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Sedimentary basins, tectonic zones in the geological development of the Eastern Balkan Range

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М. Паскалев, П. И. Петров – Седиментационные бассейны – тектонические зоны в геологическом развитии гор Восточного Балкана (Болгария). В работе обсуждается геологическая эволюция Восточной части Балкана (Старопланинских гор) во время альпийского тектонического цикла. Становление тектонических зон является основным тектоническим событием в данной орогенной области (в данном случае – Балканской). Зоны оформляются в определенном типе пород, в которых в точно определенном интервале геологического времени образуются структуры с характерной пространственной приуроченностью. Определяющим для данной зоны является пространственный охват складок, связанных с проявлениями данной фазы. Развитие тектонической зоны проходит через несколько этапов: становление седиментационного бассейна; складчатость пород в ходе проявлений одной или нескольких структурых фаз; горизонтальное перемещение пород на большее или меньшее расстояние (такое перемещение характерно для почти всех тектонических зон в Восточном Балкане).

Основным результатом работы является описание последовательностей, выявленных в развиитии тектонических зон, принадлежащих к Восточнобалканскому тектогену, а именно: Котелской, Качулской, Среднегорской и Лудокамчийской зон. Установлено, что во время олигоцена на территории Восточного Балкана создается новая седиментационная зона. Пока еще она не стала тектонической зоной, так как ее отложения не испытали деформаций.

Abstract. In the article is presented geological evolution during Alpine tectonic cycle in the area of the Eastern Balkan Range. The establishment of a tectonic zone is the main tectonic event to take place in an orogenic region, such as the Balkan Range. Tectonic zoning is based on structures, which have specifically developed in the space (in a specific type of rocks) in an exact interval of the geological time. The main define for the zone is the spatial range of the folds formed as a result of the activity of a specific phase.Throughtout its development, the tectonic zone has passed through few phases, namely: establishment of a sedimentary basin, folding of its deposits as a result of the activity of one or more structural phases. The formation of nearly all tectonic zones in the Eastern Balkan Range ends with a horizontal displasement of the rocks, which is more or less regarding the amplitude.

The main result of the work is the establishment of the tectonic evolution of the Kotel tectonic zone, Kachulka tectonic zone, Sredna Gora tectonic zone and Luda Kamciya tectonic zone in the limits of the Eastern Balkan tectogen.

A new sedimentary zone was formed in the Eastern Balkan Range during the Oligocene. The last one is not tectonic yet due to the lack of the deformation within its constructive deposits.

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Key words: tectonic zone, sediment basin, Alpine tectonic cycle, fold, nappe.

Introduction

The Eastern Balkan Range has undergone numerous geological changes during its geohistorical development. Some of the rocks located on its territory have been formed in situ, while others have undergone bigger or smaller horizontal displasements. The establishment of the Eastern Balkan tectogen was entirely formed during of the Alpine tectonic cycle.

The establishment of a tectonic zone (or zones) is the main tectonic event to take place in an orogenic region, such as the Balkan Range. Hence the tectonic zoning is based on structures, which have specifically developed in the space (in a specific type of rocks) and in an exact interval of the geological time. The main decisive for the zone is the spatial range of the folds formed as a result of the activity of a specific phase. Throughout its development, the tectonic zone has passed through few phases, namely: establishment of a sedimentary basin, folding of its deposits as a result of the activity of one or more structural phases. The formation of nearly all tectonic zones in the Eastern Balkan Range ends with a horizontal displacement of the rocks, which is more or less regarding the amplitude.

Kotel tectonic zone (Бончев и др., 1965) (Fig. 1)

The very first geological activities in the East Balkan tectogen are connected with significant horizontal movements of sediments. Due to the expression of the Austrian phase, mainly black flysch sediments with Jurassic age (subject to discussion for many years) and less flyschlike Norian deposits (also dark in colour) are upthrusted on Lower Cretaceous deposits (Glogov upthrust – Паскалев, 1988; Veselinovo upthrust – Паскалев, 1990). This lead to the establishment of the oldest tectonic zone within the limits of the Eastern Balkan Range – Kotel. The upthrusted sediments have undergone a double folding, resulting from the expression of the old Cimmenian phase and the young Cimmenian phase (Паскалев, 1988). There are no certain facts about the primary location of the basin, where those sediments have been deposited. Similar rocks are formed in the Northern region of Strandzha (near the village of Krushovets). In the black Jurassic sediments to the south of the village of Veselinovo one will find a number of subvolcanic (dyke and dyke-like) bodies. Their chemical composition may be correlated to similar bodies from Strandzha (Georgiev et. al, 2006). These facts indirectly confirm the great horizontal displacement (upthrust) of the rocks, which form the zone (Fig. 2).

One of the characteristic feature of the Kotel zone is the presence of a number of "floating" blocks, forming olistostromes and tectonic melange. Both are consist of Middle-Upper Triassic limestones and marls, and red and grey organogenic limestones of Liassic age. The difference between them consists only in the tectonic material processing.

The zone of Kotel as a part of the East Balkan tectogen has passed through additional three tectonic events, which will be further considered below.

Zone of Kachulka (Паскалев, 2002) (Fig. 1)

Just like the zone of Kotel, the zone of Kachulka was not formed as a sedimentary basin on its current location. It has been probably emplaced as a result of thrusting of the Triassic deposits over Lower Creta-

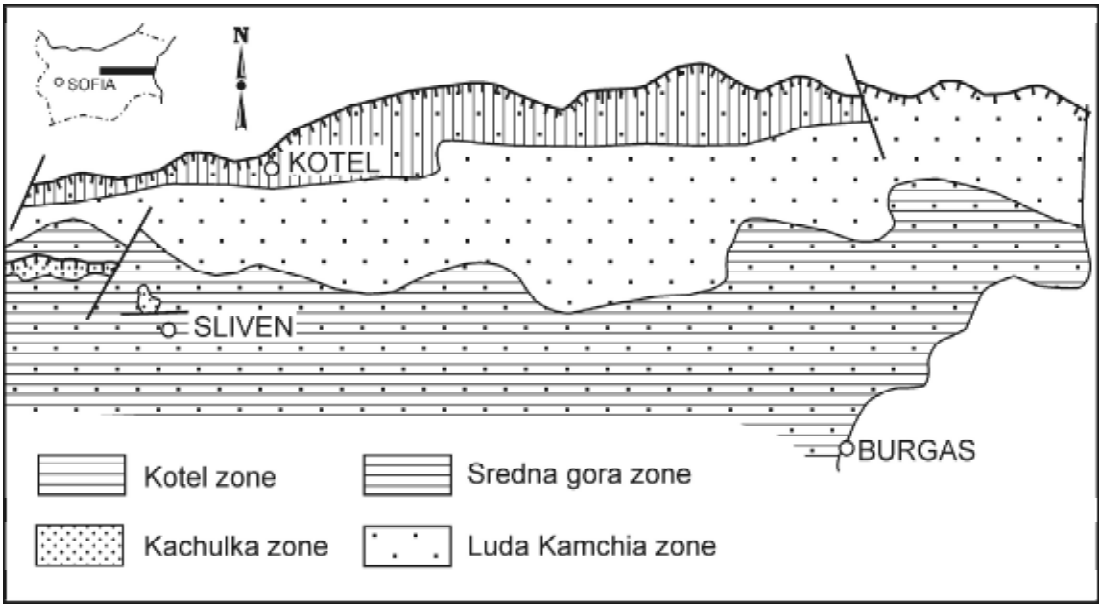

Fig. 1.

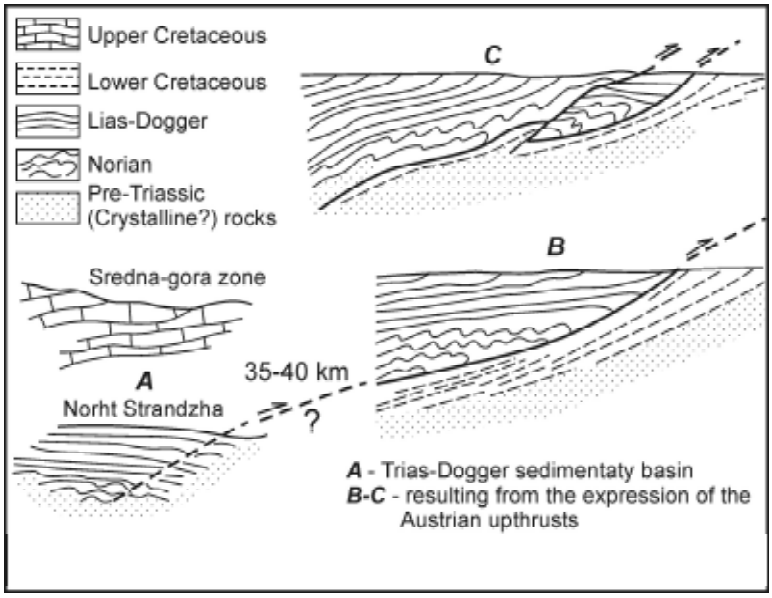

Fig. 2. Model of paleotectonic development of the Kotel zone

ceous ones. Most likely the upthrusting took place on about one and the same upthrusting plane as of the Glogov upthrust.

The zone of Kachulka has separated as a result of the independent tectonic location of the Lower Triassic marls and sandstones, and first of all of the Middle-Upper Triassic dolomites. The structural facts from the uppermost levels of the Upper Triassic section indicate an angular variance and discordance imposed between the Triassic sediments and the Upper Cretaceous sediments, which cover them. The cleavage established in the Triassic (along Sasa dere – to the north of the village of Gradsko, between the mines of Kachulka and Brusiya) is always characterized by a smaller dip (usually of 30–35°) than the bedding in the same sediments. The above proves that, the Upper Triassic deposits, together with the Low and Middle Triassic deposits, are probably a relict of an overturned part of a Pre-Upper Cretaceous fold (Паскалев, 2002) (Fig. 3). Regardless of the lack of Jurassic rocks and regardless of the lack of relations between them and the Triassic rocks, we may assume the presence of an Austrian fold upthrust beneath the Upper Cretaceous sediments. The strong cataclasis of the Triassic dolomites is a proof of this. Unlike them, the Upper Cretaceous sediments, which cover them, are strong and almost uncracked.

The formation of the Upper Cretaceous–Eocene sediment basin started at the beginning of the Upper Cretaceous. The complete profile of the Upper Cretaceous epoch and the Palaeogene may be established at many places, as both are presented by various litostratigraphic units. The presence of olistostromes is one of their characteristic features. They may be found in sediments of Turonian, Senonian and Eocene age.

Tectonic zone of Sredna Gora (Паскалев, 1994) (Fig. 1)

At the end of the Upper Cretaceous epoch a folding formed near and to the south of the present ridge of the Balkan Range, as this folding was an obvious result of the Laramian phase (fourth structure formation within the limits of the East Balkan tectogen). The folds are characterised by their submeridional orientation (Паскалев, 1988, 1994, 2005). The same are being established in the sediments of the Emine Formation (Campanian–Early Paleocene) and in undivided Turonian–Senonian sediments and volcanogene-sedimentary deposits (Turonian–Senonian) (Кънчев, 1995) (located within the limits of the Balkan Range and Sredna Gora). There is no doubt that the formation of these structures is a result of the Laramian phase. The Emine Formation is the youngest sediments, where the same are being established within the Eastern Balkan Range. The same are not located neither in the clay-terrigenous formation (Paleocene) from the Emine Stara Planina Range (as this formation is laying above it), nor in the formation of the thick-layered flysch (Upper Paleocene–Lutetian, Кънчев, 1995) in the Sliven Balkan Range.

The expression of the Laramian phase is characteristic only for the tectonic zone of Sredna Gora. The finding of structures (folds) resulting from this phase and within the limits of the Eastern Balkan Range, leads to the conclusion that the northern border of the zone is not limited by the so-called sub-Balkan fault (there are no data established about such structure to the east of the town of Tvarditsa). Hence, the northern border of Sredna Gora zone in the Eastern Balkan Range has to be traced about 10 km to the north, i.e. to the places where the submeridian folds are being established.

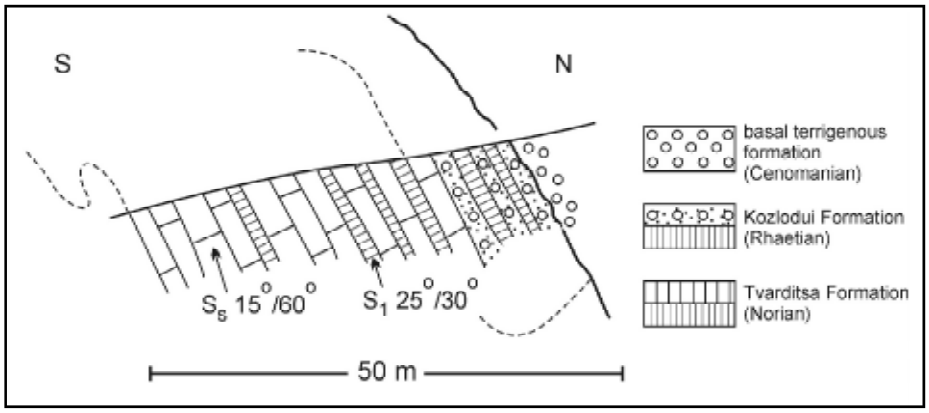

Fig. 3. Angular unconformity and superimposed disharmony the Triassic sediments and Upper Cretaceous sediments (along Sasa dere)

Tectonic zone of Luda Kamciya (Бончев и др., 1965) (Fig. 1)

As a result of the Illirian phase, two strong and wide-ranged structural events appear in the Upper Cretaceous-Paleogene (including until Lutetian) sedimentary basin. During the first one – (fold-forming – fifth structure-forming process) folds were formed. They can be found in all parts of the East Balkan tectogen (Паскалев, 1985, 1988, 1990; Tzankov et. al., 1991) and are located in the Triassic–Jurassic, as well as in the Upper Cretaceous–Paleogene materials. Their most characteristic feature is the subequatorial orientation of their axes. They occured as meso- and macro-structures. They are also found beyond the limits of the Eastern Balkan Range. The same are being established within the entire Fore-Balkan region, as their quantity decreases to the north from the Elena–Varbitsa parallel, as the folds are clearly bent. Such folds are also found to the west – in the region of Gabrovo.

During the second structural formation (the sixth one for the East Balkan tectogen), which occurred immediately after the fold-formation, upthrusts developed here (Kotel's, Balabendere's, Karavelyov's, Sliven's upthrust and Arabadzhiburun-Peshtera-Bata reverse fault-upthrust). The horizontal amplitude of the Sliven upthrust is 7–8 km, as the horizontal amplitude of the other structures is not more than 1–1.5 km. Eventually, probably due to the activity of the Iberian phase, there was one more upthrust of black flysch (Jurassic) deposits (Koilo upthrust). It is presumed that North Strandzha was also the initial place from where the same moved. The horizontal displacementis of the order of a few tens of kilometers (Fig. 2).

A sedimentary basin was formed in the Eastern Balkan Range during the Oligocene, when clay and clay-terrigenous rocks was deposited (together with olistostromes at some places). The same are not folded, as they lay on older sediments transgressively and with an angular discordance. They initiate the formation of a new sedimentary zone (as it is not tectonic yet due to the lack of deformation within its constructive deposits) within the limits of the East Balkan tectogen.

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Резюме. М. Паскалев, П. Петров – Седиментни басейни, тектонски зони в геоложкото развитие на Източния Балкан. В работата е разгледана геоложката еволюция на Източна Стара планина през алпийския тектонски цикъл. Основното тектонско събитие в една орогенна област, каквато е Стара планина това е създаването на тектонски зони. Те са резултат на структури, които са се проявили по характерен начин в пространството (в даден тип скали) и в точен интервал от геоложкото време. Определящ за зоната е пространствения обхват на формираните в резултат от изявата на дадена фаза гънки. В своето развитие тектонската зона преминава през няколко етапа: създаване на седиментен басейн, нагъване на изграждащите го отложения в резултат на изявата на една или повече структурни фази. Накрая формирането на почти всички тектонски зони (в Източния Балкан) завършват с по-голямо или по-малко, по амплитуда, хоризонтално преместване на скали.

Основен резултат от работата е дешифрирането на тектонското развитие на Котелската, Качулската, Средногорската и Лудокамчийската тектонски зони в пределите на Източно-балканския тектоген.

Установено е, че през олигоценската епоха на територията на Източна Стара планина се създава нова седиментна зона, която все още не е тектонска поради липса на деформация в изграждащите я отложения.