts., Central Dobrogea, Apuseni Mts.) but also on other Jurassic succession which potentially can expose such type of discontinuities (Haghimas Mts., Codlea area, Hateg basin, Resita – Moldova Noua basin).

The hardgrounds occurrences studied for present paper is located on the western flank of the Bucegi Mountains. For the Bucegi Mts., Patrulius (1969, 1980) mentioned the occurrences of some indurations surfaces with limonitic crusts, hardgrounds type, within the Jurassic deposits that outcrops in the area Strunga – Strungulita, Grohotisul Mountain, confluence of the Tatarului Valley and Ialomitei Valley. Lazăr (2006) made an extensive discussion about previously studies (from Suess, 1867, to Patrulius, 1969, 1980 and Neagu, 1996) concerning this condensation levels, heavily mineralized with limonitic crusts.

The most interesting areas from the Bucegi Mts. were different hardgrounds levels have been recorded within the Jurassic succesion are: La Politie Pass, Gaura Valley, Grohotisul Mountain, the area between Strunga Pass and Strungulita Pass, Tatarului Valley, Zanoaga Valley, Rateiului Valley, Lespezi Mountain, and within the olistholites from the eastern part of the Bucegi Mts. The present study describes the fossil assemblages recorded from the hardgrounds levels and adjacent beds from some of these outcrops. The hardgrounds are developed on top of a mixed siliclastic-carbonate sandstone body. The species identified until now from the studied hardgrounds levels are represented by bivalves: *Isoarca bajociensis* d'ORBIGNY, *Grammatodon (G.) clathratus* (LECKENBY), *Inoperna sowerbyana* (d'ORBIGNY), *Gervillella aviculoides* (SOWERBY), *Chlamys (C.) textoria* (SCHLOTHEIM), *Eopecten aff. spondiloides* (ROEMER), *Limatula cerealis* ARKELL, *Pseudolimea duplicata* (SOWERBY), *Plagiostoma bellula* MORRIS & LYCETT, *Plagiostoma cardiiformis* SOWERBY, *Astarte sp., Neocrassina sp.*, *Pholadomya angustata* SOWERBY, *Pleuromya sp., Thracia lata* (GOLDFUSS) and other unidentified boring bivalves; gastropods: *Pyrgotrochus elongatus* (SOWERBY), *Pleurotomaria monilifera* TERQUEM et JOURDY; *Proconulus sp*. (very abundant in Strunga Pass outcrop), *Pseudomelania sp*., crinoids pieces of the stems, few terebratullids and rhynchonellids brachiopods, one small specimen of an solitary coral, small colonies of cyclostamata bryozoans (*Berenicea* sp.) , serpulids worms tubes, ammonites and belemnites. The associated cephalopod fauna will be described in a further paper (Lazăr, I. and Marcu,I., in progress).

TAXONOMY, PALEOECOLOGY AND PALEOBIOGEOGRAPHICAL SIGNIFICANCE OF THE *LACUNOSELLA* BRACHIOPOD ASSEMBLAGE FROM UPPER JURASSIC OF HASMAS MOUNTAINS (EASTERN CARPATHIANS, ROMANIA)

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The brachiopod assemblage dominated by the genus *Lacunosella* from Fagul Oltului (central part, western Haghimas or Hasmas Mountains) represent an outstanding fossil assemblage. The presence of this very rich level with *Lacunosella* in the area of Hasmas Mountains was mentioned previously by Pelin, 1965; Preda, 1967, 1973; Grasu, 1974. However, this is the first detailed taxonomic description of the brachiopods and consideration of their taphonomy, paleoecology and paleobiogeographical significance.

The *Lacunosella*-rich horizon is *1.63 m thick and i*s packed full of rhynchonellid brachiopods which occur in tens-of-thousands. The degree of preservation is remarkable, the brachiopod shells are well-preserved, complete, and the specimens show no evidence of being deformed by compaction. Early cementation would have reduced deformation among the brachiopods; the attachment surface of the diductor muscles and the mantle canal patterns are very well preserved in almost all individuals. This assemblage is represented by a very abundant oligospecific association, strongly dominated by the rhynchonellids *Lacunosella* (70%), *Septaliphoria*, and *Rhynchonella* (20%), related to quite distal red crinoidal limestone (*Saccocoma* facies).

Several species of *Lacunosella* have been described from the Late Jurassic (and Early Cretaceous). In view of the demonstrated variability of the external characters shown by approxmiately 1200 specimens that have been studied so far, a revision of the existing species is necessary. At the present time we refer this material to *Lacunosella arolica* (Oppel). Biometrical analysis of specimens of *Lacunosella* shows it is difficult to justify defining more than one species based only on the variability of external characters. The individuals show a normal growth series within a large population. Serial cross sections of different external shapes of the rhynchonellids brachiopods recoded from the same level show very similar characteristics (massively thickened shell, incipient septum in the dorsal valve, falciform crura that project dorsally from the hinge plates) features which are consistent with genus *Lacunosella*.

The wide-range of shell sizes are preserved indicating a paleobiocoenosis. Specimens are infilled or partially infilled with matrix and geopetal infills are common indicating the top of the unit and that the specimens have not been transported. Hundred of specimens are very well preserved, the shells are not decorticated in to the sediment, not eroded. The brachiopods have the shell's internal structure well preserved as reflected by cathodoluminescence (non-luminescent long prismatic LMC) and by UV fluorescence (intrinsic fluorescence). However, relatively high amount of Sr has been found in the shell (micro XRF) indicating at least some aragonite traces and stable isotopes are typical for early diagenetic environment.

Specific for the *Lacunosella* rich red limestones are the presence of stromatactis structures.

The microfacies and diagenetic aspects could point to a gravitational flow of slurry and brachiopods pushed up by the internal pressure of the mud, rearrangement of this sediment after deposition and decaying of the organic matter creates the stromatactis stuctures.

The genus *Lacunosella* is well-known in Alpine Europe and has a Tethyan distribution. We consider that the studied Upper Jurassic sequences belong to an oceanic basin (corresponding to the Central East Nappe System, according to Săndulescu, 1984) that allowed faunal connections between NW European and Mediterranean brachiopod provinces.

MARINE JURASSIC ROCKS OF PENINSULAR THAILAND: UPDATED LITHOSTRATIGRAPHY AND PALEONTOLOGY

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Marine to brackish Jurassic rocks of peninsular Thailand are well exposed in Nakhon Si Thammarat and Krabi Provinces, and less extensively in Chumphon and Trang Provinces. They are generally underlain unconformably by Permian and marine Triassic strata, and overlain by non-marine Cretaceous strata and Quaternary sediments. Based mainly on three selected areas, the marine Jurassic Khlong Min Formation of the Thung Yai Group is generally exposed throughout the areas. Mudstone, siltstone, sandstone, and limestone are the dominant lithologies for the formation. Based mainly on bivalves, vertebrates with additional data of ostracode, the rocks are largely Middle-Upper Jurassic age. According to recent investigations, the Khlong Min Formation is stratigraphically underlain by red beds lying on marine Triassic limestones of the Sai Bon Formation. These red beds are interpreted as having been deposited by meandering rivers with well preserved calcrete horizons (paleosols) at the topmost part of the sequence. At the top part of the Khlong Min Formation, the brackish rocks are grading up to lacustrine deposits containing vertebrate faunas. Paleontologically, the presence of the oyster *Actenostreon* sp., the bivalves *Protocardia* sp., *Myrene* sp., *Praemytilus* sp., the flora *Pinus* sp. and Amber, indicates that the rocks were mainly deposited in brackish-water with partly very near-shore environments.

THE TRIASSIC-JURASSIC BOUNDARY AFTER THE VOTES: PROSPECTS AND PROBLEMS OF GSSP-BASED CORRELATION

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After successive votes within the Triassic-Jurassic Boundary Working Group, the International Subcommission on Jurassic Stratigraphy, and the International Commission on Stratigraphy, the Global Stratotype Section and Point (GSSP) for the base of the Jurassic System has been selected, pending ratification by the executive of the International Union of Geological Sciences, at the locality of Kuhjoch in the Karwendel Mts., Tyrol, Austria. The primary marker is the first occurrence of the newly described ammonoid subspecies *Psiloceras spelae tirolicum*. Additional stratigraphic marker events recorded in the stratotype section include FODs and LOD of palynomorph, foraminiferan, and ostracod taxa and a pair of negative $\delta^{13}C$ excursions.

The definition of the base Jurassic GSSP followed intensive scientific research and concludes a long period of debate. Here I review the benefits and correlation opportunities offered by the GSSP as well as the pitfalls and emerging problems. Particular attention is paid to the potential of marine to terrestrial correlation.

The following advantages are recognized: (i) As in all cases, the GSSP definition removes ambiguity of the boundary position, stemming from different interpretation by individual researchers. (ii) The primary marker ammonoid species allows long-distance correlation with at least one section in North America and another one in South America. (iii) Most significantly, a high-resolution record of organic carbon isotope ratios is available from the stratotype section, which provides for chemostratigraphic correlation, also between the marine and terrestrial realms. (iv) Detailed palynological studies identified biostratigraphic marker events which also allow marine to terrestrial correlation. (v) Marine microfossils (and the more scarce macrofossils) are well documented.

However, some issues remain problematic. (i) Precise chronology of the FOD of ammonoid subspecies, different between Europe and the Americas, is difficult to establish, in the absence of means to distinguish between geographic vs. chronosubspecies. (ii) Unfortunately, the new TJB GSSP doesn't provide for magnetostratigraphy or radiometric dating at or near the system boundary. (iii) The FOD of a key palynostratigraphic marker species (*Cerebropollenites thiergartii*) is said to be at the TJB level in the proposal, yet reported from ~3 m lower in a recently published paper, suggesting that subsequent collecting effort may lead to significant extension of some taxon ranges. (iv) The presence of faults, other tectonic complications, and concerns about the quality of outcrop at Kuhjoch have been denied, downplayed or not disclosed during the deliberation leading up to the votes.

Practicing stratigraphers will judge the suitability of the TJB GSSP in years to come. Traditionalist views prevailed in the votes, fixing the TJB GSSP at the FOD of the oldest known species of *Psiloceras*, itself long regarded as the first Jurassic ammonoid genus. Although ammonoids are the prime index fossils for most of the Mesozoic, the TJB events led to their near elimination and concomitant rarity in the aftermath of extinction. To take a perhaps more progressive approach by recognizing the main peak of biotic extinction and turnover, and the arguably synchronous initial carbon isotope anomaly as the boundary marker (similarly to the Paleocene-Eocene boundary) remained the minority view during the votes.

T/J BOUNDARY IN POLAND – GLOBAL EVENTS AND BIOTIC TURNOVERS IN CONTINENTAL ENVIRONMENT

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Kamień Pomorski IG-1 borehole from Pomerania, Western Poland and several outcrops in Central-Southern Poland yielded important observations from the Triassic-Jurassic transition in continental deposits. Sedimentological and sequence stratigraphic studies allowed precise recognition of alluvial plain – lacustrine environments with two marked sequence boundaries in Upper Rhaetian and at the T/J boundary. Pronounced but gradual climatic change from semi-arid into the humid one is observed in the Late Rhaetian.

Carbon-isotope values measured in the phytoclast fraction of palynomacerals show significant fluctuations in the upper Rhaetian interval with the prominent negative δ13Corg excursion (the "initial" one) showing characteristic two "sub-peaks" of negative values. The onset of the second ("main") carbon isotope excursion was also registered. Position of the initial negative carbon isotope about 12 meters below the T/J boundary allows precise correlation with marine profiles, including Kujoch profile (Austria), chosen for the GSSP for T/J boundary. Osmium-Rhenium isotope system has been also examined across the T/J boundary interval and obtained values of ^{187}Os/^{186}Os *initial* vary between 2,905 and 4,873, which is typical for the products of continental crust weathering. Also the iridium content is consistently very low, about 5 ppt. Collectively, these results speak against theory of a meteorite impact at the T/J boundary and an extraterrestrial cause of the T/J mass extinction. Marked two increases of unradiogenic ^{192}Os, particularly the lower one, concomitant with the upper "sub-peak" of the first negative δ^{13}C org. excursion and coupled also with ^{187}Os/^{188}Os decrease, point to the increased volcanic activity periods, which can be registered not only in the oceanic, but also in atmospheric system.

63 palynomorph taxa have been determined from the T/J transitional section studied: 42 spore taxa, 21 pollen taxa, and 1 Acritarcha indet. Two major palynological assemblages have been distinguished: the lower one, typically Rhaetian, named *Limbosporites lundblandii* association, which corresponds to the *Rhaetipollis-Ricciisporites* (= *Rhaetipollis-Limbosporites*) Zone and the upper one, typically Hettangian, named *Conbaculatisporites mesozoicus* - *Dictyophyllidites mortoni* - *Lycopodiumsporites semimuris* - *Zebrasporites interscriptus* - *Cerebropollenites thiergartii* association (with indicative pollen *Cerebropollenites thiergartii*), which corresponds to the *Pinuspollenites-Trachysporites (= Trachysporites-Heliosporites*) Zone. The boundary zone of these two associations (marking palaeofloral turnover from a low-diversified, late Triassic assemblage, to a well-diversified palaeofloral community) coincides with the higher, T/J sequence boundary, upper carbon isotope excursion and second Os isotope perturbation and is identified with the T/J boundary.

Taking into account presence of charcoal fragments, elevated concentration of unsubstituted, pyrolytic polycyclic aromatic hydrocarbons (PAHs) and high amount of terrestrial debris in the samples we suggest the presence of wildfires periods during T/J boundary sedimentation (two or even three wildfire episodes). These wildfire episodes coincidence with carbon and osmium isotopic disturbances and thus they could be ignited by volcanic activities. It is also postulated, that the amount of oxygen at the T/J transition must have been at least 13% and possibly much higher.

This study shows that the most marked boundary (event) within continental deposits of Rhaetian/Hettangian interval is connected with sequence boundary and approximately coeval floral turnover. Climatic and floral turnover caused pronounced changes in invertebrate and vertebrate communities. Presence of knob walled tunnels and vertical branching tunnels may point to insect bioturbation of soil (possibly by Coleoptera or crayfishes), but some structures produced by earthworms could be similar. Ellipsoid chambers also show affinity to insect trace fossils, namely to the Pallichnidae ichnofamily representing pupation chambers of beetles, although they may have been produced also by earthworms. Particularly intriguing are large associated chambers with serial septa, which can be attributed to nesting behaviour of insects (?cicadas). Insects played an important role in the earliest Jurassic terrestrial ecosystem, they were relatively abundant and their interaction with wood material is proven by the presence of wood borings and gnawing traces, such as cf. *Xylonichnus* isp., *Linckichnus terebrans* and *Helminthoidichnites* isp. Moreover, they played an important role in formation of soil. and formed an important element of food chain, providing food for other animals like small amphibians, reptiles and mammal-like animals, which numerous footprints have been found. Dinosaur footprints of the T/J boundary transition show several stages of evolution, instead of one turnover.

LOWER JURASSIC CONTINENTAL FORMATIONS OF THE SOUTH CARPATHIANS, ROMANIA

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The South Carpathians include Lower Jurassic continental formations in the Getic Nappe and in the Danubian Units. The Getic Nappe yields such formations in the Reşiţa Basin (Reşiţa – Moldova Nouă sedimentary Zone), the largest sedimentary basin of the Getic Nappe, in the Haţeg Basin, and in the Holbav Basin. The Danubian Units include Lower Jurassic continental formations in the Sirinia (Sviniţa-Svinecea Mare sedimentary Zone), Presacina and Cerna-Jiu Basins.

The Reşiţa Basin represents the largest sedimentary basin of the Getic Nappe, yielding the coal bearing Steierdorf Formation, Hettangian – Sinemurian in age, with two members, the Dealul Budinic Member (Lower Hettangian, coarse, red colored sequence) and the Valea Tereziei Member (Middle Hettangian – Sinemurian, coal measure). The most important coal minig locality of the Reşiţa Basin is Anina (Steierdorf), a fossile-Lagerstatte locality for both degree of preservation and high diversity of the fossil plants. Recently, tetrapod tracks and vertebrate burrows were described. Anina was also an important locality due to its mining works, the deepest in Romania (1300 m deeep), which opened three-dimensionally the Steierdorf Formation, offering ideal possibilities for plant collecting.

The Hettangian is marked by the *Thaumatopteris brauniana* range Zone, while the Sinemurian is marked by the *Nilssonia* cf. *orientalis* acme Zone. The flora is very diverse, belonging to Bryophytes, Pteridophytes and Gymnosperms, it usually contains cuticles suitable for cuticular analysis, in situ spores and pollen.

The Dealul Budinic Member is a basal, coarse unit, dominated by alluvial fans features, often red colored, lacking of plant fossils, but bearing vertebrate burrows in Colonia Cehă Quarry. The Valea Tereziei Member is the coal measure of the Steierdorf Formation, it includes braided river features, a dense succession of paleosols, swamp and lacustrine environments as well.

The Sirinia Basin belongs structurally to the Danubian Units of the South Carpathians (Romania), and it is the westernmost basin of these tectonic units. It includes Lower Jurassic, both shallow marine (Munteana Formation, Pliensbachian – Aalenian in age) and continental deposits (Glavcina Formation, the continental facies being known as the Cozla facies, Hettangian – Sinemurian in age). The continental, coal bearing deposits yield a rich, compressive flora, with a high coal genesis potential. The flora of the Sirinia Basin is recorded from more than 16 former coal mining localities, such as Bigar, Cozla, Camenita, Pietrele Albe, Buschmann, Pregheda or Rudaria, among others. The compressions usually lack cuticles, posing a series of problems in systematics. From a sedimentological point of view, the rare outcrops of this age are dominated by fluviatile features (channel fills mainly).

The Presacina and Cerna-Jiu Basins also yield Lower Jurassic formations, the richest in plant fossils being the Schela Formation (Cerna-Jiu Basin), with a high diversity of plant taxa but with a low degree of preservation, usually being slightly to moderate metamorphosed.

PALYNOLOGY AND PALYNOFACIES OF UPPERMOST JURASSIC – LOWER CRETACEOUS SEDIMENTS

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The latest Jurassic and earlist Cretaceous were marked globally by low sea-levels and consequent provincialism of marine biota. North hemisphere biotas are divaded biogeographically into the southern Tethyan province and the northern Boreal province. The distinctive nature of the biota in these provinces has necessitated the establishment of independent zonations and stage nomenclature.

Jurassic/Cretaceous boundary sediments were studied in two totally different regions Tethyan and Boreal. Tethyan studies are situated to the Outer Western Carpathians (Brodno section - Slovakia, Skalice section – Czech Republic) and Northern Calcareous Alps (Leube Quarry – Austria). Jurassic/Cretaceous boundary beds (Upper Volgian and Ryazanian) in the Nordvik Peninsula (North Siberia) were studied from Boreal region.

As for the Western Carpathians samples of the Late Tithonian contain very poorly preserved dinoflagellates prevail. Together with them, the inner linings of foraminifers and bisaccate pollen grains are present. This composition shows the conditions of open sea with the limited supply of terrestrial material. The remaining materials are black and brown phytoclasts. Black phytoclasts (from 70 to 90%) and amorphous organic material (from 10 to 20%) predominated in the samples of the Early Berriasian. Dinoflagellates indicate the conditions of open sea. In the composition of assemblage of dinocysts, representatives of the genus *Muderongia* (varying salinity group) prevail together with representatives of littoral group represented mainly by the genus *Systematophora*. Besides the above mentioned paleoecological groups of dinocysts, the species *Cometodinium habibii* is abundant in the assemblage. Dinocysts *Amphorula metaelliptica, Systematophora penicillata* and *S. scoriacea* occures in the Late Tithonian. The base of the Berriassian was defined on the occurence of *Endoscrinium campanula*. *Circulodinium distinctum, Ctenidodinium elegantulum* and *Prolixosphaeridium* sp. A occur for the first time in the Early Berriasian in the calpionellid Calpionella biozone, Alpina Subzone.

The palynological assemblages of the studied part of the Northern Calcareous Alps are mainly composed of dinocysts, only in few samples were found few representatives of sporomorphs and foraminifera linings. Algae occur in the Late Tithonian. In addition, dark amorphous particles, plant debris (light and dark brown in colour) occur in the samples. Samples of the Tithonian contain dinocysts, such as *Ctenidodinium ornatum, Occisucysta balois, Prolixosphaeridium mixtispinosum, Senoniasphaera jurassica, Systematophora areolata, Tehamadinium evittii* etc. Stratigraphically the most important species *Muderongia tabulata* and *Achomosphaera neptunii* occurs firstly in the Early Berriasian. Simultaneously this interval includes *Amphorula delicata, Circulodinium distinctum, Ctenidodinium elegantulum, Endoscrinium campanula, Systematophora areolata, S. complicata, S. scoriacea,* etc., so species well known from the Berriasian.

The palynomorph associations from the Nordvik Peninsula comprising abundant spores and pollens of terrestrial plants as well as diverse microphytoplankton (dinocysts, green algae, acritarch, foraminifera linings). The characteristic feature of dinoflagellate cyst assemblages is low abundance and diversity of chorate and proximochorate type. The microplankton associations strongly dominated by dinocysts with numerous gonyaulacaceans evidence rather deepwater and well aerated palaeoenvironments. Dysaerobic and poor aerated conditions are characterized by the assemblages almost composed of prasinophytes. Green algae boom occur in the Late Volgian.

Samples were dominated by dinocysts, such as *Cassiculosphaeridia magna, Endoscrinimu campanula, Paragonyaulacysta borealis, Pareodinia asperata, P. ceratophora, Senoniasphaera jurassica, Sirmiodinium grossii, S. orbis, Trichodinium, Tubotuberella apatela, T. rhombiformis*. The presence of *Bourkidinium, Endoscrinium campanula* and *Spiniferites* in the Upper Volgian are interesting. They are known from the Early Berriasian of the Tethyan region.

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EARLY JURASSIC AMMONITES FROM THE PERŞANI MOUNTAINS (EASTERN CARPATHIANS, ROMANIA)

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In the Romanian Eastern Carpathians, thin-bedded, red nodular limestones crop out as different-sized olistoliths in several localities, from north to south in the Rarău, Hăghimaş and Perşani Mountains. The most fossiliferous sites are located in the Perşani Mts. which is a key region of Early Jurassic Tethyan faunas. These localities furnished type specimens of 37 nominal ammonoid species and subspecies described during the last one and a half century, and recently subjected to taxonomic revision. The study of newly collected material from three outcrops documents the stratigraphic succession of 10 faunal horizons ranging from the Middle Hettangian to the Early Pliensbachian, on the basis of more than 60 indentified ammonite taxa. Correlation of the Eastern Carpathian biostratigraphical data with the other Tethyan areas and the integration in the standard zonation is proposed. The correlation is in some cases difficult, due to the tectonized state of the olistoliths, highly condensed nature of sediments and absence of zonal index species. The Hettangian ammonite assemblage is dominated by Phylloceratidae and Juraphyllitidae, two of the characteristic ammonite families of the Tethyan realm. These taxa are represented by a large number of specimens and species which show strong affinities to the assemblages from the Bakony Mts., Northern Calcareous Alps and the Appenines, and indicate the Mediterranean bioprovince. Although these families are also common in the Bucklandi and Semicostatum Zones of the Sinemurian stage, the Arietitidae dominate this stratigraphic interval. The occurrence and biostratigraphic distribution of some problematic taxa is also discussed and a new species of *Metophioceras* and *Eucoroniceras* are presented. Systematic data of the new material is complemented with the revision of the Early Jurassic ammonite collections from the Perşani Mts. deposited in the Hungarian Natural History Museum and the Geological Institute of Hungary.

AMMONITE STRATIGRAPHY OF THE JURASSIC DEPOSITS IN THE VELIKY KAMENETS SECTION OF THE PIENINY KLIPPEN BELT (TRANSCARPATHIAN UKRAINE)

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The Veliky Kamenets section at the Novoselica Village is the key section of the Pieniny Klippen Belt of Transcarpathian Ukraine. The section is exposed in a large, a long time active quarry, where the massive Jurassic limestones, especially those of the ammonitico rosso facies, have been exploited and polished as the so-called Neresnica Marbles. The succession is representative of the Kamenets facies zone which could represent the eastern continuation of the Czorsztyn Succession deposited over the hypothetical submarine Czorsztyn Ridge, well recognized in Polish and Slovakian Carpathians.

The following lithostratigraphical units have been distinguished in the section: (1) white, soft, arkosic sandstones (Triassic/Lower Jurassic), (2) black and grey shales (Toarcian/Aalenian), (3) crinoidal limestones (Bajocian), (4) lower nodular limestones (Bathonian and Oxfordian), (5) cherty limestones/radiolarites (Upper Oxfordian/Lower Kimmeridgian), (6) upper nodular limestones (Lower/Upper Kimmeridgian), (7) pink and white micritic limestones (Upper Kimmeridgian-Berriasian), (8) organogenic limestones and breccias alternating with volcanogenic rocks (Upper Berriasian).

The lower nodular limestones yielded ammonite faunas of the Bathonian age, as well as that of the Middle and Upper Oxfordian age. The boundary between the beds yielding the two faunas is sharp and marked by discontinuity surface with stromatolite: the gap covers the Callovian and Lower Oxfordian. The Bathonian ammonites include mostly various forms of *Bullatimorphites* (*B. ymir*, *B.* gr. *bullatimorphus*, *B. eszternensis*, *B. polypleurus*, *B. costatus*, *B. hannoverianus*), but also *Parachoffatia*, *Hoemoplanulites* and *Wagnericeras*. The whole assemblage indicates stratigraphical interval from the Lower to Upper Bathonian. The Middle Oxfordian and Upper Oxfordian interval is documented by *Liosphintes plicatilis*, *Euaspidoceras paucituberculatus*, *Gregoryceras* and *Dichotomoceras bifurcates.*

The boundary between the Bathonian and Middle Oxfordian is also marked by a sharp change of microfacies – from the filament microfacies in the Bathonian- below the omission surface, and the planktonic foraminifera microfacies in the Oxfordian, above.

The paleomagnetic studies undertaken in the section (Lewandowski *et al.* 2005: *Palaeogeogr. Palaeoclimat. Palaeoecol.*, 216) proved that during the time interval of stratigraphical gap (Callovian-Lower Oxfordian) took place a marked paleolatitudinal shift indicating a fast southerly movement of the Kamentes block. The shift now documented also in Slovakian and Polish sections of the Pieniny Klippen Belt (Lewandowski *et al.* 2006: *Vol. Jurassica*, 4) is interpreted as a result of fast opening of the oceanic domain to the north – possibly the Magura Ocean – during the latest Middle, and earliest Late Jurassic.

Still younger ammonite faunas in the section studied come from the upper nodular limestones. These are Kimmeridgian in age: from the Herbichi Zone (Divisum Zone) of the Lower Kimmeridgian (*Nebrodites*, *Presimoceras teres*) through the Acanthicum Zone (*Taramelliceras pugile pugiloide*, *Progeronia* gr. *eggeri- breviceps*, *Sowerbyceras loryi*) up to the Cavouri Zone ((*Hemihaploceras*, *Aspidoceras rafaeli*) of the Upper Kimmeridgian. These datings indicate that the cherty limestone/radiolarite unit sandwiched in between the lower and upper nodular limestones is of Late Oxfordian to Early Kimmeridgian age.

FIELD TRIP GUIDE

GENERAL OUTLOOK OF ROMANIAN GEOLOGY

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The Romanian territory and its neighbouring areas cover an important part of the Carpathians Orogene and its eastern and south-eastern Foreland. Within the Foreland it is possible to distinguish: the south-west corner of the East European Kraton (the Moldavian Platform), the Precambrian Moesian Platform, the Caledono-Variscan Scythian Platform and the Cimmerian North-Dobrogea Orogene (Text-fig.1). The Carpathian Orogene is a segment of the large developed Tethyan (Alpine) Chains. It group together tectonic units which are built up of Precambrian and Paleozoic metamorphic formations and / or sedimentary Permo-Mesozoic and Cenozoic formations.

The Foreland

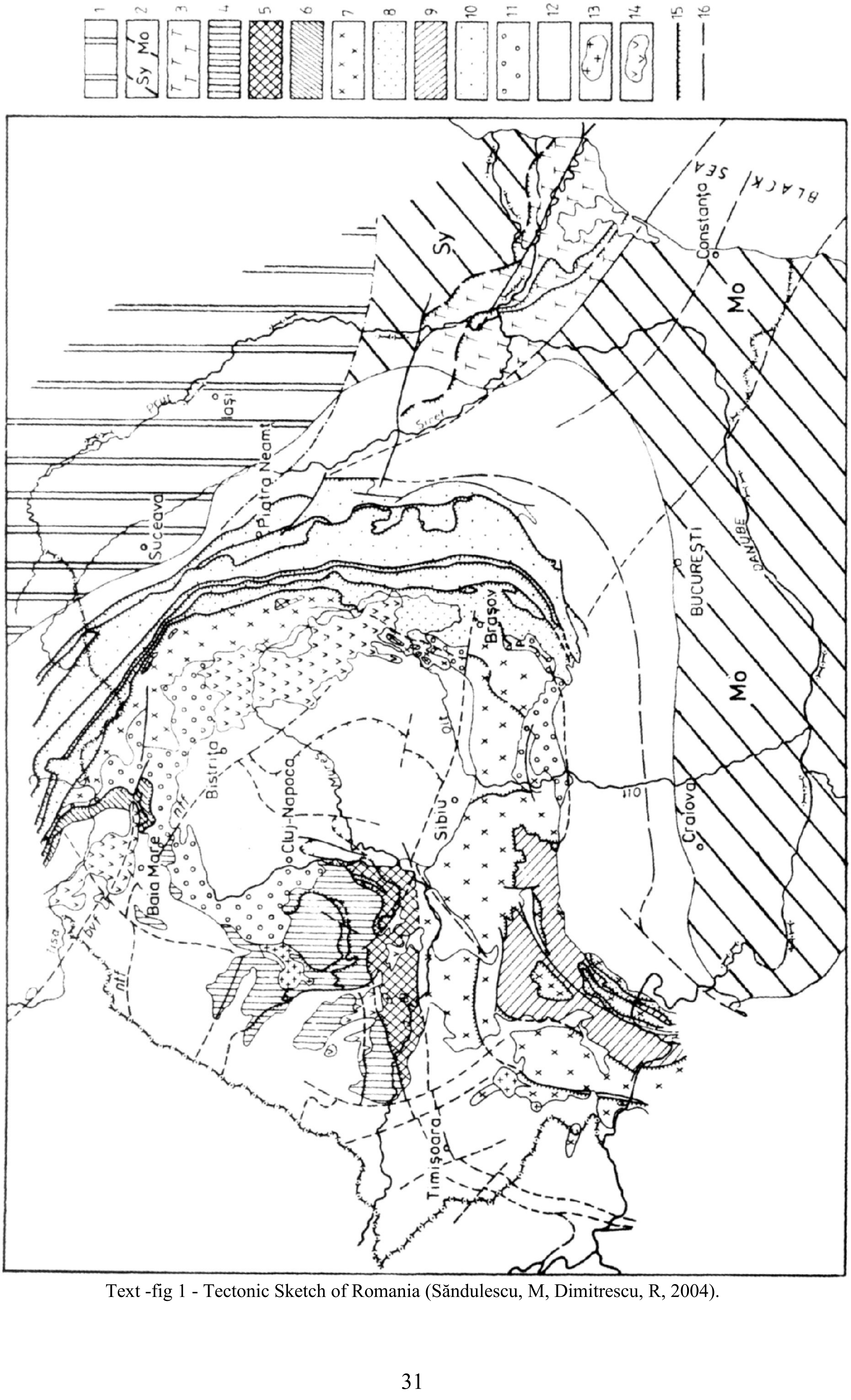
The oldest domain within the Carpathian Foreland is the *Moldavian Platform*. It is built up of a Precambrian (Sveco-Fenian) Basement (mezometamorphic rocks and granitoidic intrusions) covered by a Vendian-Neogene, very discontinous sedimentary formations. The most important gaps are in the Upper Paleozoic, Triassic, Lower and Middle Jurassic and Oligocene. The sedimentary formations are, with the exception of the Upper Neogene (brackish and lacustrian) of marine developments.

The *Scythian Platform* runs south and westward in respect with the Moldavian Platform. The two are bounded by deep fractures. The Basement of the Scythian Platform is built up of folded Vendian and Paleozoic sedimentary (ankimetamorphic) formations. They are covered by an important sedimentary cover which is built up of: Permo-Triassic (German Lithofacies), marine Middle Jurassic-Lower Cretaceous, Upper Cretaceous and Eocene, and Neogene marine, brackish and limnic molasses.

The *North Dobrogea Orogene* is located between the Scythian and Moesian platforms. In fact it proceed from an intracontinental extensive rift (Aulacogene) located above the southernmost margin of the folded basement of the Scythian Platform and developed during the Triassic and Jurassic time. During the Spathian- Carnian time within the central part of the North Dobrogea Aulacogene generated within-plate ophiolites (thinned crust) The Triassic faunas shows Tethyan paleontological biofacies communicating trough the South Crimea and North Caucasus with the Central Asia Cimmerian chains. The Jurassic formations are marines. The North Dobrogea Orogene is the only Romanian Carpathian Foreland unit, where the Lower Jurassic is known. The Cimmerian structure of the North Dobrogea Orogene was generated in two tectogenetic “moments” : the End-Triassic (Old Cimmerian) and the End-Jurassic or Neocomian (Young Cimmerian).

The folded North Dobrogea Orogene is discordantly covered, on-shore, by a marine Albian-Senonian post-tectogenetic cover. This cover is mainly developed off-shore, within the continental plateau of the western Black Sea, where also Eocene (marine), Oligocene-Lower Miocene (euxinic) and Neogene (brackish and limnic) formations was drilled.

The *Moesian Platform* is separated from the North Dobrogea Orogene by the Peceneaga-Camena Fault. Toward north-west, west and south the Moesian Platform border the South Carpathians and the Balkans, namely the Danubian Domain and the Prebalkan.



Text -fig 1 - Tectonic Sketch of Romania (Săndulescu, M, Dimitrescu, R, 2004).

Carpathian Foreland:
1- East European Craton
2 - Scythian (Sy) and Moesian (Mo) platforms
3 - North Dobrogea Orogene. Carpathians
4 - Inner Dacides (Northern Apusenides)
5 - Transylvanides
6 - Pienides (5+6 - Main Tethyan Suture)
7 - Median Dacides (Crist. - Mesoz. Zone, Getic and Supragetic)
8 - Outer Dacides (Ceahlău-Severin)
9 - Marginal Dacides (Danubian)
10 - Moldavides
11 - Post-tectogenetic covers
12 - Neogene Molasse despressions and Foredeep
13 - Up. Cret.-Paleoc., magmatic arcs
14 - Noegene magamtic arcs
15 - thrust - sheets
16 - faults

The Basement of the Moesian Platform shows a complex Precambrian structure . There may be reccognised two parts (blocks) within the Moesian Platform, the Dobrogean and the Valachian ones, separated by the Intramoesian Fault. The sedimentary cover is very thick in several places (more than 6000 m), It was possible to separate several sedimentary cycles : Paleozoic (Cambrian to Upper Carboniferous marine formations), Permo-Triassic (German lithofacies), Middle Jursssic–Cretaceous and Eocene marine formations and Neogene molasses. As well as in the Moldavian and the Scythian platforms, the Lower Jurassic, the Paleocene and the Oligocene-Lower Miocene are missing.

A part of the Foreland units prolongate on the western Black Sea Continental Plateau. There are the Scythian Platform which cross the Odessa Bay and join the central and north Crimea. South of it prolongate the Norh Dobrogea Orogene which join the Alpine Crimea (South Crimea) The Moesian Platform develops south of the North Dobrogea-South Crimea Chain. The Peceneaga –Camena and the Intramoesian faults prolongate also within the Continental Plateau of the western Black Sea.

The Carpathians

The Carpathians are a segment of the Tethyan Chains. Toward west they oin the Alps and toward south and south-east the Balkans and Rhodope.

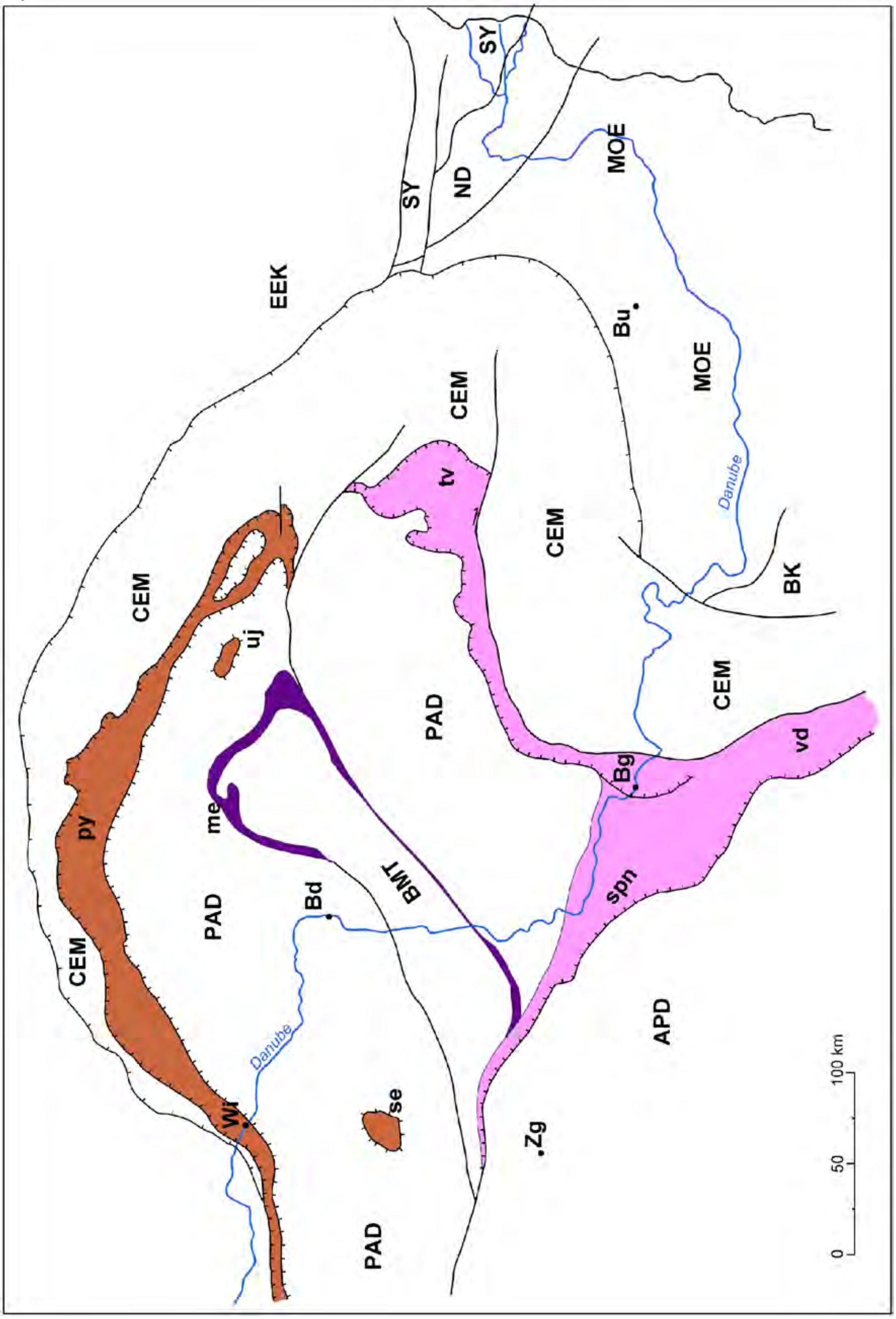
On the main part of the Romanian territory develops a part of the Carpathians Orogene. Namely the East Carpathians, the South Carpathians and the Apuseni Mts. The main structures of these mountains develops also in the basement of the Transylvanian and Western Pannonian, Neogene depressions.

The Carpathian Folded Area include pre-Alpine (pre-Upper Carboniferous) metamorphic formations which belong to Paleozoic and Precambrian chains. The actual structure of the Carpathians is the result of several tectogenetic events of different ages:

- Middle and End Cretaceous, which generated the Inner Zones, named Dacides,
- Lower and Middle Miocene,which generated the Outern Zones named Moldavides,

The Pienides and the Transylvanides belong to the Main Tethyan Suture Zone (MTS), which group together the units proceeding from the Tethyan oceanic domain (oceanic crust). They are built up of Mesozoic ophiolitic complexes and sedimentary formations. The tectogenetic events which generated the MTS units are Middle and End Cretaceous for the Transylvanides, Upper Cretaceous and Lower Miocene for the Pienides.

The **Main Tethyan Suture,** represented by the Vardar Zone (which is situated between the European and the Apulian continental margins) branch, north of Beograd, in two main sutures: the _Transylvanido-Pienidian_ and the _South Pannonian_ (Text-fig. 2). A secondary suture, connected to the South Pannonian suture is the _Meliata Suture_. The _Transylvanian Nappes_, obducted above the European Continental Margin, proceed from the Transylvanido-Pienidian Suture.



Text -fig 2. The main Tethyan Ophiolitic Sutures within the Carpathian Realm.

1 - Jurassic - Lower Cretaceous suture
2 - Cretaceous sutures
3 - End Cretaceous and Lower Miocene suture; Voreland:
EEK - East European Kraton
SY - Scythian Platform
ND - North-Dobrogea Orogene
MOE - Moesian Platform,

Tethyan Chains
CEM - Carpathian deformed European Margin
BK - Balkans
PAD - Pre-Apulian Domain
BMT - Bukk-Meczek Terrain
APD - Apulian Domain

Sutures:
vd -Vardar
tv - Transylvanides
spn - South- Pannonian
me - Meliata
py - Pienidyan + uj - Ujgorod Window and se - Semmering Window

Localities:

Bd - Budapest
Bg - Beograd
Bu - Bucharest
W - Wien
Zg - Zagreb

The Transylvanido-Pienidian Suture, together with the Transylvanian Nappes, show both Triassic (Ladinian-Carnian) and Jurassic (mostly Middle Jurassic) ophiolites. The ophiolites bearing units of this suture crops out within the South Apusenides (Transylvanides) units and the Transylvanian Nappes. The Triassic, Jurassic and Lower Cretaceous sedimentary formations connected to this units are, neritic or deep marine, mostly limy and, sometimes in the Cretaceous, turbiditic.

The **Pre-Apulian Microplate (PAM) (Inner Dacides)** is situated in the Carpatho-Alpine domain in the opposite side with respect to the European Continental Margin considering the MTS a major geotectonic axis of symetrie of the Tethyan Chains. The PAM groups together the Austroalpine, the Central West Carpathians and the North Apusenides units as well as some units covered by the Pannonian Neogene Depression.

The Northern Apusenides (Inner Dacides) are built up of several pre-Gosau shearing nappes built up of Precambrian and Plaeozoic metamorphic formations and granitoids and/or Permo-Mesozoic sedimentary Formations. These units, north and nort-east vergent, shows Triassic and Lower Jurassic marine formtions with the same lithostratigraphic palinspastic pleogeography as the Austo-Alpine and West Carpathians units. The Middle and Upper Jurassic as well as the Lower and Middle Cretaceous show peculiar developments. The Senonian Gosau Formation cover discordantly the nappe structure.

The **European Continental Margin (ECM)** group togetherthe East Carpathians (the Pienides belong to the MTS) and the South Carpathians as well as the Balkans. It is to stress out that these chains are the nearest group of tectonic units in respect with the oceanic domain (MTS). In fact the East and South Carpathians belong to the alpine deformed ECM.

The <u>*Median Dacides*</u> group together basement shearing Nappes of Mid-Cretaceous and End-Cretaceous age. Within the Central East Carpathians there are the Bucovinian, Subbucovinian and Infrabucovinian nappes. In the South Carpathians the Getic Nappe is equivalent with the Infrabucovinian and the Supragetic one with the Subbucovinian. Each of this nappes is built up of Precambrian and Paleozoic metamorphics covered by Upper Carboniferous-Permian and Mesozoic, sedimentary formations. Some post-tectogenetic basins shows Upper Cretaceous or Paleogene-Lower Miocene sedimentary formations.

The *Outern Dacides* proceed from an intracontinental rift system in extension, at least, since the Middle Jurassic. A thick turbiditic (flysch) sequence was generated during the Upper Jurassic and the Lower Cretaceous. The Outern Dacidian Rift developed in front of the Median Dacides.

The *Marginal Dacides (Danubian Domain)* crops out only in the South Carpathians. There are known Precambrian and Paleozoic metamorphics and granitoids as well as remnats (ophiolites) of an Caledonian or Variscan suture. The sedimentary formations belong to the Uppermost Paleozoic and to the Mesozoic. The Danubian is the nearest alpine deformed unit of the ECM, in respect with the Moesian Platform. The Danubian Domain prolongate in the Balkans, namely in the Prebalkan and Stara Planina units.

The *Moldavides* are the outernmost overthrusted cover nappes known in the Carpathians. They are built up of Lower Cretaceous to Miocene sedimentary formations There are mainly turbiditic – type (flysch) formations of Cretaceous and Plaogene age and turbiditic, molasic and salt formations of Lower and Middle Miocene.

The primary crust above wich were sedimented the Moldavidian formations was a thinned and / or oceanic-type crust. It was "consumpted" by subduction , "pushed" by the underthrusting of the Foreland continental crust. Its subduction generated the Neogene Volcanic chain of the East Carpathians.

The *Neogene Molassic Depressions* develops since the Middle Miocene – the Transylvanian and the Pannonian depressions – or the Upper Miocene (Sarmatian) the Foredeep.

Geotectonic History

End- Proterozoic (Panafrican) cratonization is recognized in the whole Carpathian Foreland. And also in the Carpathian Orogene as relicts reworcked within the Caledonian and Variscan metamorphisms. This huge cratonic area preserved actually in the European Craton was split south and west of the former within the Paleozoic mobile areas. The folded basement of the Scythian Platform proceeds from one of these, while Paleozoic metamorphic series of the Carpathians from another branch. Within these branches remnants of Paleozoic oceanic crust-bearing domains seems to be acceptable. A second large cratonisation occur after the Early Carboniferous, including the Carpathians and parts of its Foreland.

The earliest riftings - Early Triassic – occur along the future Tethyan Ocean and in the North Dobrogea – South Crimea Aulacogene. The first one precedes the opening of the oceanic Tethys The second oane is a rifts system opened along the southern margin of the Scythian Platform, prolongatig through the Central North Caucasus toward east.

Tethyan oceanic spreading start in the Middle Triassic (in accordance with the oldest ophiolites recorded in the nappes obducted from the Transylvanidian suture) separating the Pre-Apulian Microplate from the European Continental Margin. The spreading processes continues during the Early and Middle Jurassic. At the Middle / Late Jurassic Boundary the Tethyan Ocean reach its largest sizes in the Carpathians; the youngest ophiolites proceeding from it being of pre-Kimmeridgian age.

Riftings, wich generated oceanic-type crust, occurs within the European Continental Margin (Outern Dacides) since the Middle Jurassic. The main subsidence of this rift is during the Tithonian and a part of the Lower Cretaceous. Its first deformation is of Middle Cretaceous age. At this moment in the South Carpathians the Rift was deformed and entirely overlapped tectonically by the Getic Nappe (1st Getic tectogenesis). In the East Carpathians it was folded but not entirely overlapped tectonicaly. The second tectogenetic moment was of End-Cretaceous age (2nd Getic tectogenesis). In the South Carpathians the Severin Nappe (Outer Dacides) was tectonically overthrusted at the base of the Getic Nappe above the Danubian Domain.

The important Cretaceous overthrustings in the South Carpathians were generated by the underthrustings of the Danubian Domain, pushed toward west by the wandering of the Moesian Platform. Consequently the western Black Sea Basin, with oceanic-type scrust, spreaded.

The tectogenetic deformations of Miocene age involved the Pienides (Pienidian segment of the Main Tethyan Suture) ad the Moldavides (the main tectonic nappes of the Ca Flysch Zone from the Eastern and Northern Carpathians) there was three tectogenetic moments: Lower Miocene, Middle Miocene and early Upper Miocene.

Regional Geology of the Western South Carpathians

Within the western South Carpathians crops out all the tectonic units known in the southern Median Dacides (Text-fig. 3).

The innermost unit is the Supragetic Nappe cropping out in the Poiana Ruscă Mts and in the western Banat, west in respect with the oravița Fault. It is mostly built up of Precambrian and Paleozoic, mesometamorphic and epimetamorphic respectively, formaions. Discontinous and thin developed, detrital Permian, neritic limestone of Upper Jurassic and Urgonian age and detritaal Upper Cretaceous, are known.

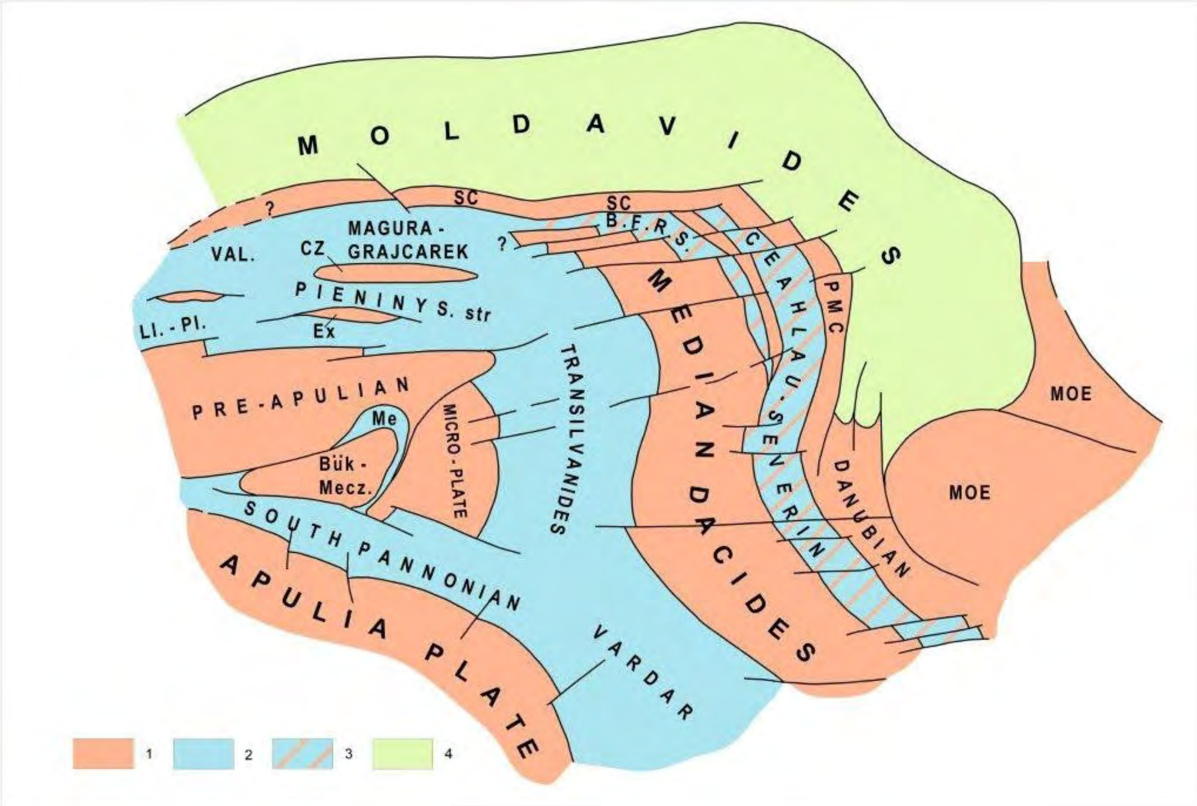
In front of the Supragetic Nappe in the southern Reşița-Moldova Nouă Zone and prolongating south of Danube in Serbia develops a narrow unit – the Sasca-Gornijak Unit – built upof detrital continental Permian, Lower and Middle (dolomitic and calcareous) Trias and a thin sequence of Jurassic and Cretaceous formations (of the same lithofacies as the Reşița-Moldova Nouă Zone. Thhe Sasca-Gornijak Unit seems to be a innermost scale of the Getic Domain.

The Getic Nappe is the main tectonic nappe of the South Carpathians. An important part of his body is built up of metamorphic formations, mainly Precambrian, intruded by few granitoids. Thhe sedimentary formations which overlapped the metamorphics were preserved, in the western South Carpathians, in two zones: the Reşița-Moldova Nouă and the Hațeg ones. The oldest sedimentary sequence known is of Upper Carboniferous-Permian age, well developed in Reşița-Moldova Nouă Zone. The Trias is absent (due to pre-Jurassic erosions ?!!) within the western South Carpathian, Getic Domain. It is well developed (excepting the Upper Tias) in the eastern area of the Getic Nappe and in some equivalent areas of the Balkans. The Jurassic-Cretaceous sequence is well developed both within the Reşița-Moldova Nouă and Hațeg zones. And also in the eastern part of the Getic Nappe, the Țara Bârsei-Dâmbovicioara Zone.

The Severin Nappe was carried at the base of the frontal part of the Getic Nappe during the End-Cretaceous overthrusting of the second one. The Severin Nappe is built up mainly of Upper Jurassic-Neocomian turbiditic (flysch) formations (Sinaia Formation). In several areas at the base of Sinaia Formation are preserved Callovian-Oxfordian radiolarites and Mid-Jurassic ophiolithes.

The Getic Nappe and, consequently the Severin Nappe too, were eroded after the Upper Cretaceous, namely after the youngest overthrusting of its. Several outliers were preserved. They crops out tectonicaly above the Danubian Unit in it central part (Godeanu Outlier) or in it external part (Baia de Aramă and Porțile de Fier (Iron Gates) outliers).

The Danubian Domain is the deepest major tectonic unit of the western South Carpathians. It is constitute of two main units : the Inner (Upper) Danubian and the Outer (Lower) Danubian. The relationships between this two are tectonic.



Text -fig 3. Paleogeographic - palinspatic reconstruction of the Alpine-Carpathian chains at the Upper Jurassic / Lower Cretaceous boundary (acc.to Săndulescu M., 2009, in press)

1 - Continental crust
2 - Oceanic crust
3 - Oceanic Rifts crust
4 - Thinned and Oceanic - type crust

VAL. - Valaisanne trough, LI.-PI. - Liguro - Piemontais trough, CZ - Czortstyn ridge, Ex - Exotic ridge, B.F.R.S - Black Rift System, SC - Silezian Cordillera, PMC - Peri-Moldavian Cordillera, MOE - Moesian Platform.

The most important part of the Danubian Domain are built up of Precambrian metamorphics, intruded by important granitoidic bodys.The Paleozoic, slight metamorphosed formations are relatively small developed. The Permian molasses are developed mostly in the Inner Danubian Unit. The Trias is missing (also by Pre-Jurassic erosion), while it is developed in the Prebalkan Domain in a lithofacies similar with the Moesian Platform. The Jurassic and Cretaceous formations are well developed both in the Inner as in the Outer Danubian units. In the Upper Jurassic and the Lower Cretaceous sequences it is possible to stress out that the Inner Danubian Unit shows generally deep water lithofacies while in the Outer Danubian Unit this formations are generally neritic. The Upper Cretaceous shows, mostly in the Outer Danubian, a specific exolistrostomic (wildflysch) lithofacies. The exolistolites are of Getic and Severin origin.

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GEOLOGICAL HERITAGE VALUES IN THE IRON GATES NATURAL PARK, ROMANIA

Popa, M.E. (2003)

The South Carpathian Mountains are crossed by the Danube between Baziaş and Schela Cladovei, and along this transect, an important series of outcrops, geosites and Sites of Special Scientific Interest (SSSI) are recorded and discussed. An important SSSI along the Danube Gorges is the paleontological reserve from Saraorschi Creek, with a diverse and well preserved Middle Jurassic cephalopod fauna. Important geosites along the Danube Gorges are recorded at Cozla (Early Jurassic plants), Munteana-Dumbrăviţa (Lower to Upper Jurassic and Lower Cretaceous invertebrate faunas and sedimentary structures, spectacular structural features, including the famous "suspended fold" at Dumbrăviţa), Trescovăţ (a Permian lava dome), Stariştea (Permian porphyry), Romanian Greben (various types of folds and faults, formerly described as the geological "gothic" style, even more spectacular along the Serbian Greben shore), Zelişte and Veligan Peaks (Lower Jurassic conglomerates, with unique sedimentary and geomorphological features), Tri Cule (geomorphological features, Lower Jurassic fanglomerates generating a spectacular cuesta), Selschi Creek (Permian red-beds and a post-Liassic dyke), Dubova (geomorphological features in Cretaceous limestone), Cazanele Mici and Cazanele Mari Gorges (geomorphological sites) and the Ponicova Cave (speleological site). Excepting the SSSI and the geosites, a long series of important outcrops occurs, both along the Danube's shore and within the Almăj Mountains, and these outcrops show interesting geological features.

The Danube Gorges is not the only area with important geological heritage values, such values occurring within the Almăj Mountains as well, in the central or eastern areas of the natural park. An important preserved site is Bahna SSSI, in the eastern part of the park, with a very rich and well preserved Miocene invertebrate and rare vertebrate fauna. Significant geosites are here recorded at Baia Nouă, Eibenthal, Cucuiova and Povalina (Late Carboniferous and Permian fossil plants), Bigăr, Stanca, Pietrele Albe, Buschmann (Early Jurassic fossil plants), together with interesting outcrops along various valleys in Almăj Mountains.

The geological heritage of the Iron Gates Natural Park represents one of the most significant heritages of this kind in Romania. Such values deserve a better and a more responsible protection, especially when enforcing the new Romanian Law of Environment. Fortunately, as the natural park is now reorganized, illegal collecting of fossils and the general loot of the geological heritage values will receive a better, stronger institutional response.

The Iron Gates Natural Park is an important area for geoconservation in Romania, as its geological heritage is among the richest in the South Carpathians. The series of structural units, typical for the South Carpathians, crossed by the Danube, shows unique features from paleontological, structural and morphological points of view, making the Park one of the most interesting areas in Geosciences, for research and education.

The Geology of the Iron Gates Natural Park is complicated and it is still a matter of debates from many points of view, such as structural, tectonic, sedimentological and paleontological perspectives. This paper is not intended to contribute new geological data, but to emphasize the outstanding geological heritage and potential of the park. The geology of the park represents the backbone for all the other natural aspects representing the natural heritage in the area, as the geology is one of the most important biotope aspects of the entire system, a true frame in which all the other elements are included and related with.

The history of the geological research in the region is long and it begins with the first papers of Austrian, Romanian and Hungarian geologists of the XIX-th Century. Among the most important contributions to the Geology of the South Carpathians must be cited those of Murgoci (1905), Streckeisen (1934), and Codarcea (1940). For the area including the Iron Gates Natural Park, that of Răileanu (1953) is the most important, a synthesis still valid today, 50 years after its publication. Later, contributions of Pop (1988, 1996), and Stănoiu and Stan (1986), Berza et al. (1983), Berza and Drăgănescu (1988), for tectonics and sedimentology, and of Bercia and Bercia (1975), Mărunțiu and Seghedi (1983), for the metamorphic basement, detailed the knowledge in the area of the natural park. In Paleontology, important contributions are those of Kudernatsch (1852), Semaka (1963, 1970), Antonescu and Avram (1980). A series of field guidebooks were edited by Codarcea et al. (1961), Năstăseanu et al. (1981), Berza et al. (1984) and Pop et al. (1997), the last title detailing the geology of the Danube Gorges.

The Iron Gates Natural Park includes all tectonic units of the South Carpathians, from west towards east: Supragetic Nappe, Sasca-Gornjak Nappe, Getic Nappe, Severin Nappe, and Danubian Units. The Supragetic, Getic and Danubian Units include both basement and sedimentary terranes, while the Sasca-Gornjak and Severin Nappes lack basement elements. Within the natural park, two important basins are recorded: Resita Basin (sedimentary cover of the Getic Nappe in the area) and Sirinia Basin (sedimentary cover of the Danubian Units in the area). These basins record an Upper Paleozoic sequence (Upper Carboniferous – Permian), a Mesozoic sequence (Lower Jurassic – Middle Cretaceous) and a Tertiary post-tectonic cover (Miocene-Pliocene and Quaternary). The southernmost parts of the Danubian Presacina and Cerna-Jiu Basins are recorded north of Orsova, in the NE area of the park. Sediments belonging to the Severin Nappe (such as the Sinaia beds), and to the Sasca-Gornjak Nappe (Triassic carbonate sediments), are also well documented in the park.

The geological heritage in the Iron Gates Natural Park can be assigned to the following categories: 1. Sites of Special Scientific Interest (SSSIs); 2. geosites; and 3. important sites. SSSIs are strictly preserved paleontological areas of the park. Geosites are defined in this paper as outcrops, road cuts, quarries or coal mine sterile dumps, important for their fossil, mineral or structural content, or as geomorphological elements, and they are not administered as SSSIs, although some of them deserve such a status. Important sites are local quarries, roads or natural outcrops showing an interesting structural, tectonic, lithological or paleontological feature, making them useful for education, field trip stops, photographs or landscape views.

Sites of Special Scientific Interest (SSSIs)

Saraorschi Creek SSSI (Text-fig. 4, point no. 1) is also known as Svinița paleontological site, as its occurrence is close to Svinița village. This site is preserved for its highly valuable paleontological content, and it is one of the most important paleontological reserves in the South Carpathians. From a lithological point of view, the site is represented by a sequence of Middle and Upper Jurassic red, nodular limestone, very rich in ammonoids and brachiopods. The Aalenian limestone is less fossiliferous, the Bajocian sequence has brachiopods and ammonoids, the Bathonian – Lower Callovian, in Klaus facies, is rich in ammonoids and contains even a very dense ammonitid lumachelle, 1-1.5m thick, with *Oxycerites aspidoides*, *Macrocephalites macrocephalus*, *Holcophylloceras mediterraneum*, *Lytoceras adeloides*, etc. The Middle Callovian-Oxfordian has also cephalopods, while the Tithonian is again rich in ammonoids, the site having more than 60 taxa of cephalopods (Bleahu et al., 1976). This site was first studied by Kudernatsch (1852), making it widely known in the paleozoological scientific community, the fossil material collected after 1852 being curated in Romania and abroad as well. Unfortunately, the site was systematically sacked for many, long years, but in spite of all collecting activities, legal or illegal, the site is still rich and well preserved, as the fossiliferous bed has been covered.

Bahna SSSI (Text-fig. 4, point no. 2) occurs close to Bahna village, although the preserved sites of Bahna SSSI are scattered between Ilovita and Bahna villages. This SSSI preserves Miocene (Badenian) fauna, with bivalves, gastropods and vertebrates, about 400 taxa totally (Bleahu et al., 1976). The facies is represented by reef limestones, sandstones, sands and clays, the limestone sequences being the richest in fossils. The Miocene Bahna basin had a short evolution as a marine channel connecting the Pannonian and Dacian Basins. Ostreid assemblages are the most impressive, accumulated in thick, large beds, very dense in fossils. Marinescu (1965) studied in detail the paleofauna of the Bahna Basin. Bahna is an important SSSI for several reasons: the fossil fauna is highly diverse and well preserved, the paleoecological information is well preserved too, and the quality of the outcrops is still good, in spite of successive looting and recent plant growth.

Both Saraorschi and Bahna SSSIs deserve a very attentive and careful protection. First of all, this protection should be undertaken by continuous monitoring of the sites. Local people were informed repeatedly with regard to the importance of these sites, and they are aware of the sites value, but geological education is still very necessary for the locals, as they should be the first keepers of the sites. Park rangers represent today another warranty for the preservation of these unique SSSIs.

Geosites along the Danube Gorges

Cozla mine has a rich sterile dump along the Danube's shore (Text-fig. 4, point. No. 3), although the main dump is in the Danube itself. At Cozla, within the Sirinia Basin, Lower Jurassic coals are still extracted; in spite of numerous technical and financial difficulties, the Cozla mine is still in function. The underground exploitation horizons are well outcropped and the collecting possibilities are good, although not so seducing like those at Anina, where the mine is ideal for detailed paleobotanical research (north of the park, in Anina Mountains, in Popa, 2000a, b). The Lower Jurassic coal measures are very rich in fossil plants within the Sirinia Basin, former coal mines with rich sterile dumps being located at Ida (close to Cozla), but also inland, within the Almăj Mountains, such as Camenița (Text-fig. 4, point no. 4), Bigăr (point no. 5) and Buschmann (point no. 6). They occur along the Sirinca Valley, at Stanca (Point no. 7) and Pietrele Albe (point no. 8, all north of Cozla).

The paleoflora, mainly Hettangian-Sinemurian in age when generating coal (as there is a rich drifted flora even within the Middle Jurassic marine sequences, with no coal genesis potential), is a typical Mesophytic flora, with very diverse pteridophytes and gymnosperms (Semaka, 1963, 1970, Popa, 1998). The pteridophytes are represented by horse tails (*Schizoneura carcinoides* from Cozla, an effective coal generator during Early Jurassic times), ferns (Dipteridaceae, such as *Dictyophyllum nilssoni*, *Thaumatopteris brauniana*, Osmundaceae, Dicksoniaceae, Matoniaceae, Incertae sedis such as *Cladophlebis* div. sp.). The gymnosperms include seed ferns (*Cycadopteris obtusifolia*, *Sagenopteris* sp., *Pachypteris* sp.), Cycadopsids (cycadaleans, such as *Nilssonia* cf. *orientalis*, or bennettites, like *Otozamites* cf. *molinianus*), Ginkgopsids (*Sphenobaiera* sp., *Ginkgoites* sp.), Incertae sedis (*Czekanowskia rigida*) and conifers (*Pagiophyllum* sp., *Brachyphyllum* sp., *Podozamites distans*). The Lower Jurassic flora of the Danubian Realm is not so well preserved when compared to that of the Getic Nappe, but nevertheless, these fossils represent important geological heritage values. Fossil plant collections from Sirinia Basin are curated in Bucharest (University of Bucharest, Geological Institute of Romania) or Cluj-Napoca (Babes-Bolyai University), but also abroad. These paleobotanical sites deserve a SSSI statute in the park.

At Munteana-Dumbrăvița occurs one of the most beautiful sedimentary outcrops in the Danube Gorges (Text-fig. 4, point. no. 9). The sequence begins with Lower Permian red breccias, now covered by vegetation, unconformably overlain by Lower Jurassic marine sandstones and limestones, and by Middle and Upper Jurassic nodular limestones, generating a steep hill along the Danube's shore. At Munteana, the famous paleontologist U. Schloembach fell and died in 1870, while collecting fossils.

Lower Jurassic deposits are assigned to the Glavcina (Hettangian-Sinemurian, continental facies) and Munteana (Sinemurian? - Pliensbachian – Toarcian, shallow marine facies) Formations, represented by oolithic, ferruginous limestones (Munteana facies, Hettangian-Sinemurian in age), and by marine sandstones (Pliensbachian-Toarcian in age), both with a rich fossil content of belemnites, bivalves, brachiopods and echinoderms. The belemnites generate dense, large accumulations of belemnite rostrums arranged more or less parallely by marine paleocurrents. Liassic deposits represented by oolithic, ferruginous limestones, are a rare facies for Lower Jurassic deposits in the South Carpathians. The Lower Jurassic fauna is represented by foraminifers (*Textularia* sp., *Spiroloculina* sp., *Frondicularia* sp.), bivalves (*Plagiostoma gigantea*, *Entolium liasinus*, *Uniocardium numismalis*, *Aequipecten aequivalvis*, *Gryphaea cymbium*, *G. fasciata*), brachiopods (*Spiriferina tumida*, *Terebratulla grestenensis*, *T. punctata*), ammonites (*Acanthopleuroceras rursicosta*, *Amblycoceras planicosta*, *Lyparoceras beckei*) and belemnites (*Megateuthys* sp.). The Middle and Upper Jurassic deposits (Seretina, Zelişte, and Greben Formations) are represented by nodular, red or white limestones with ammonites and belemnites, and these deposits generate south of Munteana a beautiful fold, the so-called "suspended fold" from Dumbrăvița, best seen from the Serbian shore of the Danube. The Oxfordian is represented by ammonites (*Sowerbyceras tortisulcatum*, *Callyphylloceras zignodianum*) and belemnites (*Hibolites hastatus*). The Kimmeridgian has *Aspidoceras acanthicum*, *Taramelliceras strombecky*, while the Tithonian is represented by *Lamellaptychus lamellosus*, *Streblites lithographycum*, *Lytoceras montanum*, *Punctataptychus* sp. (Codarcea et al., 1961, Năstăseanu et al., 1981). The Jurassic sequence is conformably overlain by Hauterivian and Valanginian deposits. This geosite deserves an attentive protection and the SSSI statute.

The Trescovăț Peak (Text-fig. 4, point no. 10) is a remarkable Lower Permian rhyolithic dome, very well expressed morphologically and well visible from both shores of the Danube. This dome was one of the volcanic sources for many of the terrigenous volcanites in the area of the natural park. The dome is partially surrounded by Lower Jurassic sediments.

Permian rhyolithes outcrop very impressively along the Stariştea Valley (Text-fig. 4, point no. 11), with prominent peaks and high relief energy.

The Romanian Greben (Text-fig. 4, point no. 12), downstream from the last geosite, between Vodinschi, Saraorschi and Povalina creeks, has exquisite Middle and Upper Jurassic nodular limestones, with beautiful folds cut by various faults, outcropped along the road cuts.

At Zelişte and Veligan Peaks (Text-fig. 4, point no. 13), uphill from the Svinița village, outcropped by the Tiganului Creek, occurs an impressive amphitheater generated by Lower Jurassic continental conglomerates. The conglomerates belong to the Cioaca Borii Formation (Hettangian in age) and they are the first detritic sequence to overlay unconformably the Lower Permian deposits, along a contact that is well expressed morphologically. This amphitheater is one of the most spectacular outcrops along the Danube Gorges, especially when climbed towards the two peaks, on the path to Cucuiova and Povalina. The sedimentology of the continental conglomerates is also very interesting, with very well outcropped cross-bedding at various scales, indicating alluvial and fluviatile (with channel fills) depositional systems during the Hettangian, in Svinița area.

At Tri Cule (Text-fig. 4, point no. 14), downstream from Svinița, the same Cioaca Borii Formation generates a bold cuesta, as a result of the stratigraphic unconformity. Here, the contact is even better expressed by a typical relief. The cuesta is also home for a beautiful pine community.

Close to Selski (Red) Creek (Text-fig. 4, point no. 15), along the Danube's shore, outcrops the unconformable contact between the Danubian basement (gabbros outcropping well at Iuți) and the sedimentary cover (Lower Permian basal breccias and red beds). Also, a basaltic dyke crosses both the basement and the cover. This outcrop is valuable for education and research.

Cazanele Mari (Text-fig. 4, point no. 16) are represented by Upper Jurassic (Tithonian-Neocomian), and Lower Cretaceous (Barremian – Lower Aptian, in Urgonian facies, and Albian-Cenomanian) limestones with a high relief energy. Together with Cazanele Mici (Text-fig. 4, point no. 17), they represent some of the most impressive landscapes in the Danube Gorges, especially when they are seen from the Serbian shore or from boat. At Dubova, at the SE end of the Cazanele Mici gorges, beautiful Urgonian limestone pillars occur (point no. 18).

Inland geosites

Excepting the former mines extracting Lower Jurassic coals in the Sirinia Basin, several inland geosites are important as they yield a rich Late Paleozoic flora. These geosites are located at Baia Nouă (Text-fig. 4, point no. 19), Eibenthal (point no. 20), Cucuiova (point. no. 21) and Povalina (point no. 22). Baia Nouă is the only coal mine still open, extracting Upper Carboniferous (Late Westphalian – Stephanian) anthracite. All sterile dumps of these mines yield a rich compressive paleoflora and they certainly deserve a SSSI statute. The Late Paleozoic flora of the Sirinia Basin (Semaka, 1963, Maxim, 1969, Dragastan et al., 1997) is a rich compressive flora, represented by Sphenopsids (*Calamites* div. sp.), Lycopsids (*Lepidodendron* div. sp.), pteridophylls (*Neuropteris* div. sp., *Linopteris* div. sp., *Pecopteris* div. sp.) or Cordaitaleans (*Cordaites* div. sp.). Collections with such material are curated in Bucharest (University of Bucharest) and Cluj-Napoca (Babes-Bolyai University). These geosites certainly deserve the SSSI statute.

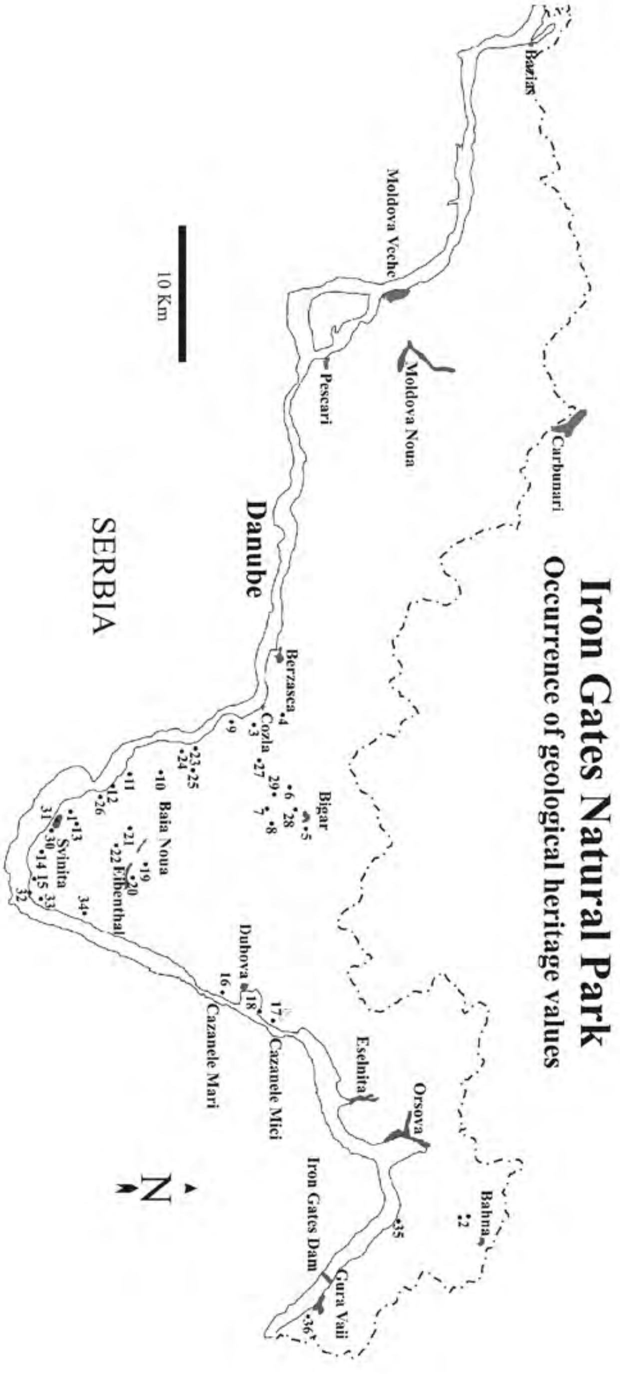
Important sites

These types of sites are recorded along the Danube Gorges and also inland. They are significant sites as they reflect an interesting geological aspect, becoming very useful from scientific, educational or esthetic points of view.

Between Stariştea and Elişeva Valleys occurs a thick continental Permian sequence, represented by tuffs and red beds. These tuffs, overlying the Stariştea porphyry, generated the Tachtalia waterfalls (Text-fig. 4, point. no. 23). Along the Elişeva Valley, the Permian volcanoclastic sequence is very well outcropped, showing excellent volcano – sedimentary structures (point no. 24). Few kilometers upstream occur the ruins of the Elişeva "Sovrom Uranium" mine (point no. 25), a former mine exploiting the Lower Permian sequences, for Uranium. Although this is not a typical "geosite", former mine galleries still give good outcrops in red beds and in volcanoclastic sequences.

On Povalina Valley, Permian tuffs are also very well outcropped (Text-fig. 4, point no. 26, Text+fig. 5). From Povalina, the Serbian Greben is best viewed, with its exquisite folds and faults in Middle and Upper Jurassic nodular limestones.

Sirinia Valley is important for its Middle and Upper Jurassic limestone outcrops with folds and faults (Text-fig. 4, point no. 27). Close to the Bigăr village, fossiliferous Middle Jurassic marls outcrop (the so called Bigăr beds), a lateral facies of the usual Dogger nodular limestones (point no. 28). Along the Sirinca Valley, beautiful, cross bedded, channel fills outcrop, Lower Jurassic in age (point no. 29).



Text-fig. 4 Distribution of SSSIs and geosites in the Iron Gates Natural Park. Sites of Special Scientific Interest (SSSIs): 1. Saraorschi SSSI; 2. Bahna SSSI. Geosites: 3. Cozla mine; 4. Camenița pit; 5. Bigăr (Palașca) coal mines (2 galleries); 6. Buschmann gallery; 7. Stanca gallery; 8. Pietrele Albe gallery; 9. Munteana-Dumbrăvița outcrops and "suspended" fold; 10. Trescovăț Peak; 11. Stariștea Valley; 12. Romanian Greben; 13. Zeliște and Veligan Peaks; 14. Tri Cule cuesta; 15. Selschi Creek; 16. Cazanele Mari; 17. Cazanele Mici; 18. Cazanele Mici (Urgonian pillars); 19. Baia Nouă; 20. Eibenthal; 21. Cucuiova; 22. Povalina. Important sites: 23. Between Stariștea and Elișeva Valleys; 24. Elișeva Valley; 25. Elișeva "Sovrom Uranium" mine; 26. Povalina Valley; 27. Sirinia Valley; 28. Bigăr beds; 29. Sirinca Valley; 30. Between Boștița Mare and Svinița (Iardumovacia) Valleys; 31. Svinița; 32. Between Iuți Valley and Selski Creek; 33. Iuți; 34. Tișovița Valley; 35. Vârciorova; 36. Between Gura Văii (Jidoștița) and Schela Cladovei.

Between Boştiţa Mare Valley and Sviniţa (Iardumovacia) Valley occurs the complete succession of Lower Jurassic to Lower Cretaceous deposits, outcropping along the road (point no. 30). At Sviniţa outcrops the Barremian fossiliferous marls, with *Phylloceras tethys*, *Silesites seranonis*, *Macroscaphites yvani*, etc (ammonites, point no. 31). Between Iuţi and Selski Valleys, few continental Miocene outcrops occur, with well preserved sedimentary structures (point no. 32).

At Iuţi (Text-fig. 4, point no. 33, Text+fig. 5), the gabbros quarry is still in good condition, while along the Tişoviţa Valley (point no. 34), massive serpentinite deposits outcrop (with dunites and serpentines). At Vârciorova, the contact between Severin Nappe and the Danubian Realm can be well observed (Text-fig. 4, point no. 35). This is a historical site, where Alexandru Codarcea understood the position of the Sinaia beds over the Danubian Realm deposits. Between Gura Vaii (Jidoştiţa Valley, point no. 36) and Schela Cladovei, Neogene (Pontian) continental deposits are well preserved along the road. These deposits are opened by the Schela Cladovei quarry.

The Iron Gates Natural Park represents one of the geologically richest areas in the South Carpathians. Unique preserved sites (Saraorschi and Bahna SSSIs), together with extremely valuable geosites (paleontological, some of them deserving the SSSI statute, mineralogical, structural, stratigraphical), and with important sites (sites interesting for research and education), make the Iron Gates Natural Park one of the most geologically important natural parks in Europe. The geology of the area represents the backbone of the entire ecosystem in the park, and the preservation of its heritage values has to be a priority for all conservation activities in the area.

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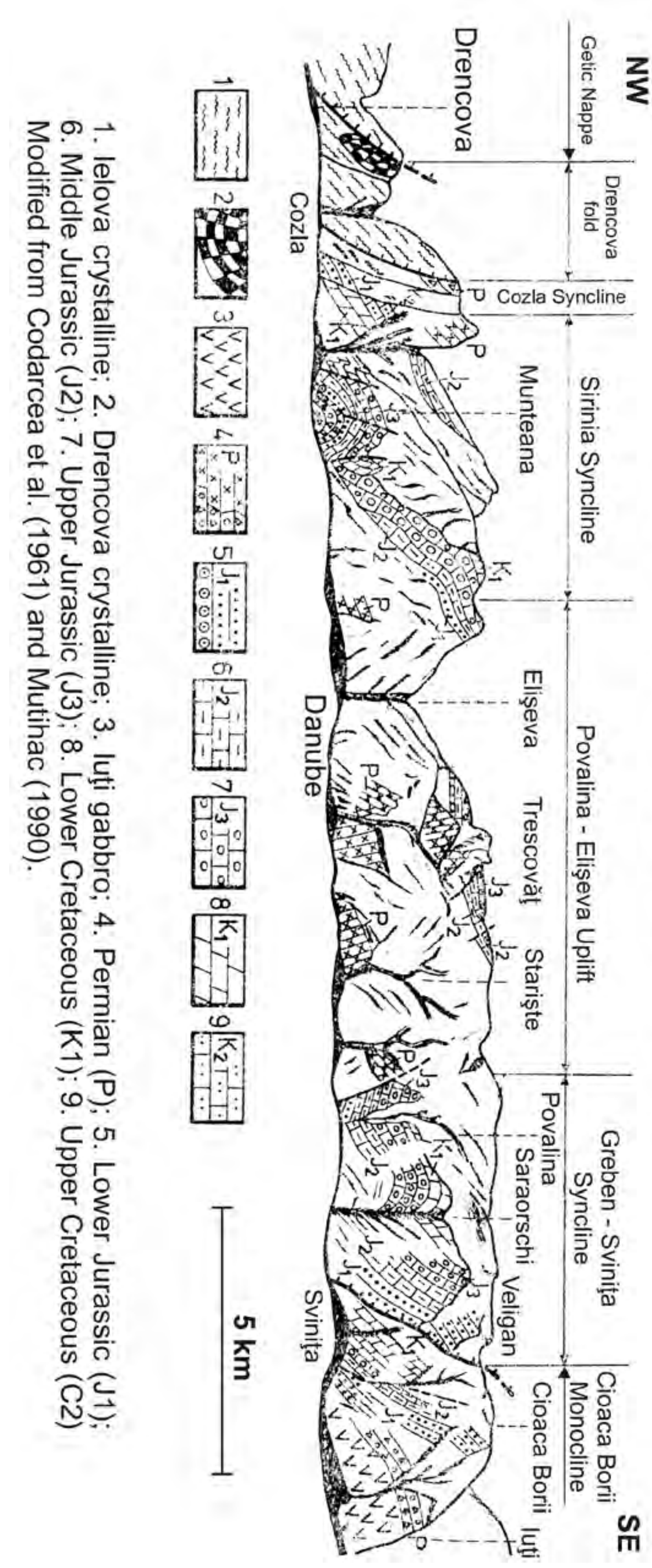

Text-fig. 5. Cross section through the Sirinia Basin, modified from Codarcea et al (1961), and Mutihac (1990).

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FIELD TRIP STOPS: DESCRIPTIONS

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PALEOZOIC AND MESOZOIC FORMATIONS IN THE REŞIȚA-MOLDOVA NOUĂ ZONE (SOUTH CARPATHIANS)

Bucur, I.I.

INTRODUCTION

The Reşița-Moldova Nouă zone is situated in the South-Western part of Romania (Fig.1) and constitute the Aninei Mountains and part of the Locva Mountains. The sedimentary succession of this area is represented by Paleozoic and Mesozoic formations, partly covered by Neogene deposits (Text-fig. 6)

PALEOZOIC FORMATIONS

Paleozoic deposits are well preserved on the western border of the northern compartment of Reşița-Moldova Nouă zone. The general succession of the lithostratigraphical units was presented by Bucur (1997):

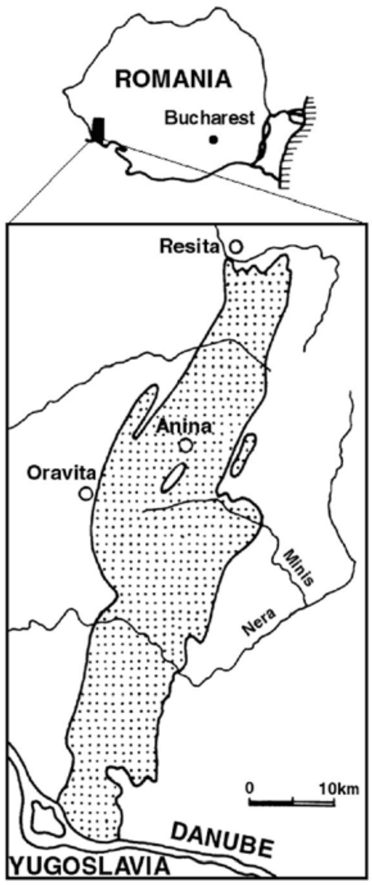
1. Reşița Formation (Bucur, 1991a) (Carboniferous) consists of three members:

1.a. Doman Member (Năstăseanu, 1978) (Westfalian). A breccious-conglomeratic complex, 100-300 m thick, consisting almost exclusively of crystalline elements.

1.b. Lupacu Bătrân Member (Năstăseanu, 1978) (Westfalian-Stephanian).

Conglomerates and sandstones, 200-400 m thick, with coal layers in the upper part. From the lower part of the succession, a flora containing *Neuropteris ovata, N. tenuifolia,* and *Linopteris neuropteroides* was described, while from the upper part *Annularia stellata, Alethopteris grandini, Calamites cisti, Pecopteris arborescens* were identified (Bițoianu, 1973).

1.c. Lupac Member (Năstăseanu, 1978) (Stephanian). A succession of sandstones and clays, 150-300 m thick, with coal. The deposits of this member provided a flora with: *Asterophyllum equisetiformis, Sphenophyllum alatifolium, Pecopteris cyathea,* and *P. longifolia* (Bițoianu, 1973).



Text-fig. 6 Location of the Reşița-Moldova Nouă zone on the map of Romania

2. Ciudanovița Formation (Bucur, 1991a) (Permian), having two members:

2.a. Gârlişte Clayey Member (Bucur, 1991a) (Autunian). Black clayey schists interlayered with sandstones, 80-100 m thick, with *Lebachia piniformis* and *Callipteris conferta*, as well as a microflora containing species such as *Florinites* and *Potonieisporites*.

2.b. Lişava Sandstone Member (Bucur, 1991a) (Autunian). Red conglomerates, sandstones and clays, about 1000 m thick, with an Autunian microflora in the lower part.

MESOZOIC FORMATIONS

1. Jurassic

Since the first research works (Kudernatsch, 1855, 1857), the complete Jurassic succession was evidenced in Reşiţa-Moldova Nouă zone. During the following decades, several researchers completed the knowledge on the Jurassic deposits with new paleontological arguments documenting the ages, and new details needed for defining the lithostratigraphical units. Important contributions belonged to Răileanu et al. (1957), Mutihac (1959) and Năstăseanu (1964). Bucur (1991a, b; 1997) presented the lithostratigraphical succession as follows (Text-fig.7):

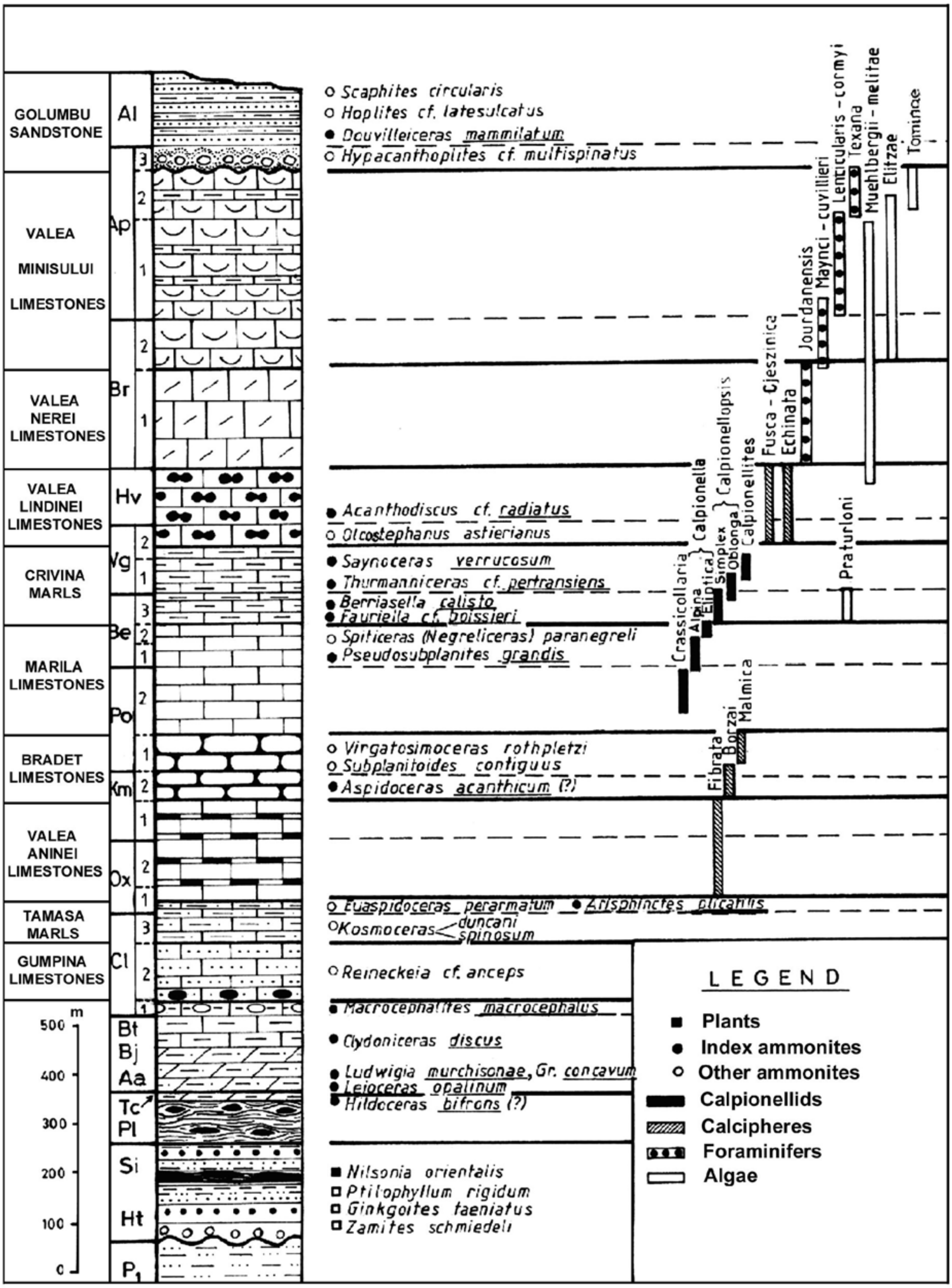
Steierdorf Formation (Bucur, 1991a), with two members: ***1.a. Budinic Conglomerate Member*** (Hettangian pro parte)**;** ***1.b. Valea Terezea Sandstone Member*** (Hettangian pro parte-Sinemurian) and

Uteriş Clayey Formation (Pliensbachian)**,** about 300 m thick in total. The first two members are mainly represented by rudites, arenites, lutites with macroflora-rich (*Zamites schmiedelii, Nilsonia orientalis, Ptilophyllum ririgidum, Ginkgoites taeniatus*) (Semaka, 1965; Givulescu, 1989; Popa, 199..) and microflora-rich (*Cyathidites minor, Dictyophyllidites harrisi, Vitreisporites pallidus, Lycopodiacidites regulatus, Osmundacidites wellannii*) (Antonescu, in Bucur, 1997) coal schists and coal interlayers. The formation consists of bituminous clays with scarce rests of macroflora, but with a relatively rich microflora association. The most significant species for age considerations are those debuting during Pliensbachian: *Foveosporites multifoveolatus, Calliallasporites dampieri, Perinopollenites elatoides*.

(3) Dealul Zânei Marly Formation (Bucur, 1991a) (Toarcian-Lower Callovian) (150-200 m thick) – a succession of marls and marly limestones. It starts with a layer of marls containing a bivalve lumaschell (small *Corbula* dominate), and ammonites (*Pseudogrammoceras cf. quadratum, Grammoceras fallaciosum* and ?*Hildoceras bifrons*) (Toarcian). Marls and marly limestones with *Leioceras opalinum, Ludwigia murchisonae, Graphoceras concavum* (Aalenian), marly limestones with *Gervillea lanceolata, Ostrea acuminata* (Bajocian), *Bositra buchi, Delecticeras delectum* and *Clydoniceras discus* (Bathonian) follow. The succession ends with a layer of marly limestones containing sandy carbonate concretions with *Macrocephallites macrocephallus* (Early Callovian).

(4) Gumpina Limestones Formation (Răileanu et al., 1957) (Middle Callovian) (120-150 m thick) – A succession of siliceous gritty limestones, having a basal layer of ellipsoidal silica nodules with *Reineckeia anceps*.

(5) Tamasa Marly-Limestones Formation (Răileanu et al.,1957) (Upper Callovian – Lower Oxfordian) (80-100 m thick). In the lower part, the succession consists of centimetric to decimetric gritty marly-limestones in plates, with *Kosmoceras duncani, K. spinosum,* and *K. gr. ornatum.* Towards the top, the deposits become progressively more carbonate-rich and contain forms of *Euaspidoceras perarmatum* and *Arisphinctes plicatilis*.



Text-fig. 7 General succession of the Jurassic and Lower Cretaceous deposits from the Reşiţa-Moldova Nouă zone (From Bucur, 1997).

(6) Valea Aninei Limestones Formation (Răileanu et al., 1957) (Upper Oxfordian – Lower Kimmeridgian) (200-250 m thick). A succession of decimetric layers of limestones rich in siliceous interlayers. In the upper part, allodaphic limestone levels can be frequently noted, as massive banks. They lack macrofauna. The only argument for dating is represented by the calcispherullid *Colomisphaera fibrata* (Bucur, 1992a).

(7) Brădet Limestones Formation (Răileanu et al, 1957) (Upper Kimmeridgian – Lower Tithonian) (80-100 m thick). Nodular limestones containing an ammonite fauna with ? *Aspidoceras acanthicum, Physodoceras cyclotum, Subplanitoides contiguus,* and *Virgatosimoceras rothpletzi.* Other forms identified within these deposits are *Saccocoma* sp., *Globochaete alpina,* as well as the age-marker calcispherullides *Carpistomiosphaera borzai* and *Parastomiosphaera malmica* (Bucur, 1992a). The Upper Tithonian – is included in the lower part of Marila Limestones – as micritic limestones with *Crassicollaria*.

2. Lower Cretaceous

The Lower Cretaceous deposits cover the largest areas within Reşiţa-Moldova Nouă zone, especially south from Minişului Valley. They usually constitue the infilling of the synclines representing the westwards extension of the Jurassic anticlines; in fact, the anticlines were overthrusting the synclines along important reverse faults with an eastwards vergence. The lithostratigraphic units and the age of the Jurassic deposits were defined in agreement with the current nomenclature rules since the first research-works; on the contrary, confusions persisted in time regarding the Early Cretaceous deposits, giving birth to various interpretations. The ammonite faunas (Avram et al., 1997; Avram, 1990), as well as the micropaleontological associations with calpionellids and calcispheres (Pop, 1974, 1989; Bucur, 1992a), calcareous algae (Bucur, 1977, 1992b, 1994a, b; Dragastan et al., 1978) and foraminifera (mainly orbitolinids) (Bucur, 1997) offered pertinent arguments for the establishment of a more detailed biostratigraphic succession within these deposits (Fig. 2):

(1) Marila Limestones Formation (Răileanu et al., 1957-pars) (Lower and Middle Berriasian) (200-250 m thick). Micritic limestones with *Pseudosubplanites grandis, Spiticeras (Negreliceras) paranegreli, Calpionella alpina* and *C. elliptica.* Towards the top, interlayers of limestones and marls with *Fauriella cf. boissieri, F. latecostata* and *Berriasella callisto,* or interlayers of allodaphic limestones with *Protopeneroplis ultragranulata* were noticed.

(2) Crivina Marls Formation, Răileanu et al., 1957 (Upper Berriasian – Upper Valanginian *pro parte*) (150-200 m thick). Consists of marls and marly limestones hosting a rich ammonite association, among which the most important ones are: *Thurmanniceras pertransiens, Th. thurmanni, Bochianites neocomiensis, Kilianella roubaudiana* and *Saynoceras verrucosum*. In the western part of the region (Ilidia), Crivina Marls are interlayered with allodaphic limestones with *Feurtillia frequens* and *Macroporella praturloni*. The age indicated by the ammonites is also supported by the calpionellids association: *Calpionellopsis simplex, C. oblonga* and *Calpionellites darderi*.

(3) Plopa Limestones Formation, Răileanu et al.,1957 (Upper Valanginian *pro parte* -Aptian), with two members:

(3.1.) Valea Lindinei Limestones Member, Bucur, 1988 (Upper Valanginian *pro parte* - Hauterivian) (about 150 m thick). Micrites and pelmicrites frequently containing chert nodules with ammonites (*Olcostephanus astierianus, O. cf. filosus, O. cf. scissus* and *Acanthodiscus radiatus*), foraminifera (*Montsalevia salevensis, Haplophragmoides joukowskyi, Spirilina italica*) and calcispheres (*Cadosina fusca cieszynica, Stomiosphaera echinata*). They represent slope deposits which progressively grade into the carbonate platform deposits of Barremian-Aptian age.

(3.2.) Valea Nerei Limestones Member, Bucur, 1991a (Upper Barremian) (150-200 m thick). Represented by massive banks of limestones, mainly bioaccumulated, sometimes containing corals, hydrozoans and rare rudists, as well as a rich association of foraminifera and calcareous algae. Among the foraminifera of biostratigraphic importance one can mention: *Paracoskinolina? jourdanensis, Cribellopsis thieuloyi,* and *Paleodictyoconus cuvillieri.* The algae association consists of dasyclads, halimedaceans, rhodophytes and rivulariaceans (Bucur, 1994a). Some of the most important species are: *Angioporella furyae, Macroporella incerta, Suppiluliumaella (Montenegrella) tuberifera Similiclypeina paucicalcarea, Salpingoporella muehlbergii, S. melitae, Palaeosiphonium convolvens* and *Pseudolithothamnium album.*

(4) Valea Minisului Limestones Formation, (Raileanu et al., 1957) (Upper Barremian - Gargasian) (300-400 m thick) – bioaccumulated limestone interlayered with marls containing *Toucasia carinata, T. compressa, Requienia cf. gryphoides, Cladocoropsis cretacica, Salenia prestensis, Heteraster oblongus, Terebratula sella, Trochonerita mammaeformis* and a rich foraminifera and calcareous algae association. Among the foraminifera, the most important ones are the orbitolinids: *Paracoskinolina maynci, Paleodictyoconus arabicus, Palorbitolina lenticularis, Praeorbitolina cormyi, Orbitolina (Mesorbitolina) gr. parva-minuta* and *O.(M.) texana*, as well as *Neotrocholina friburgensis*. A rich calcareous algae association was identified besides the foraminifera. Among the dasyclads, *Bakalovaella elitzae* is the most frequent species within this lithostratigraphical unit. Other important forms are: *Angioporella(?) bakalovae, Cylindroporella pedunculata, Cymopolia(?) dubia, Falsolikanella danilovae, Falsolikanella nerae, Kopetdagaria sphaerica, Neomeris cretacea, Pseudoactinoporella fragilis, Rajkaella banatica, Salpingoporella melitae, S. muehlbergii, S. patruliusi, Suppililiumaella praebalkanica, Triploporella carpatica, Zittelina hispanica, Arabicodium meridionalis, Boueina hostetteri, Halimeda fluegeli, Parakymalithon phylloideum, Sporolithon rude, Permocalculus ampulacea,* and *Pseudolithothamnium album.* (Bucur, 1994a, b; 1997)

Valea Nerei and Valea Minisului Limestones represent carbonate platform deposits which form together an urgonian biosedimentary system.

(5) Gura Golumbului Sandstone Formation, Răileanu & al., 1964 (Upper Clansayesian - Albian) (100-150 m thick) – glauconitic sandstones with thin interlayers of gritty clays and rare banks of gritty limestones containing ammonites: *Hypacanthoplites* cf. *multispinatus, Douvilleiceras mammilatum, Hoplites* aff. *escragnolensis, H.* cf. *latesulcatus, Hamites compressus* and *Scaphites circularis*.

South of Nera, along the Radimnei Valley, the Albian is present as a carbonate-gritty facies (**Radimna Gritty-Limestones Formation,** Raileanu & al.,1964) with *Paraphyllum primaevum*.

The presence of Clansayesian deposits in the base of Gura Golumbului Sandstone was proved by *Hypacanthoplites cf. multispinatus*. This is an argument for attributing an Late Gargasian-Early Clansayesian age for the short sedimentary hiatus induced by "the first Getic overthrusting stage".

3. Tentative biozonation of the Jurassic and Lower Cretaceous deposits of the Reşiţa-Moldova Nouă zone

The microorganisms which may be used for the Jurassic and Cretaceous biozonation in Reşiţa-Moldova Nouă zone are the calpionellids and calcispheres (in the case of deep sea deposits) on one hand, and the foraminifera and the calcareous algae (in the case of carbonate platform deposits), on the other hand.

3.1. Biozonation of Oxfordian-Hauterivian based on calpionellids and calcispheres (Text-fig. 8)

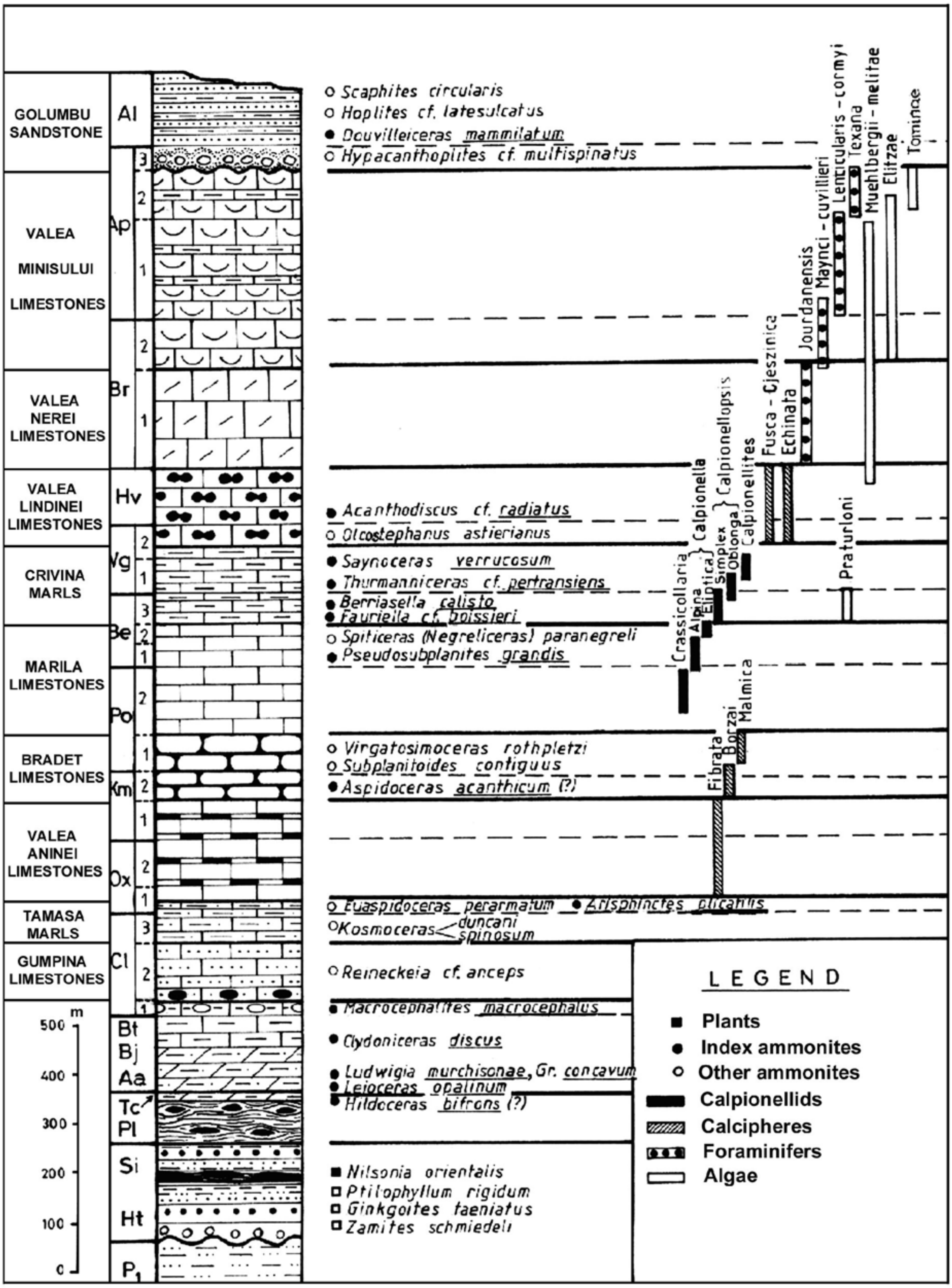
For this stratigraphic interval we attempted a combined biozonation based on calcispheres and calpionellids. As regards the calpionellids, beside our results we used the more detailed data of Pop (1974, 1989). This author identified the four standard zones of calpionellids (cf. Allemann et al. 1971) within Marila Limestones and Crivina Marls, i.e. *Crassicollaria, Calpionella, Calpionellopsis* and *Calpionellites*, each of them having two or three subzones, as follows: *Crassicollaria* biozone with *Cr. intermedia* and *Cr. brevis* subzones; *Calpionella* biozone with *C. alpina, Remaniella* and *C. elliptica* subzones; *Calpionellopsis* biozone with *C. simplex, C. oblonga* and *Precalpionellites murgeanui* subzones, and *Calpionellites* biozone with *C. darderi* and *Tintinnopsella* subzones (Pop, 1989). On this biozonation scheme we superposed the vertical distribution of the most important calcisphere species; thus the calpionellid biozonation was completed with four calcisphere zones (Fig 3): *Colomisphaera fibrata* biozone (or *Fibrata* biozone) for Late Oxfordian-Early Kimmeridgian; *Carpistomiosphaera borzai* biozone (or *Borzai* biozone) for Late Kimmeridgian; *Parastomiosphaera malmica* biozone (or *Malmica* biozone) for Early Tithonian, and *Stomiosphaera echinata* biozone (or *Echinata* biozone) for Late Valanginian-Hauterivian. Within Late Tithonian-Early Valanginian time interval, where the calpionellids biozonation is used, the calcispheres are widely occuring and have no biostratigraphic significance, except for *Cadosina minuta* (BORZA), which seems to have a limited occurrence in the Late Berriasian.

3.2. Biozonation of Late Berriasian-Aptian based on foraminifera and algae

The foraminifera and calcareous algae associations identified in the allodaphic interlayers from the uppermost part of Marila Limestones and Crivina Marls, as well as from the two lithostratigraphical units of the urgonian sedimentary system (Plopa and Valea Minişului Limestones) allowed us to separate several biozones. They are mainly based on foraminifera and some associated algae species (Fig 4). The following biozones were separated (Bucur, 1997):

1. *Andersenolina alpina - A. cherchiae* and *Protopeneroplis ultragranulata* Biozone (Late Berriasian-Early Valanginian);
2. *Montsalevia alevensis* Biozone (Late Valanginian - Hauterivian);
3. *Paracoskinolina? jourdanensis* Biozone (Early Barremian);

4. *Paracoskinolina maynci, Paleodictyoconus cuvillieri* and *Neotrocholina fribourgensis* Biozone (Late Barremian – Early Aptian *pro parte*);
5. *Palorbitolina lenticularis and Praeorbitolina cormyi* Biozone (Early Aptian), and
6. *Orbitolina (Mesorbitolina) texana* Biozone (Late Aptian, i.e. Gargasian).



Text-fig 8. Repartition of the biozone index-calpionellids and calcispherulids within the Upper Jurassic deposits of the Reşiţa-Moldova Nouă zone (From Bucur, 1997).

They were completed with five dasyclad zones, as follows:

1. *Macroporella praturloni* Biozone (Late Berriasian – Early Valanginian);

Salpingoporella muehlbergii Biozone (Late Hauterivian - Aptian);

2. *Salpingoporella melitae* Biozone (Early Barremian *pro parte* – Early Aptian);
3. *Bakalovaella elitzae* Biozone (Late Barremian - Aptian), and
4. *Heteroporella(?) tominae* Biozone (Late Aptian, i.e. Gargasian).

Text-fig.9 lustrates a tentative correlative biozonation for the whole Jurassic – Early Cretaceous interval. Besides the ammonite zones identified along the succession, also the above mentioned calpionellidds, calcispheres, foraminifera, and algae biozones are marked.

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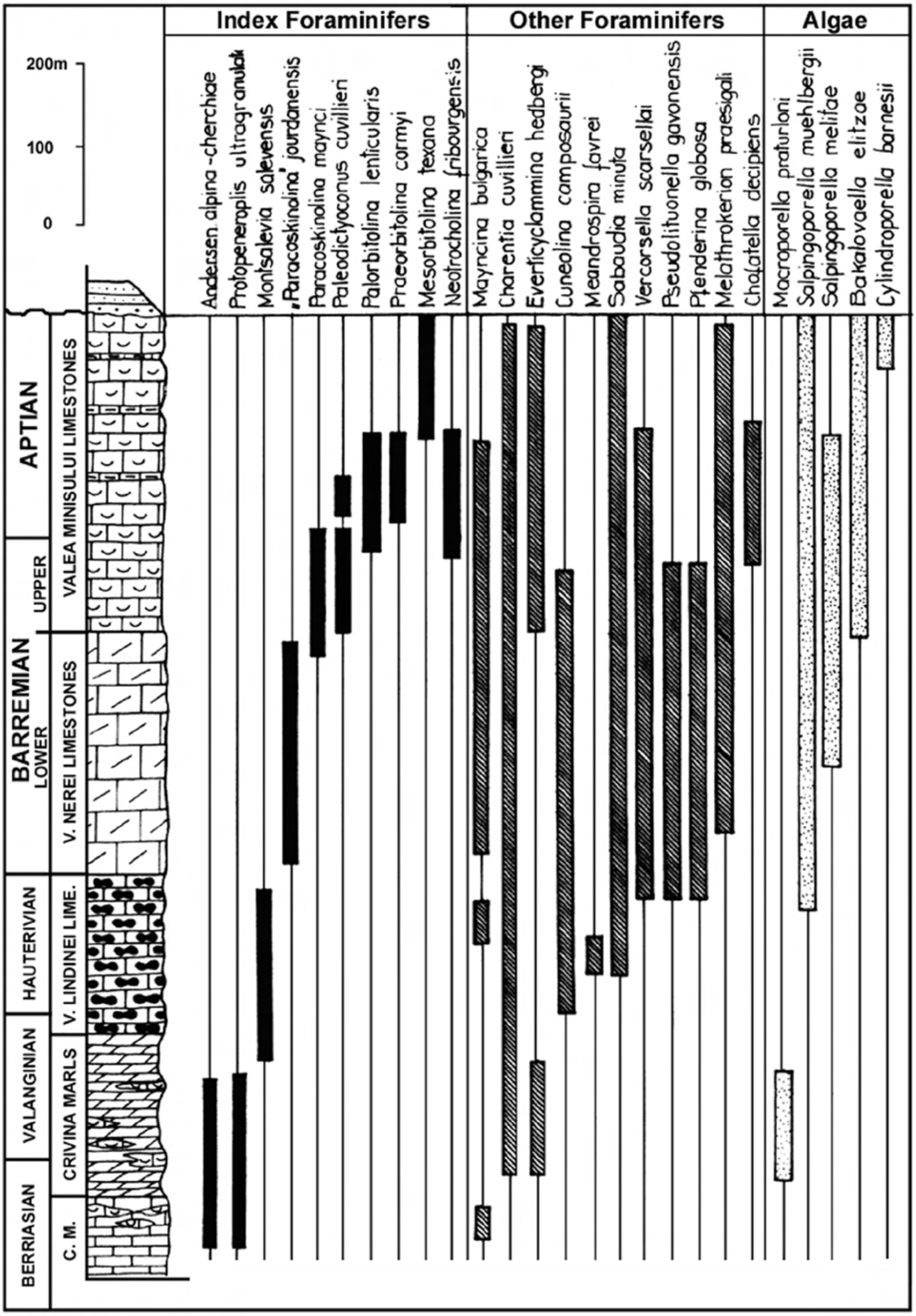


Text-fig. 9, Repartition of the biozone index-foraminifera and calcareous algae within the Lower Cretaceous deposits of the Reşiţa-Moldova Nouă zone (From Bucur, 1997).

Day 1: 31 August 2009

Stop 1: Cazanele Mici, Dubova

Popa, M.E. and Visan, M.

Location: Dubova Gulf, North of Dubova village, in the Cazanele Mici SSSI (Site of Special Scientific Interest), its southern end.

Description: The Cazanele Mici (Little Cauldrons) represent the narrowest segment of the Danube in the South Carpathians. The gorges, in both Romanian and Serbian banks, are generated by thick Lower Cretaceous (Barremian – Aptian) limestone, and they are separated from the Cazanele Mari (Greater Cauldrons) by the Dubova Gulf. The sedimentary deposits of the Danubian Units in Cazanele Mici are represented by Tithonian? – Neocomian – Barremian – Aptian massive limestone, their upper sequence including the Urgonian facies with pachyodonts. The limestone is unconformably overlain by the Nadanova Formation marls (Late Albian – Middle Turonian), overlain at its turn by a shaly formation with olistoliths including Tithonain – Neocomian flysch of Sinania-type and Urgonian limestone. The Severin Nappe, overthrusting the Danubian units, is represented by Sinaia-type flysch (Sinaia Formation), overthrusted by gneisses and micashists belonging to the Getic Nappe (Text-fig. 10).

Stop 2: Cazanele Mici, Eşelniţa

Popa, M.E.

Location: Immediately South of Eşelniţa village, in the Cazanele Mici SSSI (Site of Special Scientific Interest), its northern end.

Description: Urgonian limestone of the Cazanele Mici gorges, outcropping to their downstream end, belonging to the Danubian Units. From this point can be observed Tabula Traiana, a Roman carving on the Serbian bank of the Danube.

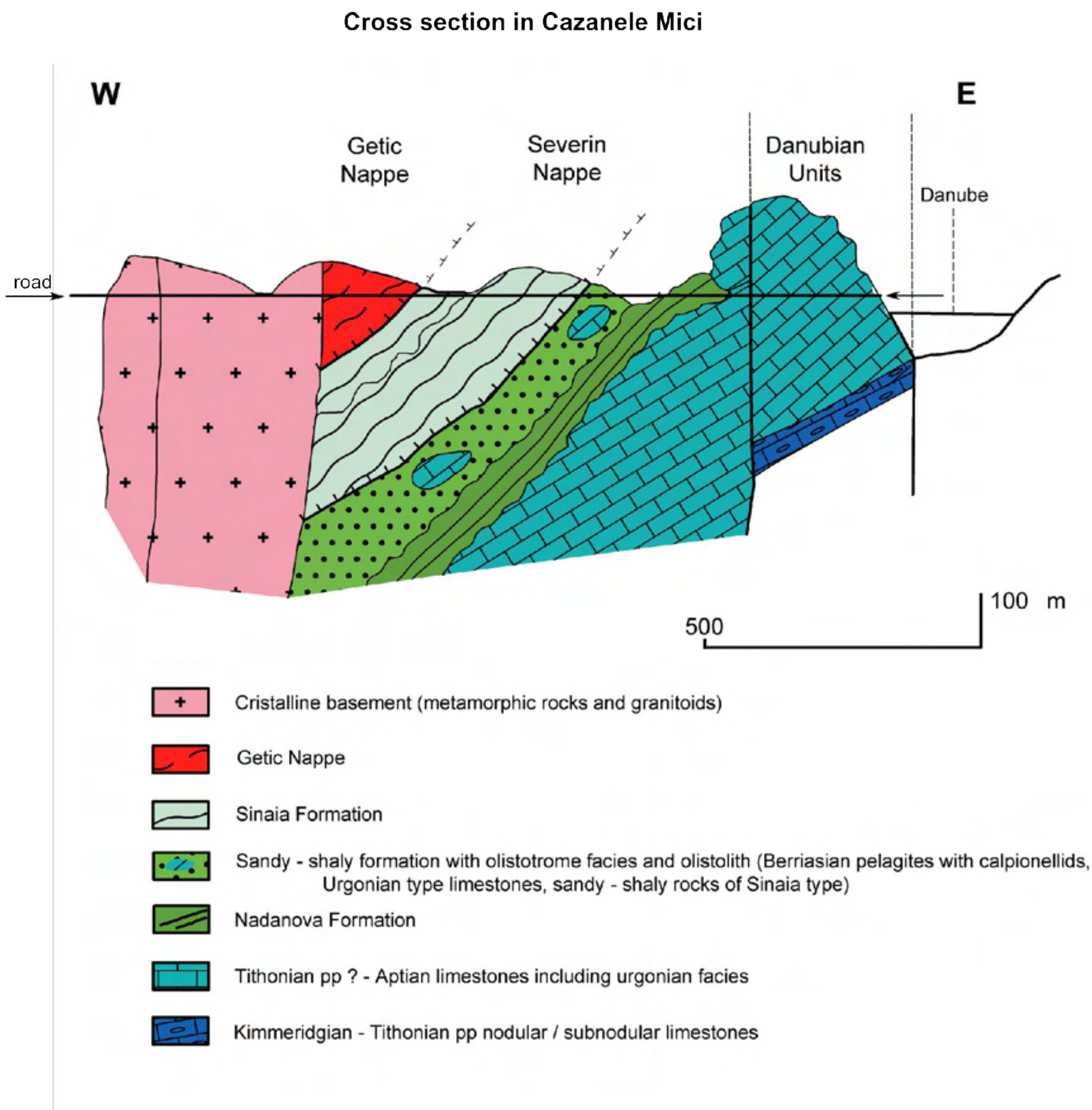
Day 2: 1 September 2009

Stop 3. Ivănici bridge

Popa, M.E.

Location: Confluence between the Ivănici creek and the Danube, next to the Ivănici bridge.

Description: The Sinaia Formation (known also as "the Sinaia Beds"), Upper Tithonian – Lower Valanginian in age, belongs to the Severin Nappe, overlying the Danubian sediments and basement. The Sinaia Formation is represented in this outcrop by flysch sequences with syndepositional folds, subsecquently deformed tectonically, carbonatic and fine detritic, showing Bouma sequences. The fossil record includes *Tintinopsella carpatica* and *Calpionella alpina* (Pop et al., 1997).



Text-fig. 10, Cross setion in Cazanele Mici, modified after Pop. et. al. 1997

Stop 4. Iuți

Popa, M.E.

Location: The confluence between Iuți and Danube Valleys, next to the Iuți Bridge.

Description: The Iuți gabbro belongs to the Danubian Units basement (Internal or Upper Danibian Units), it is included in the Tişovita-Iuți ophiolite sequence (Măruntiu, in Pop et al., 1997), as its plutonic component. The sequence was reconstructed as yielding a peridotitic base (dunites, harzburgites), cumulate rocks (dunites, gabbros), and an effusive sequence (basalts, dolerites). The outcrop shows the Iuți gabbro with aplitic dykes, fractured by a series of faults. The age of the gabbro is Pre-Carboniferous, as it is unconformably overlain by the Upper Carboniferous coal measures represented by the Cucuiova Formation (Westphalian D – Cantabrian – Barruelian in age, in Popa, 2005).

Stop 5. Pârâul Roşu (Selschi Ogaş)

Popa, M.E.

Location: The confluence between Pârâul Roşu (Selschi Ogaş, Red creek) and the Danube Valleys, next to the Selschi bridge.

Description: The Permian red beds belonging to the Povalina Formation (Stănoiu and Stan, 1986, Seghedi et al., 2001) overlain unconformably the Iuți gabbro along the Danube Valley, as a basal breccia over the gabbro can be described downstream. A basaltic dyke of unknown age outcrops as well. This stop also shows Tri Cule ruins (a XVIII-th Century fortress), Cioaca Borii cuesta (Lower Jurassic, see Stop 6), along the Romanian bank of the Danube, and Donji Milanovăț village and Porecka Valley, along the Serbian Bank.

Stop 6. Svinița

Kedzior, A., Popa, M.E.

Location: Svinița village, along the Țiganului (Gipsy) Creek, between Zelişte and Veligan peaks.

Description: The Cioaca Borii Beds oucrop above the Svinița village along a prominent cuesta, the seame sequence outcropping upstream of Selschi Ogas (Red Creek), described in stop 5. This basal, coarse sequence is overlain by Lower Jurassic (Hettangian and Sinemurian) sandstones, it is the first Mesozoic sedimentary sequence, and it overlays unconformably the Permian red beds of the Povalina Formation. The Cioaca Borii Beds are a 200m thick sequence of clastic deposits, and they are represented by conglomerates and coarse-grained sandstones, with numerous erosional surfaces at the base of conglomeratic sequences. The clasts inventory mainly consists of quartz and lithic grains up to 25-30 cm in diameter. Inside several conglomeratic layers can be observed the imbrication of clasts and typical cross bedding. The thickness of bodies embedded between erosional surfaces rarely exceed 3 m. The preliminary observations allow to conclude a fluvial origin of Cioaca Borii deposits above Svinița. The sedimentary features, geometry and thickness of conglomerate/sandstone bodies, shape and distribution of erosional surfaces suggest a braided river system.

Stop 7. Munteana

Popa, M.E.

Location: Munteana, about 10 km downstream of Cozla, along the Danube Valley, the Jurassic formations outcropping along the DN57 road.

Description: The Jurassic formations belonging to the Sirinia Basin, Internal Danubian Units, outcrop continuously along the Danube Valley, in a series of anticlines and synclines, among which the most notable are the Munteana monocline and the Munteana Dumbrăvița suspended fold, among the most impressive structural features in the Danube Gorges (Text-fig.17). The Jurassic formations overlay unconformably the Permian volcaniclastic Trescovăț and the terrigenous Povalina Formation, also Permian in age, towards Dumbrăvița (downstream of Munteana). The sediments span Lower Jurassic (Hettangian – Sinemurian) to Upper Jurassic (Tithonian) ages, and they are unconformably overlain by the Berriasian Murguceva Formation. The Munteana outcrop has also a historical significance, as the

Austrian paleontologist U. Schloembach died here in 1870 while collecting fossils, aged 32. The formal stratigraphic description of the succession was given by Pop (Pop et al. 1997).

1. **Munteana Formation**, Pliensbachian – Aalenian in age, represented by shallow marine, calcareous sandstones, to its base being recorded a chamositic-oolithic sequence. The fossil content is very rich in foraminifers (*Textularia*, *Frondicularia*, *Spiroloculina*), bivalves (*Pleuromya liasina*, *Entolium liasinus*, *Plagiostoma gigantea*, *Pinna sturii*, *Ceromya infraliasica*, *Gresslya petersi*, *Pseudopecten hinterhubertii*, *Hildoceras bifrons*, *Litoceras jurense*, etc.), brachyopods (*Terebratula gretenensis*, *T. punctata*, *Spiriferina tumida*), belemnites (*Megateuthys paxillosus*) and ammonites (*Amblicoceras planicostatus, Amaltheus margaritatus, Paltopleuroceras spinatum, Becheoceras beckei, Androgynoceras carpicornus, Grammoceras normandianum*), nautiloids (*Nautilus latidorsatus*) (Răileanu, 1963, Codarcea et al., 1961, Rusu, 1968). Pop, in Pop et al. (1997), cited the *jamesoni*, *ibex* and *davoei* biozones (indicating the Carixian), *stokesi*, *margaritatus* and *spinatum* zones (indicating the Domerian), and the *serpentinus*, *bifrons* and *insigne* zones (indicating the Toarcian).

2. **Seretina Formation**, Bajocian – Callovian in age, represented by red, nodular limestone. Includes ammonites (*Calliphylloceras disputabile*, *C. manfredii*, *C. zignodianum*, *Macrocephallites macrocephallus* var. *canizzaroi*, *Ptychophylloceras feddeni*, *Choffatia subbackeriae, Phylloceras kudernatschii, Oxycerites aspidioides, O. fuscus, Stephanoceras humphresianum*), belemintes (*Hibolites hastatus*), brachyopods (*Terebratulla bullata, Rhynchonella quadriplicata*), bivalves (*Posidonia alpina*). To its top were recorded *Calliphylloceras zignodianum*, *Sowerbiceras tortisulcatum*, *Macrocephallites macrocephalus* var. *canizzaroi*, etc. (Pop, in Pop et al., 1997).

3. **Zelişte Formation**, Oxfordian – Early Kimmeridgian in age, represented by limestone with *Calliphylloceras manfredii* and *Calomisphaera fibrata* (Pop, in Pop et al.,1997).

4. **Greben Formation**, Middle Kimmeridgian – Early Berriasian in age, represented by red and greenish nodular limestone and white limestone with ammonites (*Aspidoceras acanthicum*, *A. cyclotus*, *Perisphynctes simoceroides*, *P. scorus*, *Taramelliceras strombecki*, *Phylloceras isotypum*, aptichus such as *Laevaptichus latus*, *L. obliquus*, *Lamellaptychus beirichii*, indicating the Kimmeridgian, *Subplanites contiguus*, *Lytoceras montanum*, *Streblites lithographicum*, indicating the Tithonian, and *Berriasella pontica*, *Neocosmoceras sayini*, indicating the Berriasian, etc.). Pop, in Pop et al. (1997) described allodapic calciturbidites and debris flow interbeds.

5. **Murguceva Formation**, Middle Berriasian – Late Hauterivian in age, represented by pelagic limestone of Majolica type, with ammonites, calpionellids, nannoplankton, spores and pollen (Răileanu, 1953, Avram, 1976, Pop, in Pop et al., 1997).

The entire succession is strongly folded and faulted along the Danube's bank.

Stop 8. Gaura cu Muscă

Bucur, I.I.

Location: Gaura cu Muscă Cave, about 7 km downstream from Coronini village, along the road.

Description: Lower Cretaceous, massive limestone, belonging to the Resita Basin, Getic Nappe.

Day 3: 2 September 2009

Stop 9. Anina: Ponor and Colonia Cehă Quarries

Popa, M.E. (2001)

Location: Anina, formerly known as Steierdorf (which is now a part of the whole town), occurs at 35 km south of Resita, the main town of the region (Caras-Severin County). Anina is a coal mining locality in which coal extraction dates back to 1792, when the first coal seams were discovered. The Anina mine was closed in 2006.

Anina is a very important locality for the paleobotany and palynology of the Lower Jurassic deposits in Romania, as the paleoflora is very diverse and well preserved, this making of Anina a fossile-Lagerstatte locality. The Lower Jurassic deposits are outcropped naturally (along Terezia Valley) or artificially, in open cast mines such as Ponor or Colonia Cehă. Underground coal exploitation mines were the deepest in Romania (1300 m deep in the Northern Coalfields accessed by the Pit I). The undergound mining horizons outcroped three dimensionally the Liassic deposits that could be studied not only along vertical stratigraphic profiles but also within their lateral development at almost all stratigraphic levels of the coal measures. In this way, paleobotanical and palynological studies could be carried out in great detail, with the paleoflora control in stratigraphic succession and in surface distribution.

Between 1994-2000, Anina included a paleobotanical reserve known as the Ponor Quarry (Site of Special Scientific Interest) within the southern area of a former open cast mine for refractory clay (Ponor Quarry, near the ruins of the former Ponor Pit). This will be the visited site, close to the Steierdorf part of the Anina town.

Description: Both quarries, together with other open cast mines (Hildegard) and underground mining works were opened along the western flank of the Anina Anticline. In the Resita Basin, the Lower Jurassic deposits belong to the Steierdorf Formation (Bucur, 1991, 1997, Popa and Kedzior, 2008, Popa, 2009), with two members: Dealul Budinic Member (Lower Hettangian) and Valea Tereziei Member (Middle Hettangian – Sinemurian) and to the Uterş Formation (Pliensbachian – Middle Toarcian).

The entire Steierdorf Formation is outcropped within the Ponor and Colonia Cehă Quarries, along the southern side of the former Ponor open cast mine. Structurally, this area occurs on the western flank of the Anina anticline, where all the sedimentary layers have a vertical position and they can be surveyed stratigraphically from east towards west, from older to younger sequences.

The Dealul Budinic Member, is the lowermost sequence of the Steierdorf Formation and it has its type section in Doman, close to Resita town. It is represented by coarse deposits such as conglomerates, microconglomerates, coarse sandstones and rare clays, all being deposited within alluvial conditions. Very scarce micro- or macroflora is preserved within this member. In the area of Ponor Quarry, this sequence can be observed close to the mine headquarters position.

The Valea Tereziei Member is the coal bearing member of the Steierdorf Formation. This member is represented by various types of sandstones, conglomerates, clays of different types and coal seams, with a very rich content in micro- and macroflora. Its deposition is characterized by intramontane depression sedimentary conditions, such as fluvial, lacustrine, flood plain and coal generating swamp conditions. Generally, Valea Tereziei Member has 8 coal seams recognized in the central part of the Resita Basin (Anina area) and a refractory clay seam between the Coal seam no. 3 and 4 marking the Hettangian-Sinemurian boundary. The Hettangian-Sinemurian boundary is marked by a floral change as a result of climatic change indicated by the boundary of the Assemblage zone with *Thaumatopteris brauniana* (Hettangian) with the Acme zone of *Nilssonia* cf. *orientalis* (Sinemurian) (Popa, 2000a, b, 2009). The floral change was recorded in detail in all daylight or underground outcrops (mining horizons) of the Valea Tereziei Member in Resita Basin, especially in Anina. This member can be well observed, close to the former Ponor Pit and to the directional gallery for refractory clay extraction that has its entrance close to the pit.

The Uteriş Formation, overlying the Steierdorf Formation, is Pliensbachian – Middle Toarcian in age and it is represented by black shales with siderite concretions of various shapes and sizes, with a rich content in microflora and fauna, while the macroflora is less frequent. Depositionally, it is characterized by deep anoxic lake or lagoon conditions. The Uteriş Formation can be observed westwards of the Ponor Pit, along the first stair of the Ponor Quarry. The Uteriş Formation is overlain by the marly Dealul Zânei Formation (Upper Toarcian – Callovian), which outcrops extensively in the quarry, where the stratotype of this formation occurs as well.

The Steierdorf Formation outcrops ideally with all its members in the Ponor Quarry and this is why, as the paleobotanical contents of the formation is very rich, the preserved site has such an abundance in mega- and microfossil plant remains. From Ponor site were even recorded the first Mesozoic tetrapod tracks in Romania (*Batrachopus* cf. *deweyi*, in Popa, 2000a, c). In Colonia Cehă, Popa and Kedzior (2006) described vertebrate burrows in the basal red beds of the Steierdorf Formation, produced by crocodilians or dinosaurs.

The paleoflora recorded from Ponor and Colonia Cehă Quarries counts more than 80 taxa, belonging to Bryophyta, Pteridophyta and Gymnospermophyta. The Bryophytes are very rarely encountered in the fossil record, as their potential of being fossilised is extremely low, taking in consideration their paleoenvironment. In spite of this, in Ponor Quarry was recorded *Hepaticites* cf. *arcuatus*, a moss belonging to Hepaticae. The Pteridophytes are very abundant (Popa, 1997), such as the true ferns (Filicopsida) but also the horse-tails (Sphenopsida), while the club-mosses (Lycopsida, Isoetales) were recorded only from underground mining horizons. As important ferns from Ponor Quarry can be cited *Marattia intermedia* (Marattiales), *Thaumatopteris brauniana*, *Hausmannia buchii*, *H. ussuriensis, Dictyophyllum nervulosum*, *D. nilsonii* (Filicales, Family Dipteridaceae), *Osmundopsis sturii* (Osmundaceae), *Matonia braunii*, *Phlebopteris woodwardii* with in situ spores (Family Matoniaceae), *Kylikipteris arguta* with in situ spores and the oldest known record (Hettangian), *Coniopteris murrayana* (Family Dicksoniaceae) or *Cladophlebis denticulata*, *C. nebbensis*, *C*. sp. *X* (Incertae sedis), etc.

The gymnosperms are very abundant as well, with pteridosperms (Corystospermales, Caytoniales), cycadopsids (Cycadales and Bennettitales), ginkgoals (Ginkgopsida) and conifers (Coniferopsida). The Corystospermalean pteridosperms show an interesting Hettangian assemblage with *Pachypteris speciosa*, a coal generator and a swamp dweller with berets, female reproductive structures (*Umkomasia* sp.), roots and branches, *P. rhomboidalis*, (Hettangian-Sinemurian) and *Ptilozamites cycadea* (the latter belonging to Incertae sedis pteridosperms). Caytonialeans are represented mainly by *Sagenopteris* foliage. The Hettangian bennettites are recorded only with *Pterophyllum* species (*P. longifolium*, *P.*

andraeanum), while their Sinemurian representatives are more abundant. Such is the coal generator *Zamites schmiedelii* with *Weltrichia banatica* male reproductive structure, *Z. aninaensis*, *Ptilophyllum maculatum* with *Weltrichia alfredi*, *Otozamites molinianus*, which is more frequent within the Dealul Zinei Formation, and many other species. This difference in bennettitalean abundance and content is a climatic driven effect recorded not only for the bennettites but for other plant groups as well, within all profiles of Valea Tereziei Member. True cycadaleans are represented by *Nilssonia* cf. *orientalis*, *N. banatica*, *, N. undulata*, *Ctenis* sp., etc. Ginkgoaleans are frequent too, especially *Sphenobaiera longifolia* with its seeds, and *S. grandis*. The conifers are represented by various types of foliage (*Brachyphyllum*, *Pagiophyllum*, *Geinitzia, Podozamites*) or cones (*Elatides*, ?*Ourostrobus*), some of them being coal generators, such as *Podozamites paucinervis*, a Hettangian broad leaf conifer (Incertae sedis).

The uppermost levels of the quarry outcrop Hettangian and Siemurian fossiliferous sites, such as the sites P39/C2 – P45/C2, very rich in plant material. Leaves and branches are usually in situ, associated with flood plain deposits and paleosols. Trunks are usually transported and they can be recorded in channel fill and crevasse splay deposits.

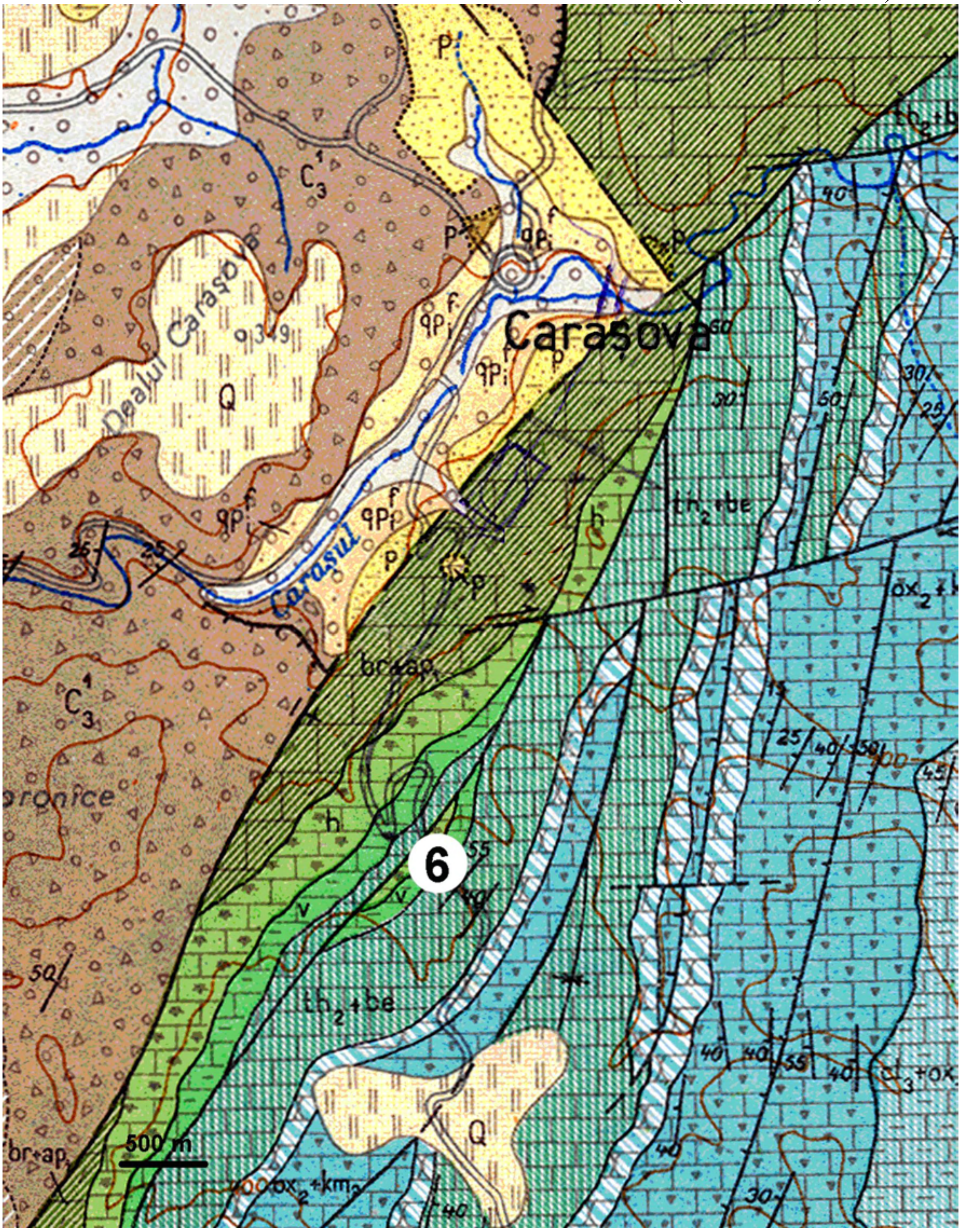
The lowermost level of the quarry outcrops large structural surface which is a paleosol in vertical position. Stratigraphically, this structural surface is Sinemurian in age, it belongs to the Valea Tereziei Member, and it occurs between the equivalents of the Coal seams no. 6 and 7, over the refractory clay seam which was exploited along the second ground of the quarry (the following, upper stair). Within the outcrop, the B microhorizon of a flood plain paleosol shows in situ trunks of the tree fern species *Cladophlebis denticulata* (Incertae Sedis, probably belonging to Family Osmundaceae, Order Filicales). The trunks are more or less circular in outline, 10-30 cm in diameter, and they are caught in a black, lithic sandstone rich in rhizoid remains. Their state of preservation is good enough although the coal remains of the trunks is continuously weathered. The A microhorizon of the paleosol is scarcely preserved as it is a coal, shaly clay, preserving a dense, monotypical association of *Cladophlebis denticulata* foliage. This foliage was shed from the top of the living tree ferns and this is the proof of the trunks systematic affinity. The density of the trunks in the surface is high, indicating a forest environment. This site with its paleosol outcrop is unique in Europe.

Stop 10: Caraşova

Bucur, I.I.

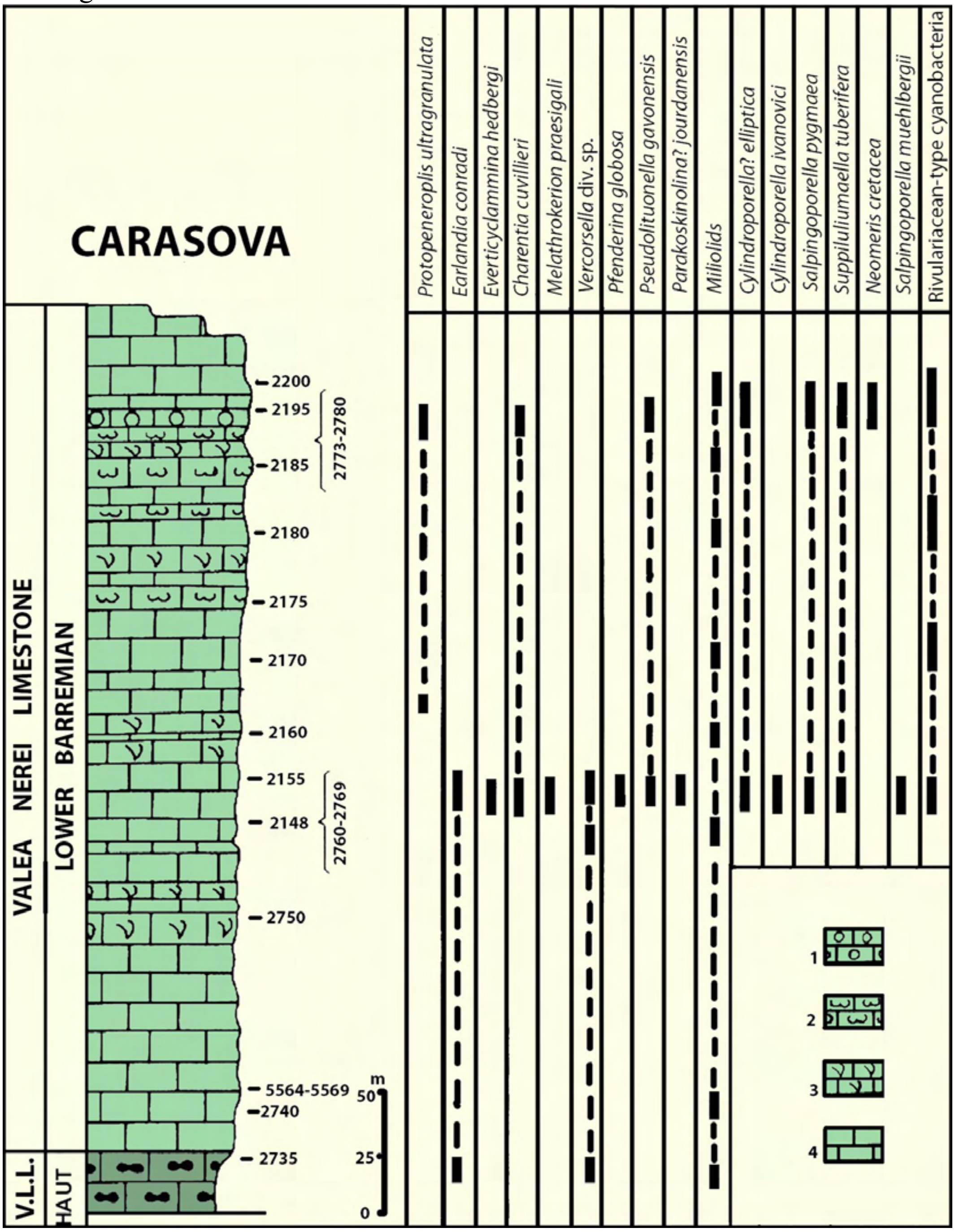
Location: Near the road between Reşiţa and Anina, next to Caraşova village (**Fig. 1**).

Description: The Upper Jurassic-Lower Cretaceous deposits occur along the road. The succession starts with Marila Limestones (Upper Tithonian -Berriasian), followed by Crivina Marls (Berriasian-Valanginian), Valea Lindinei Limestone Member (Upper Valanginian r-Hauterivian), and Valea Nerei Limestone member (Lower Barremian). The last two members belong to the Plopa Limestone formation. The Marila Limestone bear calpionellids (covering the time interval of the *Crassicollaria* biozone to the Simplex subzone of the *Calpionellopsis* biozon). Calpionellid occurence continue in the Crivina marls covering the *Calpionellopsis* biozone (Oblonga subzone) and the *Calpionellites* biozone. Avram (1990) identified in the Crivina marls the ammonites ?*Kilianella* cf. *ichnotera*, *Thurmanicearas* aff. *gratianopolitense*, *Thurmaniceras pertransiens*, *Leptoceras brunneri* and *Karakaschiceras* sp. (the last taxon colected from Caraşova section). From the Valea Lindinei Limestone Member a ammonite fauna with *Olcostephanus astierianus, O. scissus şi O. filosus* was identified, which points to the Upper Valanginian, as well as the zone index ammonite *Acanthodiscus radiatus* characteristic for the Lower Hauterivian (Avram et al., 1987).



Text-fig. 11 – Location od stop 6 on the geological map 1:50.000, sheet 121b-Reşița (after Năstăseanu et al., 1985)

In the lower half of the same limestones a micropaleontological assemblage was describes bearing *Haplophragmoides joukowskyi, Meandrospira favrei* and *Montsalevia salevensis*, species indicating also the Valanginian. The Valea Nerei Limestone Member outcrops starting form the bridge over Streneac brook on the way to the bridge over Caraş river (Text fig. 11), along several hundreds of meters and covering about 200 m stratigraphic thickness. The succession consists of bioclastic and peloidal grainstones, mudstones-packstones with rudists, ooidal grainstones, and fenestral and fenestral-laminitic limestones (Text-fig. 12). A rich micropaleontological assemblage is contained mainly by the bioclastic and ooidal grainstones; especially the presence of the foraminifer species *Protopeneroplis ultragranulata* (usually a marker for Berriasian-Valanginian, but showing a general stratigraphic range from Middle Tithonian to Barremian, cf. Bucur, 1997) is to be noted. Among foraminifera, *Paracoskinolina*? *jourdanensis* is also present, indicating an Early Barremian age of the succession.



Text-fig. 12 Succession of the Valea Nerei Limestone at Caraşova. 1 oolithic grainstone; 2 – fenestral limestone; 3 – rudist-bearing mudsones-packstone; 4- bioclastic grainstone/packstone and mudstone (after Bucur, 1993, modified).

In the profile from Caraşova, the Valea Nerei Limestone consist of internal carbonate platform deposits that hosted subtidal shoals with foraminifera, dasyclads and rudists, and frequently, intertidal sequences leading to the formation of fenestral-laminitic limestones. (Text-fig. 12). The macrofauna is represented by requienid-type rudists. The biosparites from the lower part of the succession (lebvels 2740, and 5564-5569 respectivelly) are very rich in dasycladalean algae. The assemblage is dominated by *Montenegrella (Suppiluliumaella) tuberifera* (**Plate 1**), and *Salpingoporella pygmaea* (cf. *Macroporella incerta* in Bucur, 2001). Besides, *Salpingoporella muehlbergii*, *Cylindroporella ivanovici* and *Petrascula* sp. Also can be noticed Frequently, rivulariacean cyanobacteria occur in the ooidal levels, and associated with fenestral-laminitic intertidalites. Foraminifera are represented by miliolids, agglutinated foraminifera (e.g. *Vercorsella* sp.), *Protopeneroplis ultragranulata* and orbitolinids (*Paracoskinolina* cf. *maynci*, *Paracoskinolina*? *jourdanensis*).

Stop 11. Crivina
Bucur, I.I.

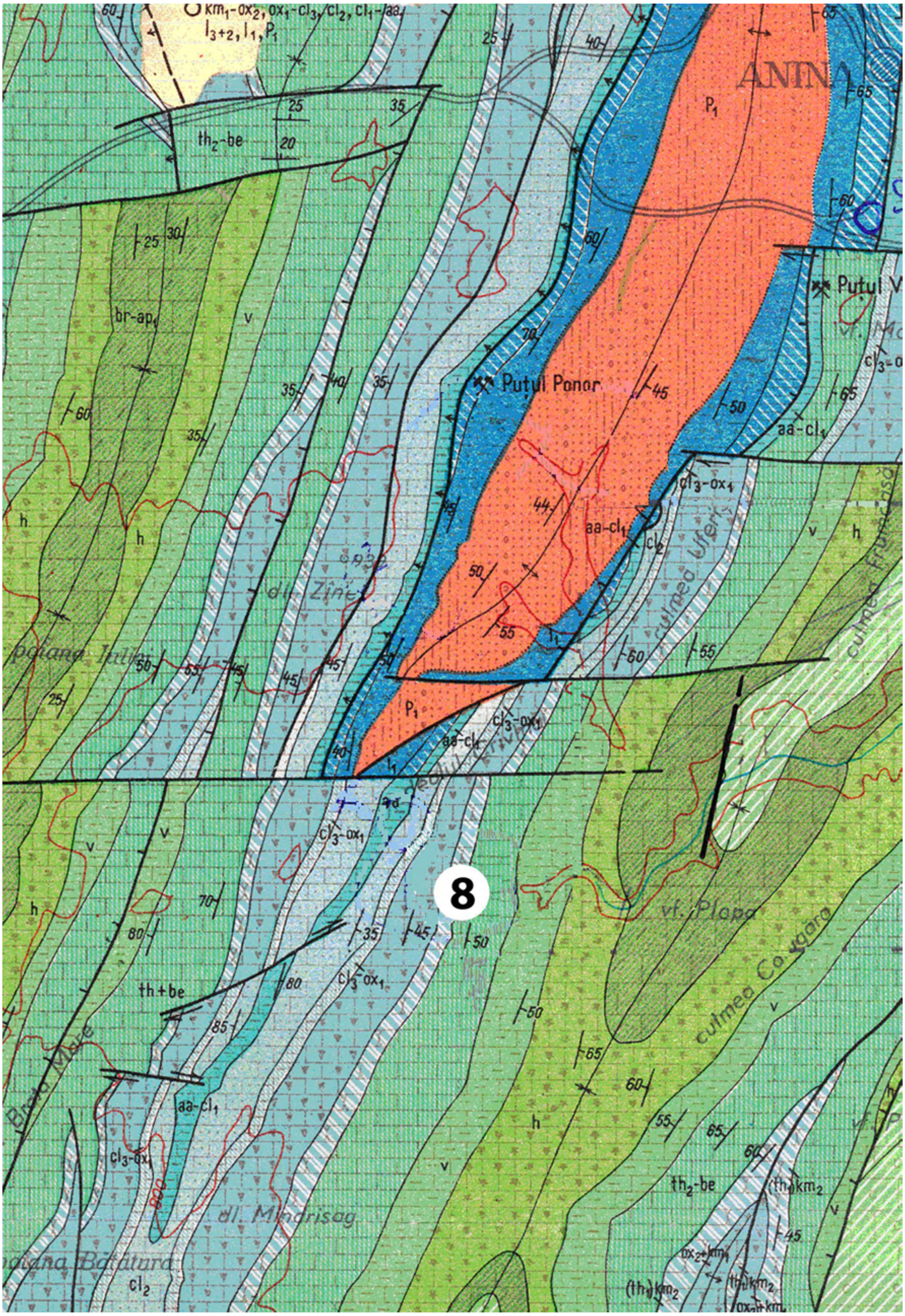
Location: Crivina, on the board of the road between Oravița and Anina, next to the former Power station (Text-fig. 13)

Description: Along the road crop out basinal limestones belonging to the Valea Aninei Limestone formation, Brădet Limestone formation, Marila Limestone Formation, and Crivina Marls Formation.

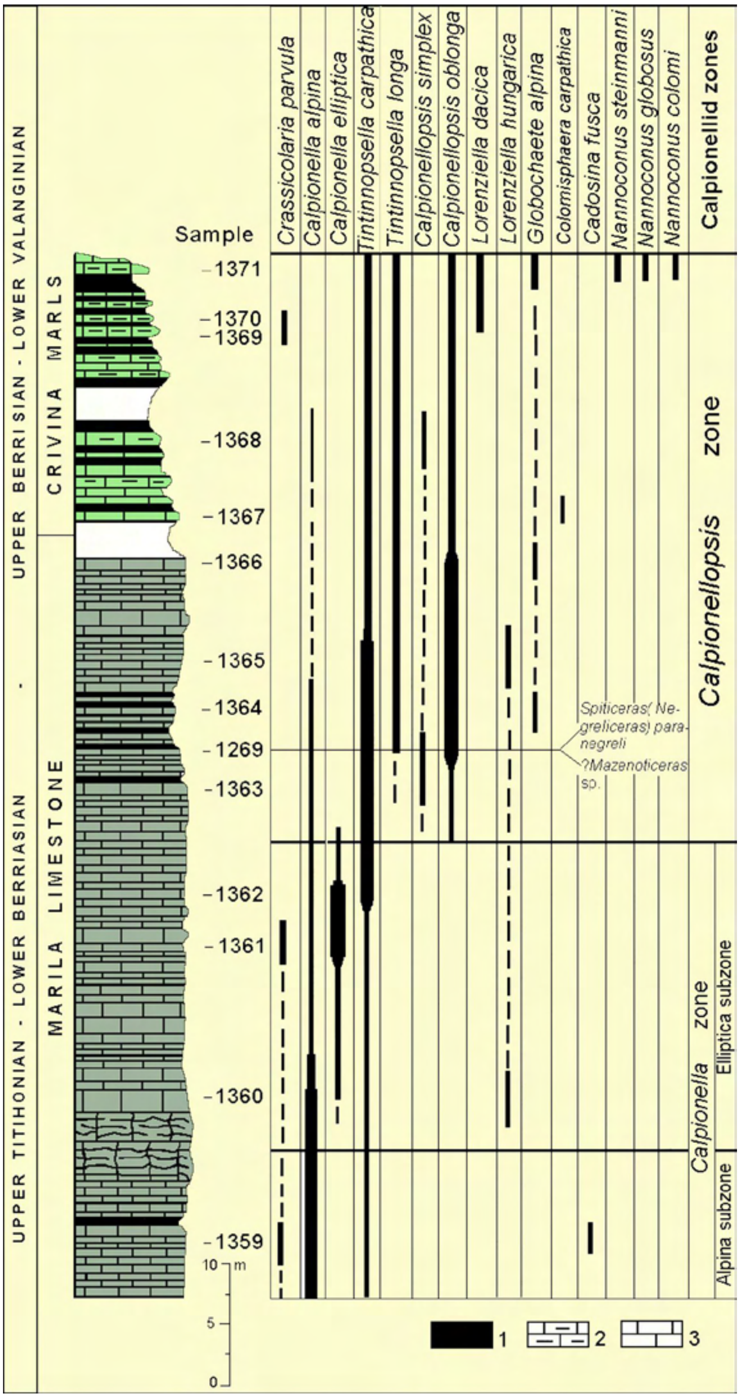
The Valea Aninei limestones have their characteristic aspect (decimetric layers with centimetric interlayers of silica) (**Plate 2, Fig. 1**). Devoid of macrofauna, these limestones contain rare microfossils, among which calcispheres have some biostratigraphic importance. In this respect, *Colomisphaera fibrata* (Nagy), found at Beu Sec, indicate the Oxfordian (namely the Late Oxfordian, in the lower half of these limestones, their upper half belonging to the Early Kimmeridgian).

The Brădet Limestones show their typical feature (nodular limestone in decimetric layers, with fine interlayers of marly-limestone) in their middle part (**Plate 2, figs. 2-3**). In Crivina section we found ammonites and aptychi within these nodular levels. The age of Brădet Limestones is Late Kimmeridgian –Early Tithonian.

The Marila Limestones are composed of fine, micritic limestone, in decimetric to metric layers, with marl interlayer at their upper part (**Plate 2, figs. 4-6**). They are followed by the Crivina Marls (succession of platy marls intercalated with decimetric layers of marly-limestone). Within the marila Limestones and the Crivina Marls (Text-Fig. 14) a calpionellid assemblage was identified, characteristic to the *Calpionella* and *Calpionellopsis* biozones. In the Crivina section only the basal part of the Crivina Marls is outcropping. Also, the ammonite *Spiticeras* (*Negreliceras*) *paranegreli* identified within Marila Limestones, at about 20 m under the boundary with Crivina Marls, points to the lower part of the Late Berriasian (the *Paramimounum* and *Picteti* biozones).



Text-fig. 13. Location of stop 8 on the geological map 1:50.000, sheat 121d, Anina
(after Năstăseanu & Savu, 1970)



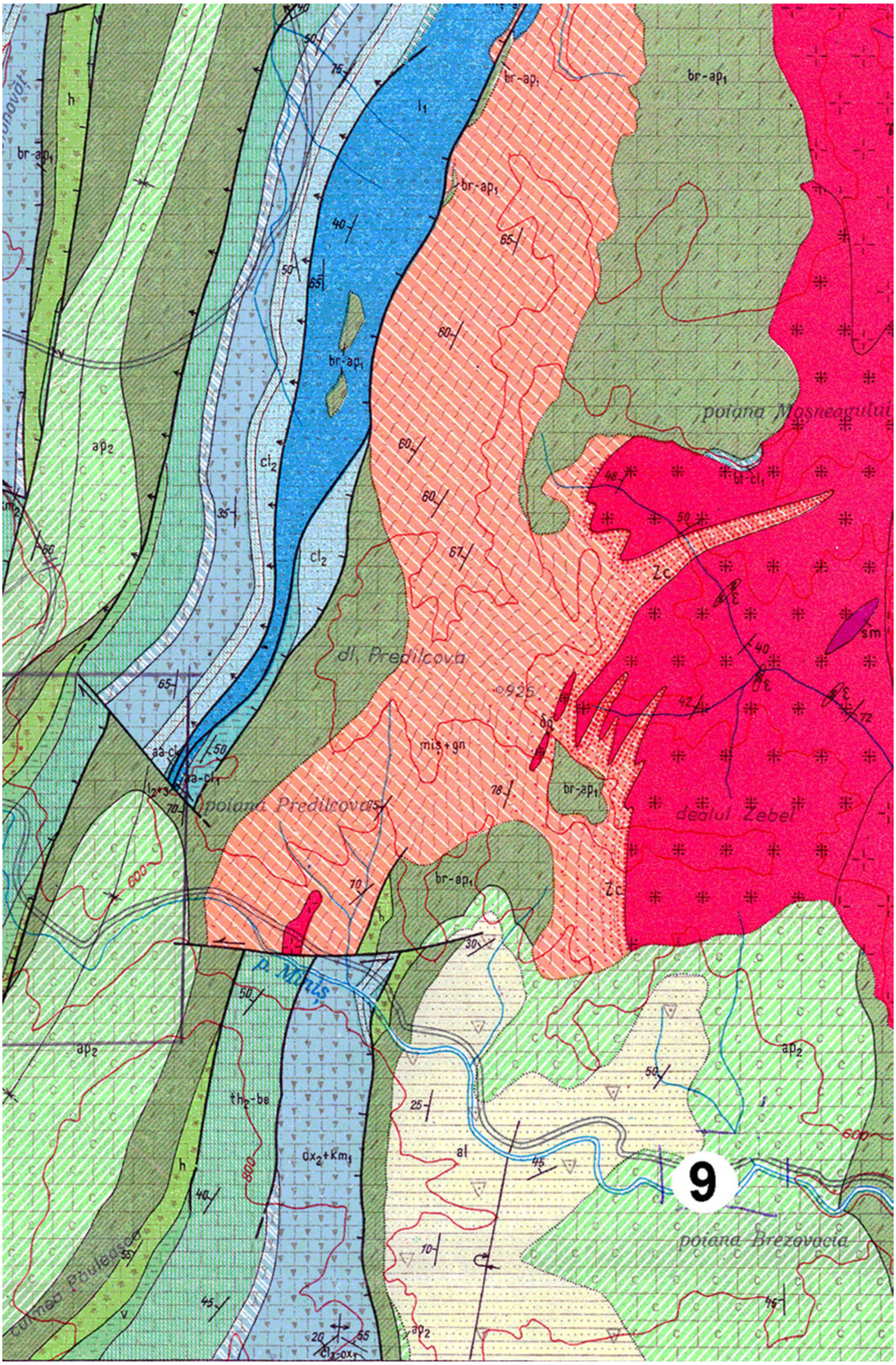
Text-fig.14 Succession of Berriassian-Valanginian deposits at Crivina. 1-marl; 2-marly-limestone; 3-limestone (after Avram et al., 1987, modified)

Day 4: 3 September 2009

Stop 12. Miniş Valley

Bucur, I.I.

Location: Central part of Reşiţa-Moldova Nouă zone, along Minişului Valley, on the road between Anina and Bozovici localities, 500 m downstream the confluence of Minişului Valley with Golumbului Brook (Text-fig. 15).



Text-fig. 15 Location of the stop 9 on the geological map 1;50.000, SHEET 121D-Anina (After Năstăseanu & Savu, 1970)

Description: The succession of Valea Minişului Limestone is presented in Text-fig 16. In the lower part it is dominated by bioclastic (peletal-bioclastic packstones-grainstones) limestones rich in foraminifera and interlayered with banks rich in rudists and chetetids. In its upper part, the succession is dominated by bioconstructed limestones. Bioconstructions mainly consist of tabular corals, the individual colonies having dish-like shapes, 5-15 cm thick and between 10 to 50 cm in diameter. Besides corals, rare sclerosponges and numerous encrusting organisms – especially foraminifera, algae and microbial structures also take part at the bioconstruction. Along the whole succession orbitolinid foraminifera are present, and they indicate a Late Barremian-Bedoulian age for the lower part (as proved by *Palorbitolina lenticularis* and *Palaeodictyoconus* div. sp.), and a Gargasian age for the upper part, proved by *Mesorbitolina texana*. The section to be visited as stop 7 is located in the upper part, at the level of coral bioconstructions. In this section, the bioclastic interlayers provided also specimens of *Mesorbitolina texana* (**Plate 4, fig. 6**) that indicate a Gargasian age.

Valea Minişului Limestones represent, in this sequence, external platform deposits. It is dificult to say if the coral bioconstructions represented marginal barier deposits. The shape of the corals and the sediment in between, as well as the included micropaleontological association indicate their genesis in waters of several tens of meters deep.

Along the Miniş Valley thick bioconstructions (lithosomes) occur which are mainly made by platy corals (**Plate 3**). They spread over a distance of approximately 1100 m and are made of two lithosomes with thickness of 16-17 m and 38-42 m, respectivelly. The two lithosomes are separated by a 15-30 m thick interval devoid of corals. The pre-lithosome unit is composed up of peloidal bioclastic grainstone-packstone intercalated with rudist- and chaetetid-bearing biostromes.

The individual coral colonies, which can reach 50 cm in diametre and up to 15 cm thickness, have platy to dish-like shapes. Corals are poorly diversified and dominated by representatives of the suborder Microsolenina and a heterocoenid *Latusastraea* sp. The assemblage is made of corals of the families Latomeandridae (*Fungiastraea* sp., *Latiastraea* sp.), and Microsolenidae (*Microsolena* sp., *Fungiastraea crespoi, Latiastraea* cf. *kaufmanni*).

Frequently, the coral bioconstructions are associated with microbial crusts and *Bacinella-Lithocodium* oncoids. (**Plate 4, figs.1, 4**). Red algae are also present: *Sporolithon rude*, *Polystrata alba* and *Pycnoporidium* sp. On the other hand, the dasycladalean alge are almost absent. Only rare specimens of the microproblematicum *Carpathoporella occidentalis* occur (**Pate. 4, fig. 2**).

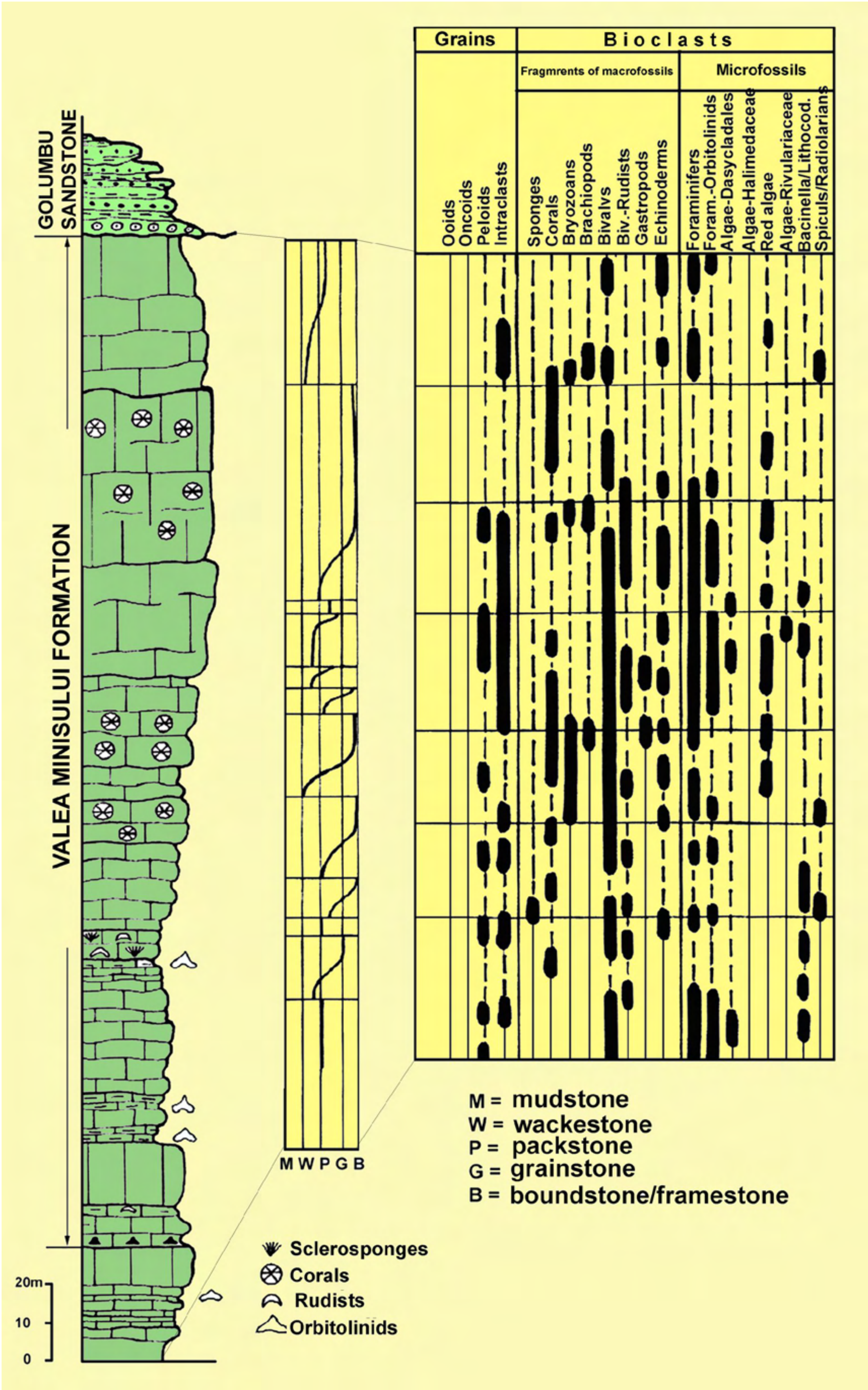
The limestone succession and its paleontologic-micropaleontologic content suggest an external carbonate platform paleoenvironment, with depths of some tens of metres. The platy corals belong to lithosomes formed within the external paltform at depths between 20 and 80 m, in a milieux with low sedimentation rate.

Stop 13. Iablanița

Popa, M.E., Kedzior, A.

Location: Iablanița village, along the road towards Bela Reca Valley.

Description: Miocene fluviatile sandstones and conglomerates in a large outcrop



Text-fig. 16 Succession of the Valea Minişului formation at its type locality (Miniş Valley, downstream of the confluence with Golumbului creek) (Din Bucur, 2001)

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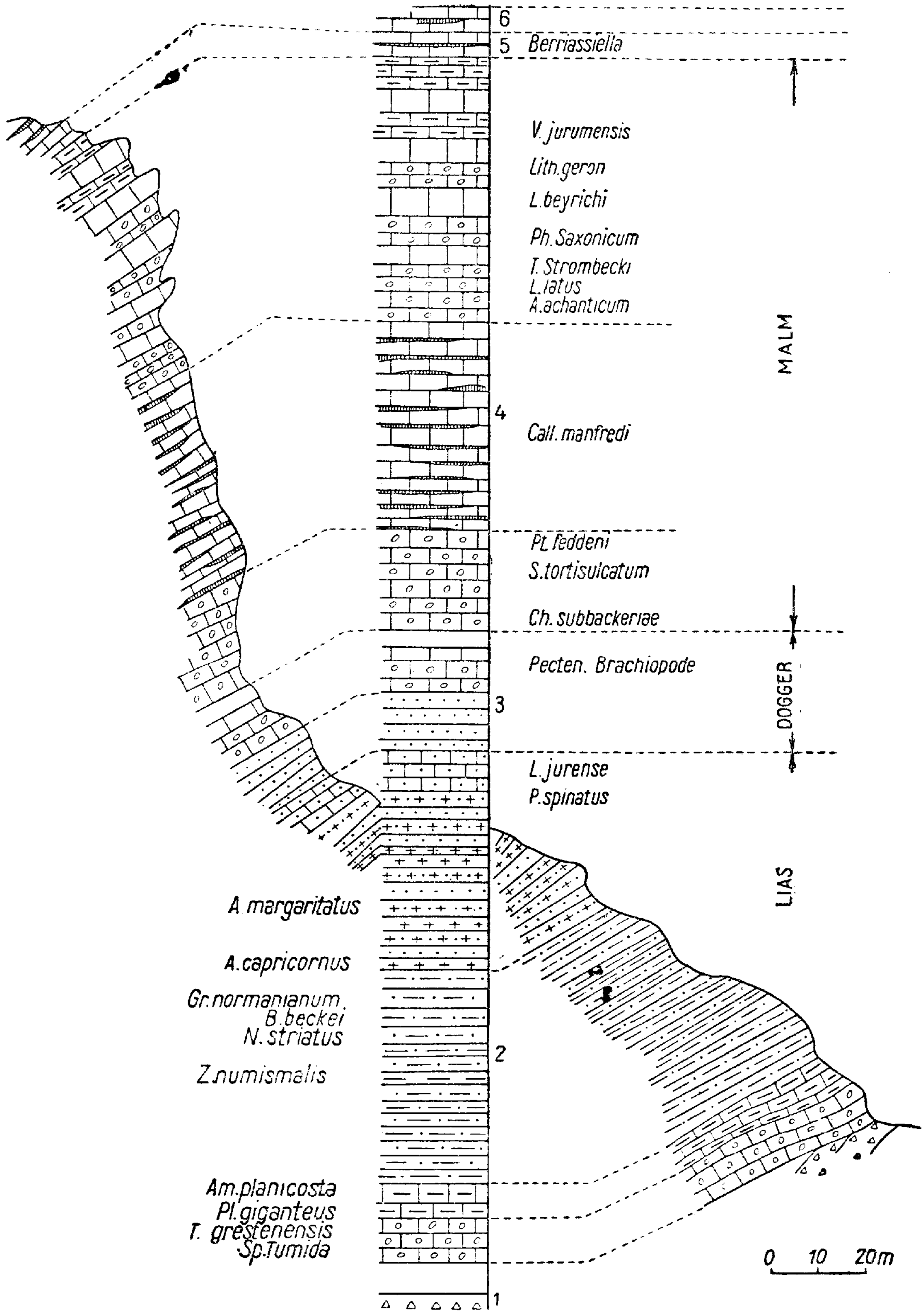

Text-fig. 17 Sedimentary log in Munteana, Sirimia Basin, after Codarcea et al. (1961)

Plate 1 : Dasycladaleans from the Valea Nerei Zlimestone, near Caraşova (stop 6) (From Bucur, 2001)

Figs.1-6 – *Montenegrella (Suppiluliumaella) tuberifera* SOKAĆ & NIKLER. 1-sample 5568, x15; 2-sample 5564, x10; 3-enlargement of fig.2, x30; 4-sample 5569, x20; 5-sample 5566, x25; 6-sample 5564, x30.

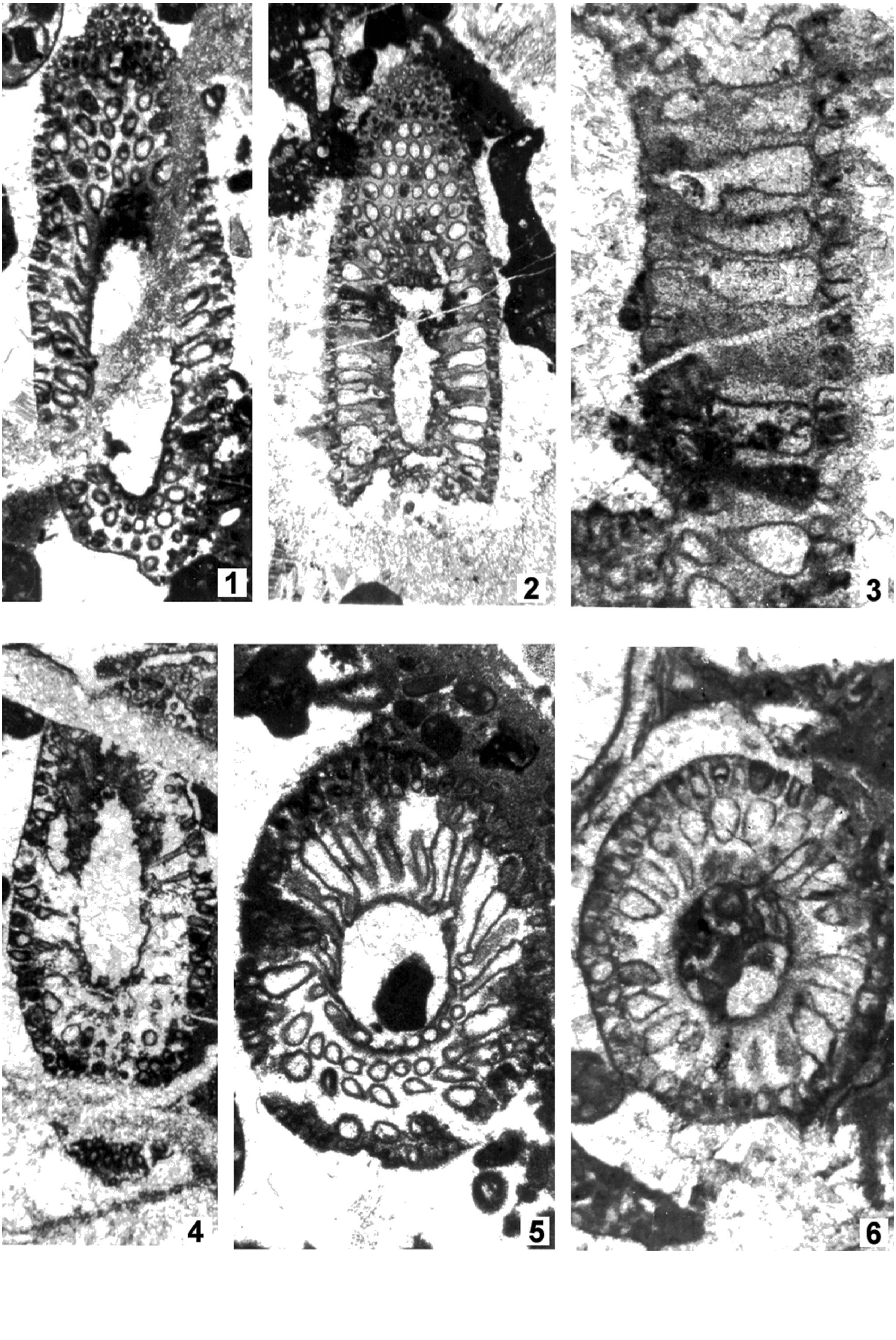
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Plate 2 : Outccroping of the “basinal” limestones in Crivina section (Stop 8).

Fig.1 – Silicious interlaers in Valea Aninei Limestone; Figs. 2, 3 – Nodular Brădet Limestone; 4-6 – Decimetric to metric layers in Marila Limestone

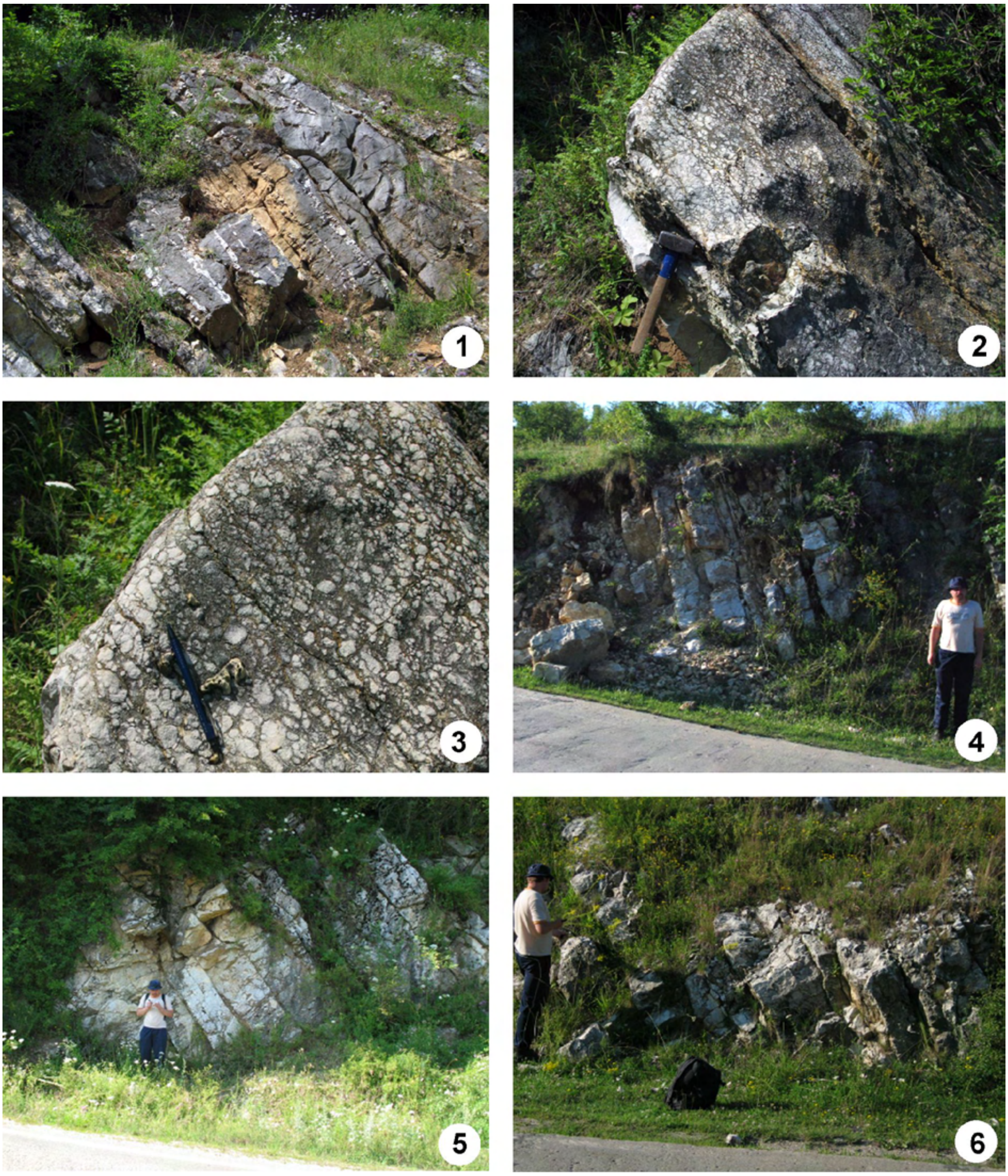
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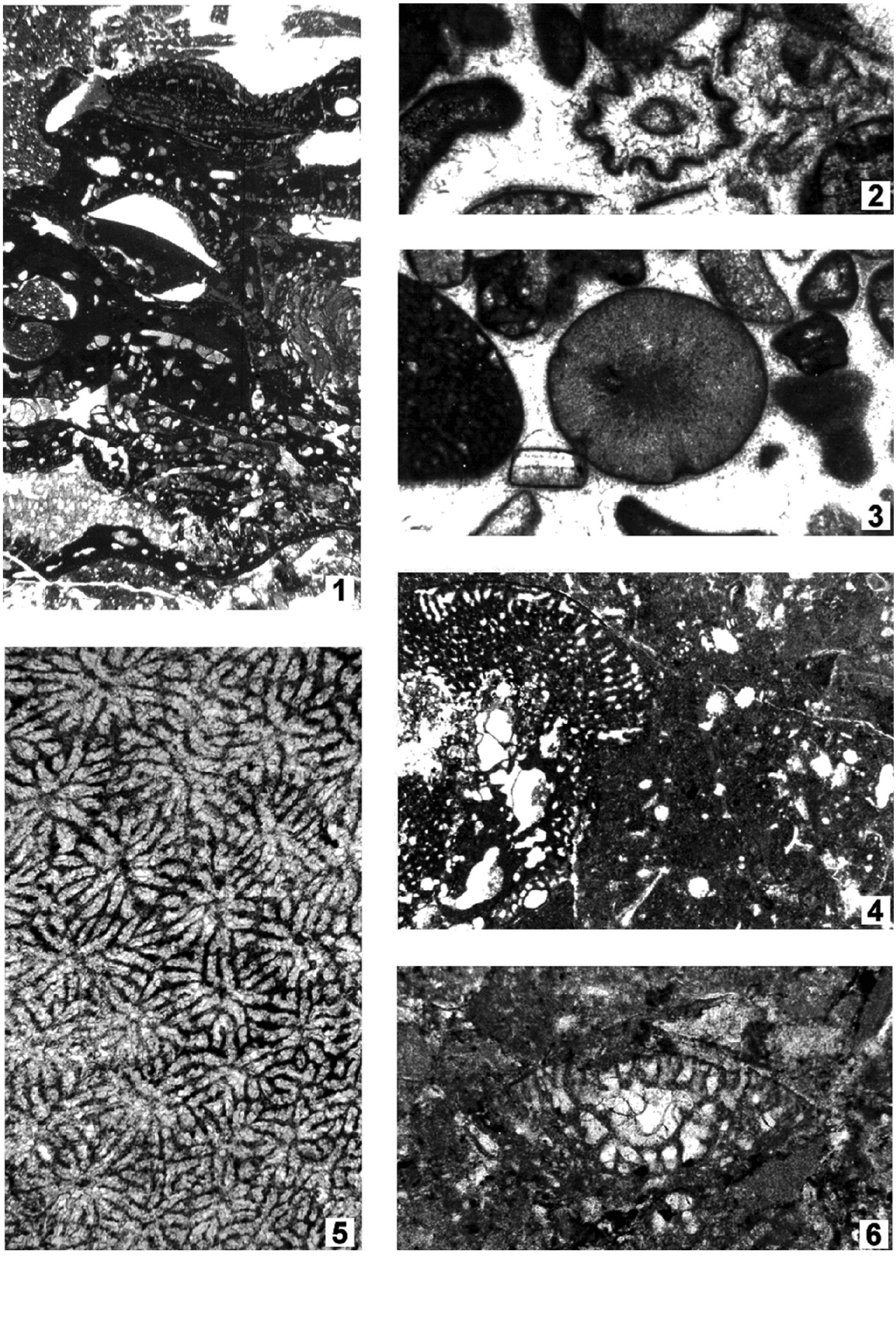
Plate 3 : Platy corals in a coral lithosome from the Miniş Valley.

Plate 4 : Facies and microorganisms in the type section of the Valea Minişului Formation (stop 9) (From Bucur, 2001).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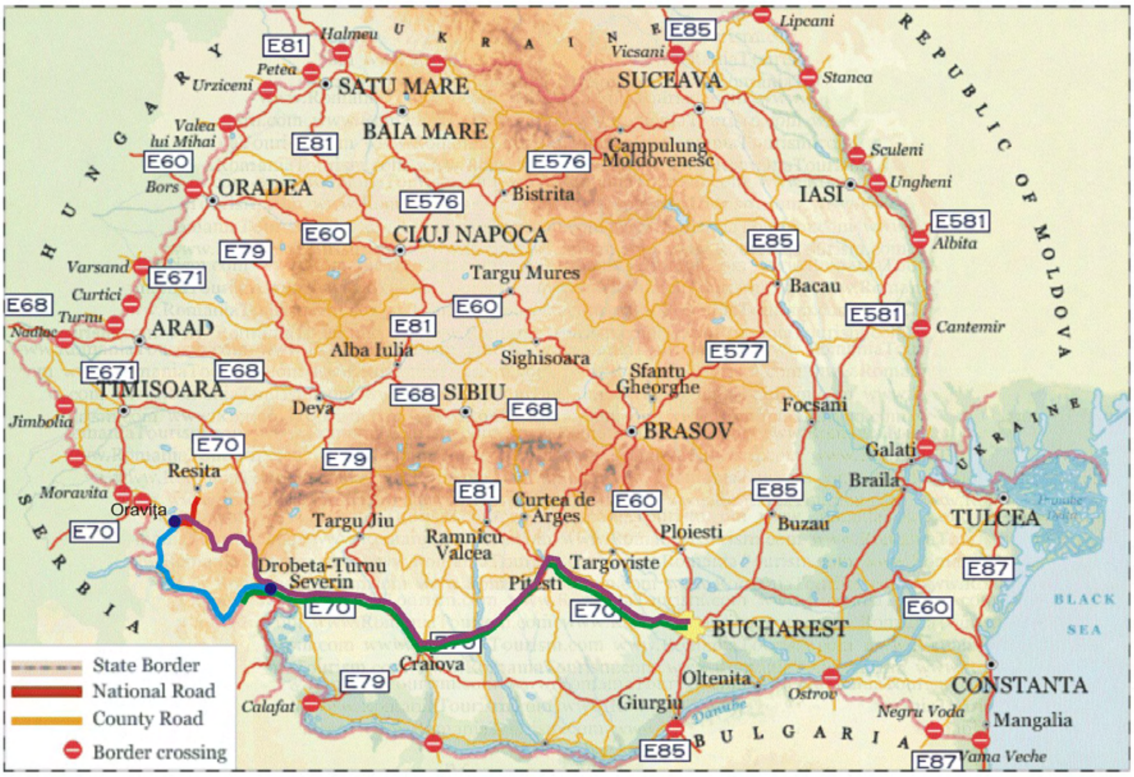
Map of downtown Bucharest, for the 8th IGCP 506 meeting

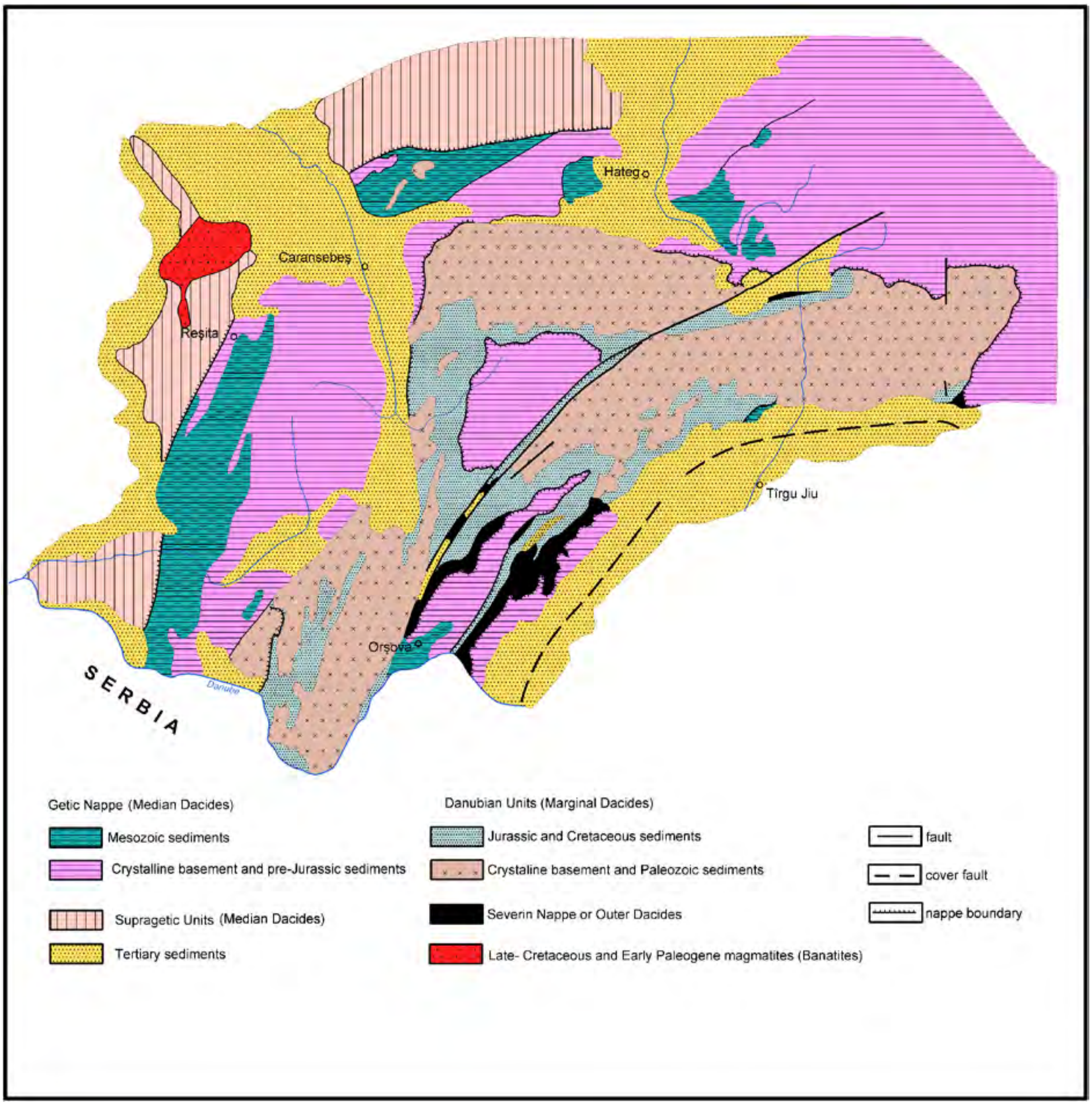
1 University of Bucharest, Faculty of Geology and Geophysics, Laboratory of Palaeontology
2 Academica Guest House, University of Bucharest
3 Ambassador Hotel
4 Tempo Hotel
5 University House, Restaurant

8th IGCP 506 meeting in Romania
Field trip in the South Carpathians

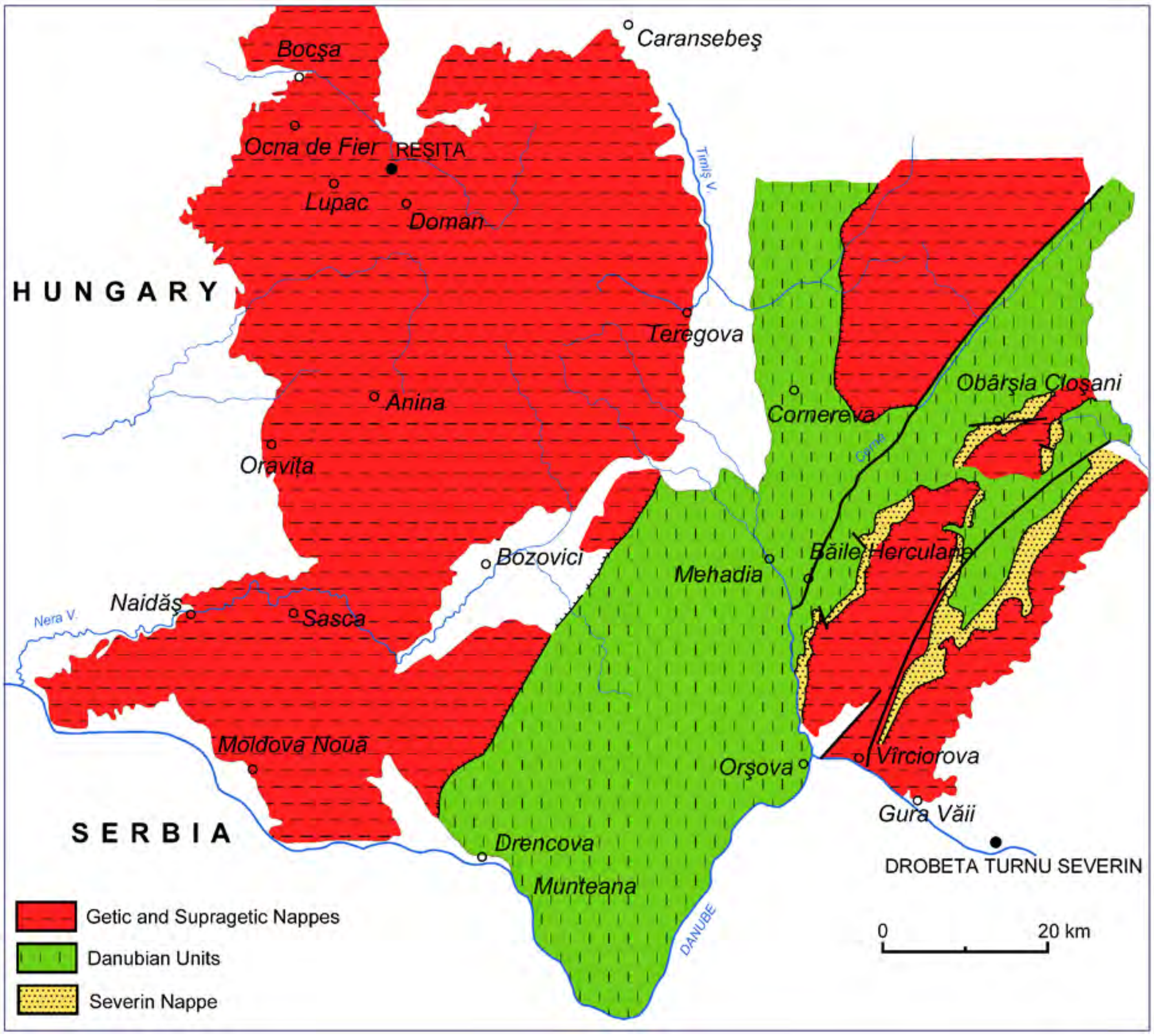


First day (31 August 2009).
Second day (1 September 2009).
Third day (2 September 2009).
Fourth day (3 September 2009).

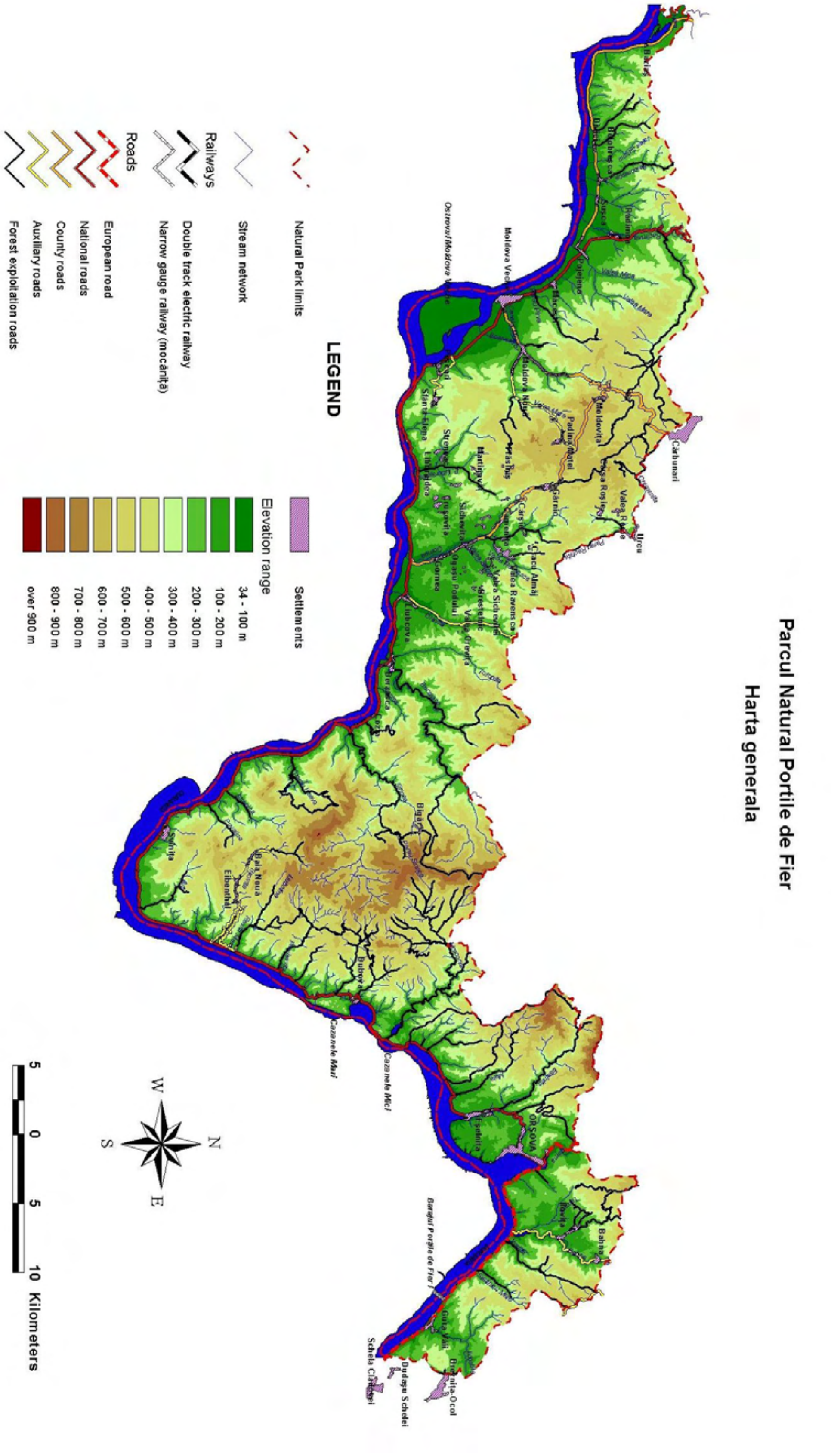
Map 2



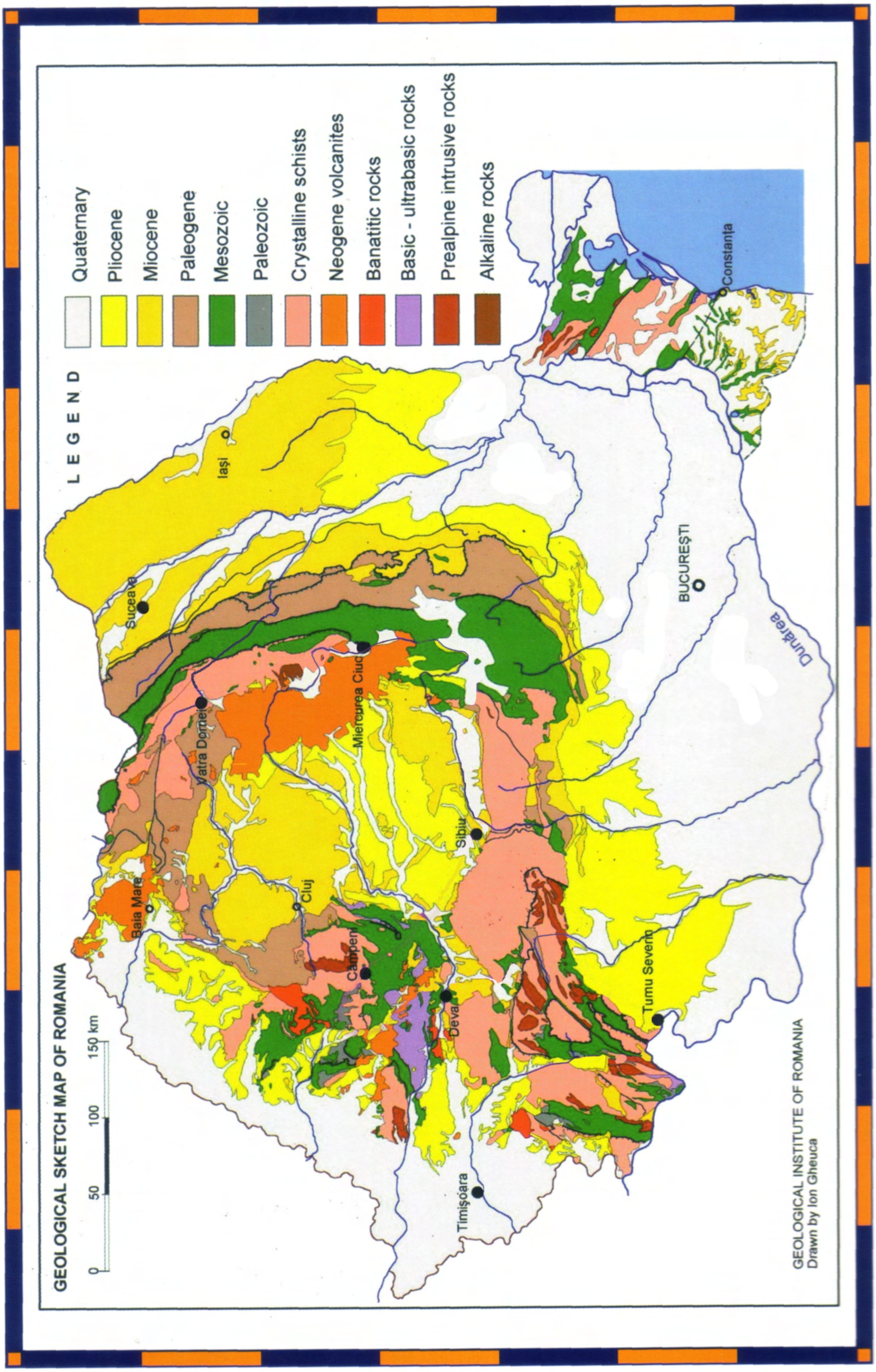
Map 3. Geological sketch of the South Carpathians modified after Pop et.al. (1997)



Map 4. Tectonic units of the South Carpathians



Map 5. Map of the Iron Gates natural park, by Viorel Popescu (CCMESI)



Map 5. Geological map of Romania.