Геол. ан. Балк. полуос. Ann. Géol. Pénins. Balk.	64 (2001)	1–12	Београд, децембар 2002 Belgrade, Decembre 2002

UDC (УДК) 550.838.5:551.781.51/782.1:551.24.01(497.11–11)

Original scientific paper
Оригинални научни рад

PALEOMAGNETISM OF THE LATE PALEOGENE AND NEOGENE ROCKS OF THE SERBIAN CARPATHO–BALKANIDES: TECTONIC IMPLICATIONS

by

Milun Marović[*], Ilija Djoković[*], Vlada Milićević[**], Marinko Toljić[*] and Nataša Gerzina[*]

This paper focuses on results of the paleomagnetic research conducted in the territory of Serbian Carpatho–Balkanides, within the following basinal domains: Babušnica–Koritnik (the Oligocene deposits), Žagubica (the upper part of the Lower Miocene and the lower part of the Middle Miocene deposits) and Dacian (the Pontian deposits). The clockwise rotations are established for each basinal region: Babušnica–Koritnik 10°, Žagubica 5–10° and Dacia 5–20°. On the basis of these results and the available data on rotations in the Romanian Southern Carpathians, new tectonic implications are discussed as a contribution to understanding the genesis of the Paleogene–Neogene and Neogene fabric of the Carpatho–Balkanides in Serbia. It is shown that this region has been subjected not only to vertical, but also to horizontal mobility during the latest stage of its geological development.

Key words: Serbia, Carpatho–Balkanides, paleomagnetism, Paleogene, Neogene, tectonics.

У раду су презентирани резултати палеомагнетских истраживања која су извршена на територији Карпато–балканида Србије, у оквиру следећих басенских домена: Бабушничко–коритничког (олигоценске наслаге), Жагубичког (горњи део доњомиоценских и доњи део средњомиоценских наслага) и Дакијског (понтски седименти). Ротација у правцу казаљке на сату је утврђена за све басенске регионе: Бабушничко–коритнички 10°, Жагубички 5–10° и Дакијски 5–20°. На бази ових резултата и расположивих података о ротацији у јужним Карпатима Румуније, нове тектонске импликације су разматране у смислу доприноса разумевању генезе палеогено–неогеног склопа Карпато–балканида Србије. Показано је да је ова област изложена не само вертикалној, већ и хоризонталној мобилности током најмлађег стадијума њеног геолошког развоја.

Кључне речи: Србија, Карпато–балканиди, палеомагнетизам, палеоген, неоген, тектоника.

INTRODUCTION

The Carpatho–Balkanides represent a segment of the orogenic belt of the same name, the segment which surrounds the Moesian plate (i.e. Dacian basin) from the West

[*] University of Belgrade, Faculty of Mining and Geology, Institute of Regional Geology and Paleontology, Kamenička 6, 11000 Belgrade (e-mail: nacy@EUnet.yu).

[**] Geoinstitute, Rovinjska 12, 11000 Belgrade.

and southwest. This is the area that represents, in geographic sense, the connection between the Romanian Southern Carpathians and Bulgarian Eastern Balkans. In geologic sense, however, it is a unique orogenic system (Fig. 1).

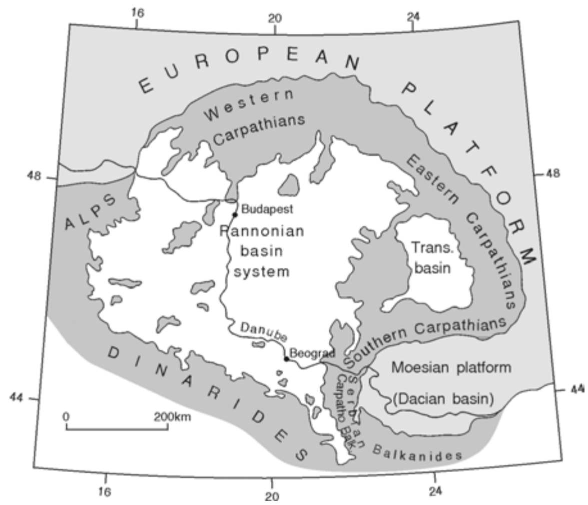

Fig. 1. Position of the research area within the Carpatho–Balkanidic–Pannonian region.
Сл. 1. Положај истражног простора у оквирима Карпато–балканског–панонског простора.

Generally held opinion is that the Carpatho–Balkanidic tectogene on the territory of Serbia was generally formed by the Cretaceous–Paleogene movements and it was finally shaped during the Oligo–Miocene. From the end of the Lower Miocene up to the recent time, it was mostly subjected to vertical movements. Recent geological and geophysical – especially paleomagnetic data from the Southern Carpathians in Romania (Pătraşcu, 1976, 1993; Pătraşcu et al., 1994; Panaiotu et al., 1996; etc.), and some parts of Serbia, point to a significant horizontal mobility and rotation of these structures, mainly during the Paleogene and Miocene and locally up to the Pleistocene as well. In order to recognize and determine the effects of such Late Paleogene and Neogene activity in the domain of the Serbian Carpatho–Balkanides, i.e. in order to determine horizontal movements and rotations, paleomagnetic investigations of the Oligocene, Karpatian–Badenian and Pontian rocks from the three following basinal localities: Babušnica–Koritnik, Žagubica and Dacia, were carried out. Unfortunately, these were not detailed investigations, but they were sufficient to determine the above mentioned phenomena. Therefore, the achieved results should be accepted with certain reserve – they need a further confirmation by a detailed paleomagnetic research in the first place, but other methods, the paleostress analysis for example, should also be applied.

METHODS AND REVIEW OF THE RESULTS

All collected samples of the Neogene age were subjected to thermal treatment, i.e. warming from room temperature up to 600°C, while observing the spectrum of the coercive forces. Measuring was carried out on spinner magnetometer JR−5 with a sensitivity of ±3 pT. Accuracy was obtained for each datum and threshold of tolerance amounted to 1%. Warming was carried out with steps of 50°C at temperatures lower then 300°C, while steps amounted to 25°C or 15°C at higher temperature. During the thermal treatment, changes of paleodeclination and paleoinclination were observed on the Zijderveld diagram.

Stable values of remanent magnetization were determined depending on: (a) the "fall" of the components to the initial point and (b) the temperature levels. Corrections for the tectonics and B−axis were required in all cases.

The results of the paleomagnetic investigations have shown the general features of the samples of the Neogene age. The sample marked N−132 was used as a characteristic example.

On the Zijderveld diagram (Fig. 2a), two−component nature of the remanent magnetization can be recognized. Secondary forms of magnetization were removed at temperatures up to 150°C, and real magnetic signals were recorded at temperatures from 450°C to 600°C.

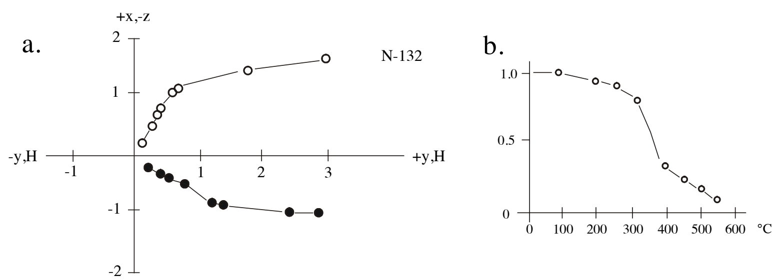

Fig. 2. (a) Zijderveld diagram, (b) thermodemagnetization diagram and (c) Schmidt diagram for the characteristic sample N−132.

Сл. 2. (а) Зајдервелдов дијаграм, (b) дијаграм термодемагнетизације и (c) Шмитов дијаграм за карактеристични узорак Н−132.

On the thermodemagnetization diagram, sudden descend of the curve was noticeable at the temperatures between 300°−400°C (Fig. 2b), and concentrations of remanent magnetization direction on the Schmidt diagram (Fig. 2c) had the confidence interval radius α_{95}=11,5° before, and α_{95}=7,8° after the correction for the tectonics. These statistical parameters have shown that the mean paleomagnetic direction is representative, and that the stable component of the primary magnetization has been preserved.

Paleomagnetic investigations were carried out in three basinal regions: Babušnica−−Koritnik, Žagubica and Dacia.

Babušnica−Koritnik Basin

The oldest deponates in Babušnica basin are most probably of the Lower Oligocene age (Dj. Mihajlović personal communication). However, age of the deponates from which the samples for paleomagnetic investigations were taken, was not determined more precisely. In any case, we are talking about freshwater equivalents of the Oligocene age. These deponates were subjected to deformations at the end of the Oligocene and the beginning of the Miocene, so bedding dip angles are sometimes even 60°.

Seven samples from the area of Babušnica–Koritnik basin were analyzed, and the following results were achieved (Table 1).

Table 1.
Табела 1.

Sample (узорак)	Locality (локалитет)	Paleodeclination (D) (палеодеклинација D)	Paleoinclination (I) (палеоинклинација I)
1	Bela Palanka, dam	347°	54°
2	Divljana 1	121°	18°
3	Divljana 2	31°	56°
4	Zvonce	188°	–59°
5	Našuškovica	11°	56°
6	Valniš	8°	27°
7	Raljin	69°	55°

All data except those from the Raljin (7) and Divljana 1(2) show similar values, which point to a mean paleodeclination D_m=10° and paleoinclination I=56°. This indicates the 10° clockwise rotation of this region in the Oligocene (Fig. 3). Similar results were given by Milićević & Djurašinović–Gavrilović (1990). Results that do not fit into these values (Raljin and Divljana 1), could be explained either by a local block rotation within the zone of a fault, or by a mistake in value determination caused by chemical processes, etc. Statistic data analysis determined the Oligocene north latitude of these regions at φ =38°±2°.

Žagubica Basin

The sample that was used to determine paleomagnetism of the Neogene rocks of the Žagubica basin was taken from the locality Selište (eastern part of the basin). These are sandy–marly deposits, freshwater equivalents of the Karpatian and probably the Lower Badenian. These deposits have been deformed, so bedding planes dip at 15–30°, mostly towards the central parts of the basin. Unfortunately, only one location was analyzed and it shows paleodeclination D=18° and paleoinclination I=57°. These data point to the Karpatian–Lower Badenian clockwise rotation for 5–10° (Fig. 3). Because of the insufficient number of data, paleolatitude of this area at the time of the Karpatian–Lower Badenian deposition could not be determined without a great deviation. That is why it was not calculated.

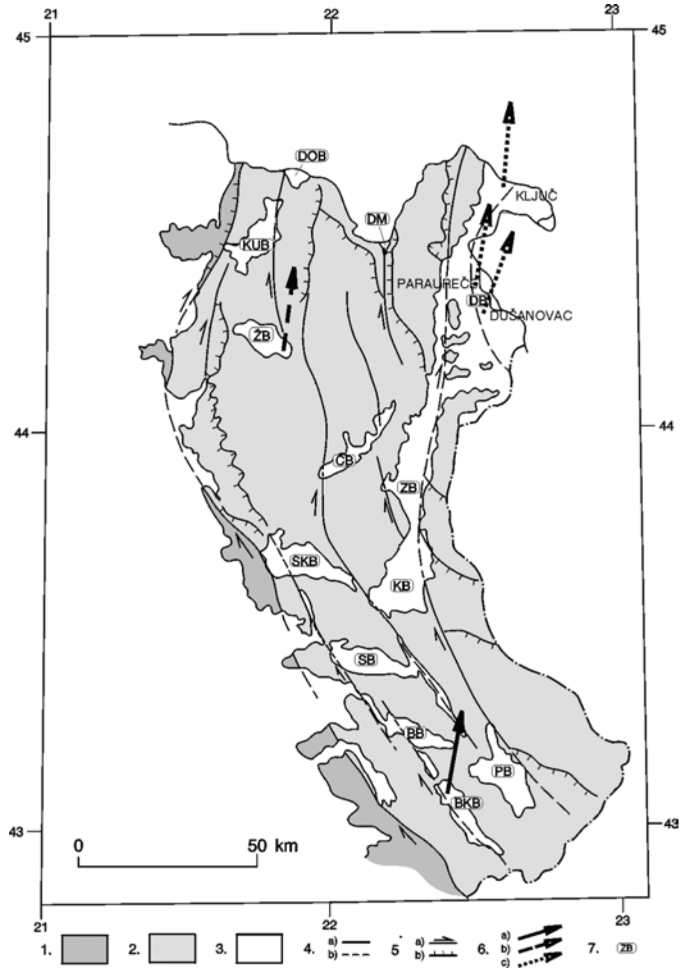

Fig. 3. Paleomagnetic declinations in the Late Paleogene and Neogene deponates in the Serbian Carpatho–Balkanides. Legend: 1. Suprageticum, 2. Carpatho–Balkanides, 3. Terraines composed of the Paleogene and Neogene deponates, 4. Faults (a. certain and b. supposed), 5. Fault kinematics (a. strike–slip and b. reverse faults and overthrusts), 6. Paleomagnetic declinations (a. Oligocene and the Lowest Miocene, b. the uppermost Lower Miocene and the lowermost Middle Miocene, c. Upper Miocene–Pontian). 7. Some of the Paleogene and Neogene basins (KUB – Kučevo, DOB – Dobra, DM – Donji Milanovac, ŽB – Žagubica, DB – Dacia, CB – Crna Reka, ZB – Zaječar, SKB – Sokobanja, KB – Knjaževac, SB – Svrljig, BB – Bela Palanka, PB – Pirot, BKB – Babušnica–Koritnik).

Сл. 3. Палеомагнетске деклинације у каснопалеогеним и неогеним творевинама Карпато–балканида Србије. Легенда: 1. Супрагетикум, 2. Карпато–балканиди, 3. Терени изграђени од палеогених и неогених творевина, 4. Раседи (а. сигурни б. претпостављени), 5. Кинематика раседа (а. транскурентни и б. реверсни и навлаке), 6. Палеомагнетске деклинације (а. олигоцен и доњи део доњег миоцена, б. горњи део доњег, и доњи део средњег миоцена, ц. горњи миоцен–понт). 7. Називи неких палеогених и неогених басена (KUB – Кучевски, DOB – Добрански, DM – Доњомилановачки, ŽB – Жагубички, DB – Дакијски, CB – Црноречки, ZB – Зајечарски, SKB – Сокобањски, KB – Књажевачки, SB – Сврљишки, BB – Белопаланачки, PB – Пиротски, BKB – Бабушничко–коритнички).

Dacian Basin

Samples for paleomagnetic investigations in the Dacia basin were taken from the Pontian deposits. These are slightly deformed deponates dipping at low–angles. The samples from the following localities: Ključ, Paraureče and Dušanovac were analyzed. The results of paleomagnetic investigations acquired from all samples point to clockwise rotation of these areas in the Pontian. The amount of rotation varied: Ključ 5°, Paraureče 10° and Dušanovac 20° (Fig. 3) (Krstić & Milićević, 1989; Milićević et al., 1988; Milićević & Krstić, 1991). The latest datum deviate significantly from previous ones and, in particular, from that one in its neighborhood (Pareureče), so it is probably not a result of the overall trend of rotation in this region in the Pontian, but the result of the local influences (shearing along faults) or some other factors.

DISCUSSION

The Carpatho–Balkanides in Serbia went through a significant Mesozoic–Early Paleogene shortening of the lithofacial (formational) content, and a nappe and overthrust fabric with clear east vergence was formed as a result of such an activity. At the end of the Cretaceous and the beginning of the Paleogene, two major overthrust systems: Getic and Infra–Getic, and one auto(para)chthonous system – Danubian, were individualized (Grubić, 1980). The processes of the further shortening within the Serbian Carpatho–Balkanides, that continued into the middle Lower Miocene, led to a break down of these major overthrust systems into lesser units bordered with reverse faults striking approximately N–S. In that way, east–vergent fabric was emphasized (Grubić, 1980). From the end of the Lower Miocene up to the lower part of the Middle Miocene, the Serbian Carpatho–Balkanidic tectogene was subjected to an extensional event (peripheral reflex of a much stronger activity demonstrated in the area of the Pannonian Basin) which, during the Ottnanghian, Karpatian and probably the Lower Badenian, led to the formation of numerous basinal structures in these regions (Marović et al., 1998). Disposition of the Carpatho–Balkanidic orogene was enabled by the overall phase upliftings manifested from the beginning of the Sarmatian into the recent time.

Tectonic activity in the Romanian Eastern and Southern Carpathians was a little bit different, especially when we are considering the Paleogene and Neogene tectonic shaping. According to the numerous geological and geophysical (paleomagnetic, in particular) data, intense east–vergent shortening of lithofacial (formational) content in the outer zones of the Romanian Eastern and Southern Carpathians, occurred during the Paleogene and Neogene. This continued to a lesser extent also during the Pleistocene, locally in the Southern Carpathians (Burchfiel & Royden, 1982; Royden, 1993; Csontos, 1995; Linzer, 1996; Zweigel, 1997; Girbacea, 1997; and others). Such an activity is a consequence of the convergent relationships between Tisia–Dacia lithospheric entity (TD) and European–Moesian margin, demonstrated during the Paleogene and Neogene (Ratschbacher et al., 1993; Csontos, 1995; Linzer, 1996; Zweigel, 1997; etc.) (Fig. 4). Progression of the Tisia–Dacia block into the area which is going to be, by the subduction–collision relations, transformed into the orogenic system of the outer Eastern and

Southern Carpathians (Tertiary flysch and molasses), went through the following events: (1) dextral translation and 70° clockwise rotation around the western rim of the Moesian plate (the Upper Eocene–Lower Miocene, with the paroxysm of transpressional activity in the Upper Oligocene and the Lowest Miocene; (2) eastward translation and 25° clockwise rotation of the areas between the Dragoš Voda fault (sinistral strike–slip) in the North and Southern Carpathian–Peri–Moesian transpressional area in the South (dextral strike slip), in the Badenian; (3) NW–SE directed translation of the furthest southeastern parts between the Trotuş fault (sinistral strike–slip) and Intra–Moesian fault (dextral strike slip), in the Sarmatian, and (4) the Pliocene–Quaternary NW–SE translation of the furthest southeastern parts in the bend area between the Eastern and Southern Carpathians, still along the Trotuş and Intra–Moesian faults. Such an activity in the Romanian Southern Carpathians (horizontal mobility and, in particular, the rotation) had to affect the Serbian Carpatho–Balkanides in some way, the nearest parts (the direct extension of the Southern Carpathians in Serbia) in the first place, disregarding the fact that they were not directly involved in convergent relationships between the Tisia–Dacia entity and European and Moesian plate demonstrated through the subduction–collisional processes during the Paleogene and Neogene.

Paleomagnetic investigations of the rocks in the Babušnica–Koritnik basin, freshwater equivalents of the Oligo–Miocene, show that these regions were, during the time of deposition, located at a significantly lower latitude than today. Obtained results (φ=38°±2°) show that the Serbian Carpatho–Balkanides were drifted northwards for over 500 km during the last 30–35 million years. Small amount of clockwise rotation (10°) and structural characteristics of the basin point to the Oligocene–Oligo–Miocene dextral activity, transtensional at first and then transpressional, along the faults striking approximately N–S. The basin of such type was formed and later inverted within the sections of these faults. Unfortunately, going from this locality further to the North all the way to the Romanian Southern Carpathians, not any kind of paleomagnetic investigation has been conducted, so it is unknown if there were changes in the amount and direction of rotation. It would be realistic to expect rotation and increasing of its amount with approaching the Romanian Southern Carpathians where the clockwise rotation amounts up to 70° (Pătraşcu, 1993; Pătraşcu et al., 1994; Panaiotu et al., 1996). With approaching to the Southern Carpathians, the wrench–corridor, which was "established" west from the Moesian plate in the area of the Serbian Carpatho–Balkanides and even further in the West – in the domain of the Serbian–Macedonian Massif, is bending more and more northeastwards and eastwards, i.e. around northwestern and northern rim of the Moesian plate (Figs. 3, 4). This bending caused faster east–vergent epicrustal transport of the Southern Carpathian nappes and overthrusts, followed with pronounced dextral transpressional progradation towards northeast and East (Ratschbacher et al., 1993). Such an activity led to transtensional and pull–apart opening and subsequent transpressional inversion of the Paleogene and Paleogene–Neogene basins in the Southern Carpathians (Petroşani basin for example, according to: Berza & Draganescu, 1988; Ratschbacher et al., 1993; Hann et al., 1996; Moser & Frisch, 1996). It also produced orogene parallel extension, which led to exhumation of the Danubian autochthon below the Infra–Getic and Getic allochthon (Schmidt et al., 1998). The Danubian autochthon in the Djerdap area on the territory of Serbia was probably exhumed according to the same scenario.

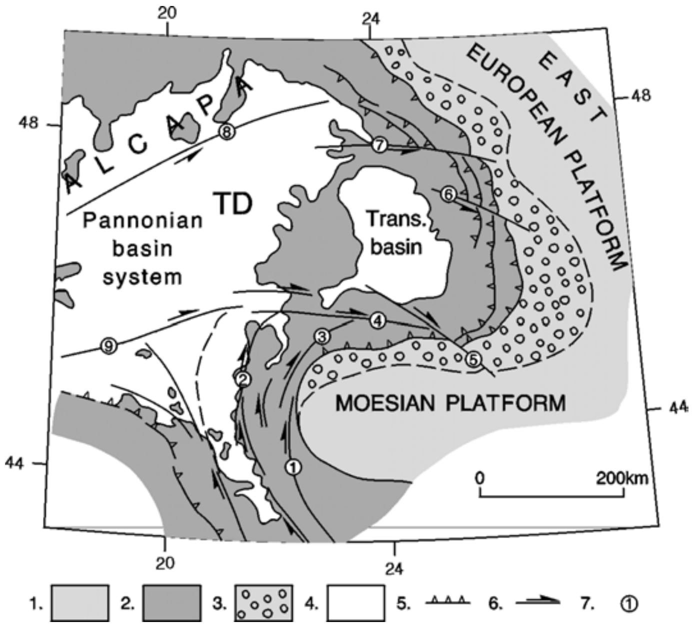

Fig. 4. Simplified sketch of the Late Paleogene and Neogene kinematics of the eastern and southeastern part of the Alpine–Carpathian–Pannonian system. Legend: 1. Platform area, 2. Orogene area, 3. Transition area between the orogene and the platform – the Carpathian Neogene forland, 4. Intracarpathian Neogene basinal and peri-basinal region, 5. Overthrusts, 6. Strike–slip faults, 7. Some of the faults active in the Late Paleogene and Neogene (1. Timok, 2. Morava, 3. Cerna–Jiu, 4. Southern–Carpathian, 5. Intra–Moesian, 6. Trotuş, 7. Dragos Voda, 8. Mid–Hungarian Line, 9. Trans–Banat–Bačka), TD – Tisia-Dacia block, ALCAPA – Alpine–Carpathian–Pannonian block (for the regions of the Pannonian Basin out of the territory of Serbia, and Romanian Eastern and Southern Carpathians, the following data were used: Zweigel, 1997; Girbacea, 1997; and Linzer et al., 1998).

Сл. 4. Упрошћена скица каснопалеогене и неогене кинематике источног и југоисточног дела Алпско–карпатско–панонског система. Легенда: 1. Подручје платформе, 2. Подручје орогена, 3. Превојно подручје између орогена и платформе – карпатски неогени форланд, 4. Интракарпатски неогени басенски и перибасенски простор, 5. Навлаке, 6. Транскурентни раседи, 7. Називи неких раседа са каснопалеогеном и неогеном активношћу (1. Тимочки, 2. Моравски, 3. Черна–Жиу, 4. Јужнокарпатски, 5. Интрамезијски, 6. Trotuş, 7. Драгош Вода, 8. Средњемађарска линија, 9. Транс–банатско–бачки), TD – Тисијско–дакијски блок, ALCAPA – Алпско-карпатско–панонски блок (за области Панонског басена ван територије Србије, источних и јужних Карпата Румуније, коришћени су подаци: Zweigel, 1997; Girbacea, 1997; и Linzer et al., 1998).

Taking all this into account, we can come to a rather realistic assumption that all the Paleogene and Paleogene–Lower Miocene (up to the Ottnanghian) basins in the region of the Serbian Carpatho–Balkanides were formed and inverted according to a transtensional (probably also pull–apart)–transpressional model, within a wrench corridor generated by the dextral interaction between the Tisia–Dacia domain and the Moesian plate (Fig. 4).

The clockwise rotation of the Serbian Carpatho–Balkanides continued during the Karpatian–Lower Badenian as well. According to the data from the Žagubica basin (Fig. 3), the amount of rotation stayed little (5–10°). It can be genetically related to the eastward translation of the Tisia–Dacia entity and its 25° clockwise rotation. Such movements were followed with extension in the area of the Pannonian Basin, but also with the opening of some basins in the Romanian Southern Carpathians like Bozovici, Sichevita, Caransebes–Mehadia (Moser & Frisch, 1996) and in the Serbian Carpatho–Balkanides (Donji Milanovac, Dobra, Kučevo, Knjaževac, Lukovo, Sokobanja and other basins; Marović et al., 1997).

Similar amounts of rotation were determined on the basis of the investigations of paleomagnetism of the Pontian deposits in the Dacian Basin, especially those in the border area between the Carpatho–Balkanides and the Moesian plate (Fig. 3). This rotation could also be related to the events in the Romanian Southern Carpathians, i.e. for the processes of NW–SE "wedging" of their furthest southeastern parts. However, it is not clear whether it is rotation *en mass* or is it a local rotation of blocks (rotation *en block*) located between the Peri–Moesian fault (the border between the Moesian plate and Carpatho–Balkanides) and the Timok fault (Intra–Carpatho–Balkanian). Judging by the different amounts of rotation and by the fact that there were no major rotations in these regions at that time, the latter explanation is more logical. Contemporary seismic activity is probably going on according the similar scenario which is supported by moderate–to–weak seismicity.

CONCLUSIONS

According to the results of the paleomagnetic research conducted in the domain of the Serbian Carpatho–Balkanides, it is determined that this region was, during the Paleogene and Neogene, subjected to both vertical and horizontal movements as well as to weak–to–moderate rotations. Disregarding the fact that there were few measurements in only three objects, i.e. in the following basins: Babušnica–Koritnik (the Oligo–Miocene deposits), Žagubica (the deposits of the upper part of the Lower and the lower part of the Middle Miocene) and Dacian (the Pontian deposits), the obtained results, together with those from the Romanian Southern Carpathians, broaden new possibilities for recognizing the Late Paleogene and Neogene tectonic activity in the Serbian Carpatho–Balkanides. One can come to a rather realistic assumption that all the Paleogene (mostly Oligocene) and Oligo–Miocene (up to the Ottnanghian–Karpatian) basins as well as their inversions, were the result of the transtensional (an probably also pull–apart)–transpressional activity, demonstrated within the dextral wrench–corridor between the Moesian plate and the Tisia–Dacia entity. Opening of the younger basins (the Ottnanghian–Karpatian–Lower Badenian age) could be a consequence of the extensional processes initiated by the eastward translation and clockwise rotation of the Tisia–Dacia crustal entity during its convergence with the East European Platform. Finalization of such an activity at the beginning of the Sarmatian, caused the definite inversion of these basins and their incorporation into the uplifted morphostructures of the Serbian Carpatho–Balkanides.

REFERENCES – ЛИТЕРАТУРА

Berza T., Draganescu A., 1988: The Cerna–Jiu Fault System (South Carpathians, Romania), a major Tertiary Transcurrent Lineament.– D. S. Geol. Geofiz., 72–73/5, 43–57.

Burchfiel B.C., Royden L., 1982: Carpathian foreland fold and thrust belt and its relation to Pannonian and other basins.– AAPG Bull. 66, 1179–1195.

Csontos L., 1995: Tertiary tectonic evolution of the Intra–Carpathian area: a review.– Acta Vulcanol., 7 (2), 1–13.

Girbacea R., 1997: The Pliocene to Recent tectonic evolution of the Eastern Carpathians (Romania).– Tübinger Geow. Arb., A, 35, 1–136.

Grubić A., 1980: Yugoslavia – an outline of geology of Yugoslavia.– 26 Intern. Geol. Congr., 1–50, Paris.

Hann H.P., Moser F., Linzer H.–G., 1996: Regionale Störungssystemme in den Südkarpaten.– Symp. Tekt. Strukturgeol., Kristall., 166–168, Salzburg.

Krstić N., Milićević V., 1989: The magnetostratigraphy of the Pontian in Eastern Serbia (Dacian basin).– In: P. Stevanović and Malez M. (Eds.) Chronostratigraphie und Neostratotypen, Pontian.– JAZU & SANU, 326–331, Beograd.

Linzer H.–G., 1996: Kinematics of retreating subduction along the Carpathian arc.– Romania Geology, 24 (2), 167–170.

Linzer H.–G., Frisch W., Zweigel P., Girbacea R., Hann H.–P., Moser F., 1998: Kinematic evolution of the Romanian Carpathians.– Tectonophysics, 297, 133–156.

Marović M., Grubić A., Djoković I., Toljić M., Vojvodić V., 1997. The Neoalpine tectonic pattern of Djerdap region, Geology of Djerdap area.– Geoinst. Spec. ed., 25, 111–115.

Marović M., Djoković I., Toljić M., 1998: Genesis of the Neotectonic Structures of Serbia.– Geol. an. Balk. poluos., 62, 25–45, Belgrade (in Serbian and English).

Milićević V., Veljović D., Krstić N., 1988: Preliminary report on the results of the paleomagneic investigation of the Pontian and Meotian siltstones from Eastern Serbia.– Zapisnici Srp. geol. dr. za 1985. i 1986. god., 175–290, Beograd (in Serbian, English Summary).

Milićević V., Djurašinović–Gavrilović M., 1990: Paleomagnetism of the Paleogene (Oligocene) basins in Serbia.– XII Kongr. Geol. SFRJ, V, tectonics, geophysics, seismology, 276–288, Ohrid (in Serbian, English abstract).

Milićević V., Krstić N., 1991: Paleomagnetic characteristics of the Negotin Upper Pontian (borehole E. VI–6).– Zapisnici Srp. geol. dr. za 1987–88. i 1989. god., 73–81, Beograd (in Serbian, English Summary).

Moser F., Frisch W., 1996: Tertiary deformation in the Southern Carpathians – structural analysis of a brittle deformation.– Symp. Tekt. Strukt. Krist., Salzburg, 280–282.

Panaiotu C., Pécskay Z., Panaiotu C.E., 1996: Which is the time of rotation? Review of paleomagnetic and K–Ar data from Romania.– Mitt. Ges. Geol. Bergbaustud. Österreich, 41, p. 125.

Pătraşcu S., 1976: Paleomagnetic study of some Neogene eruptive formations in the Calimani–Gurghiu––Harghita Mountains (Romania).– Rev. Roum. Géol. Géoph. Géogr., Geophys., 20, 51–63.

Pătraşcu S., 1993: Paleomagnetic study of some Neogene magmatic rocks from the Oaş–Igniş–Văratec––Tibleş Mountains (Romania).– Geoph. J. Int., 113, 215–224.

Pătraşcu S., Panaiotu C., Şeclăman M., Panaiotu C.E., 1994: Timing of rotational motion of Apuseni Mountains (Romania): Paleomagnetic data from Tertiary magmatic rocks.– Tectonophysics, 233, 163–176.

Ratschbacher L., Linzer H.–G., Mozer R.O., Struziewicz R.O., Bedelean H., Han N., Mogos P.A., 1993: Cretaceous to Miocene thrusting and wrenching along the Central South Carpathians due to a corner effect during collision and orocline formation.– Tectonics, 12, 4, 855–873.

Royden L. H., 1993: The tectonics expression slab pull at continental convergent boundaries.– Tectonics 12, 303–325.

Schmidt S., Berza T., Diaconescu V., Froitzheim N., Fügenschuh B., 1998: Orogen – parallel extension in the Southern Carpathians.– Tectonophysics, 297, 209–228.

Zweigel P., 1997: The Tertiary tectonic evolution of the Eastern Carpathians (Romania): Orogenic arc formation in response to microplate movements.– Tübinger Geow. Arb., A, 33, 1–158.

РЕЗИМЕ

ПАЛЕОМАГНЕТИЗАМ КАСНОПАЛЕОГЕНИХ И НЕОГЕНИХ СТЕНА КАРПАТО–БАЛКАНИДА СРБИЈЕ: ТЕКТОНСКЕ ИМПЛИКАЦИЈЕ

На простору Карпато–балканида Србије у домену басена: Бабушничко–коритничког (олигоценске наслаге), Жагубичког (наслаге горњег дела доњег и доњег дела средњег миоцена) и Дакијског (понтске наслаге) обављена су палеомагнетска истраживања. За сва три басена утврђене су ротације у смеру кретања казаљке на сату и то за: Бабушничко–коритнички 10°, Жагубички 5–10° и Дакијски 5–20° (сл. 3). Без обзира што је реч о малом броју мерења, на основу ових резултата и укључивањем литературних података о ротацијама у Јужним Карпатима Румуније, могу се извести неке тектонске импликације релевантне за боље разумевање генезе коснопалеогеног и неогеног склопа Карпато–балканида Србије.

Палеомагнетска проучавања стена Бабушничко–коритничког басена слатководних еквивалената олигомиоцена показују да су се ти простори у време одлагања наслага налазили на знатно нижој географској ширини него што су данас. Добијени резултати ($\varphi = 38°\pm2°$) показују да су за последњих 30–35 милиона година Карпато–балканиди Србије били изложени северном дрифту од преко 500 километара. Мали износ ротације од 10° у смеру кретања казаљке на сату и структурне карактеристике басена упућују на олигоценску–олигомиоценску десну, прво транстензиону, а затим транспресиону активност дуж раседа пружања С–Ј у оквиру чијих деоница је басен оваквог типа формиран а потом инвертован. Нажалост, од овог локалитета, па даље на север до Јужних Карпата Румуније палеомагнетизам стена сличне старости није проучаван тако да није познато да ли је дошло до измене износа и смера ротације. Реално би било очекивати да она постоји и да се повећава са приближавањем Јужним Карпатима Румуније где износи и до 70^0 у смеру кретања казаљке на сату (Pătraşcu, 1993; Pătraşcu et al., 1994; Panaiotu et al., 1996). Wrench– коридор који је "успостављен" западно од Мезијске плоче на подручју Карпато–балканида Србије а и западније – у домену Српско–македонске масе са приближавањем Јужним Карпатима све се више повија ка североистоку и истоку тј. око северозападног и северног обода Мезијске плоче (сл. 3 и 4). Ово повијање имало је за последицу бржи источно–вергентни епикрустални транспорт јужнокарпатских краљушти и навлака праћен још и наглашеном десном транспресионом проградацијом ка североистоку и истоку (Ratschbacher et al, 1993). Оваква активност довела је до транстензионог и pull–apart отварања, а затим транспресионог инвертовања палеогених и палеогено–неогених басена у Јужним Карпатима (на пример Petroşani басен према: Berza & Draganescu, 1988; Ratschbacher et al, 1993; Hann et al, 1996; Moser & Frisch, 1998) и до екстензије паралелне орогену којом приликом је ексхумиран дунавски аутохтон испод инфрагетског и гетског алохтона (Schmidt et al, 1997). Вероватно по сличном сценарију ексхумиран је и дунавски аутохтон у домену Ђердапа на територији Србије.

Када се све ово узме у обзир могло би се са доста реалности претпоставити да су сви палеогени и палеогено–доњомиоценски (до отнанг–карпата) басени у области Карпато–балканида Србије формирани и инвертовани по транстензионом (вероватно и pull–apart) – транспесионом обрасцу у wrench–коридору генерисаном декстралном интеракцијом тисијско–дакијског домена и Мезијске плоче (сл. 4).

Ротација Карпато–балканида Србије у смеру кретања казаљке на сату настављена је и у карпату–доњем бадену. Судећи према подацима из Жагубичког басена (сл. 3) она је такође мала (5–10°). Генетски се вероватно може везати за транслацију према истоку тисијско–дакијског ентитета и његову ротацију од 25° у смеру кретања казаљке на сату. Овакви покрети били су праћени екстензијом у области Панонског басена али и отварањем неких басена у Јужним Карпатима Румуније као што су Božovici, Sichevita, Caransebes–Mehadia (Moser & Frisch, 1998) и у Карпато–балканидима Србије (доњомилановачки, добрански, кучевски и др.; Marović et al, 1996).

Сличне вредности ротације утврђене су на основу проучавања палеомагнетизма понтских наслага Дакијског басена и то оног дела смештеног у граничном подручју Карпато–балканида и Мезијске плоче (сл. 3). И ова ротација може се везати за догађаје у Јужним Карпатима Румуније, односно за процесе "уклињавања" правцем СЗ–ЈИ њихових крајњих југоисточних делова. Међутим, није јасно: да ли је реч о *en mass* ротацији, или, о локалној ротацији блокова (ротација *en block*) смештених између деоница раседа перимезијског (на граници Мезијске плоче и Карпато–балканда) и тимочког (интра карпато–балканско). Судећи према различитим вредностима ротације а и чињеници да у то време неких ротација већег обима у овим просторима није било, логичније је ово друго решење. Вероватно да се по овом сличном обрасцу одвија и савремена активност у овим теренима на шта упућује умерена до слаба сеизмичност.