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Actuality method and facial analysis of sediment deposits as a studying tool for reconstructing late Neogene-Quaternary environments and relief evolution along mid Struma river valley

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Abstract: Analysis of sediment deposits facial features and applying actuality method, is a crucial part of reconstructing paleo geographic environments and also of big importance for clarifying relief evolution. The object of this research is to clear the late Neogene-Quaternary paleo environments along the middle Struma river, which coincide with Blagoevgrad graben morphostracture. Because of that, analysis of facial features of Dzermanska and Barakovska sediment formations is presented. Also for the purpose of the enquiry for better understanding of the relief evolution the method of actuality is applied. The genetic relation between modern tectonic activity, relief evolution and vertical dislocations of post Early-Pleistocene accumulation surface around the research area has been discovered.

Key words: Facial analysis, Actuality method, Sediment deposits, Accumulation surfaces , Tectonic activity

Introduction

Actuality method is based on the principle of uniformitarianism and is one of the basic method of reading geology history. It states that the geologic processes observed in operation that modify the Earth's crust at present have worked in much the same way over geologic time. A fundamental principle of geology advanced by the 18th century Scottish physician and geologist James Hutton, is that "the present is the key to the past." In Hutton's words: "the past history of our globe must be explained by what can be seen to be happening now." The Purpose of this enquiry is to use one of the basic principle in geology combined with facial analyze, as a tool for investigating, late Neogene, Quaternary sediments in Blagoevgrad graben in order to achieve better results in reconstructing paleo environments and relief evolution. The Neogene sediments in Blagoevgrad graben have been subject of numerous researches. First Bakalov (1977, 1978, 1979 and 1982) conducted detail investigation of the sediments and determined the stratigraphic units in Blagoevgrad graben. After that Valkov (1979), based on Bakalov separated two stratigraphic units lower clay and sandy horizon- Dzermanska formation and upper pebbles and cobles horizon- Barakovska formation. Later Nedialkov at all (1990), also separates the sediments in the graben in two formations Dzermanska and Barakovska. In new research Tzankov at all (2002) introduced the lito complex theory and include the Neogene sediments in the above mention graben in the Slatino lito complex. Also interpretation of paleo geographic evolution of grabens along Struma valley including Blagoevgrad graben based on facial analysis of the sediment deposits is done by Nedialkov and Aleksiev (2004). It divided the sediments in three facial zones. The first one consists of not well rounded sediment, deposited by temporary creeks, which is developed along east boundary of the graben close to Rila dome morphostructure, the second one is stagnant-water deposits consists mainly of clay and sand and in the middle of the graben alluvium facial zone is developed.

Method and analyze

This enquiry is based on actuality method as well as facial analysis and comparison investigation of pictures of Neogene-Quaternary sediments cuts along Blagoevgrad graben and modern alluvium sediments along river Struma, Blagoevgradska Bistritsa and Dzerman. In order of better statistical representation pictures, with different facial feature are presented, as a benchmark and crosscheck of method representativeness. The luck of similarity of the facial features also is used as analytical tool. The geographical location of the sediments cuts along Blagoevgrad graben are presented bellow in map 1

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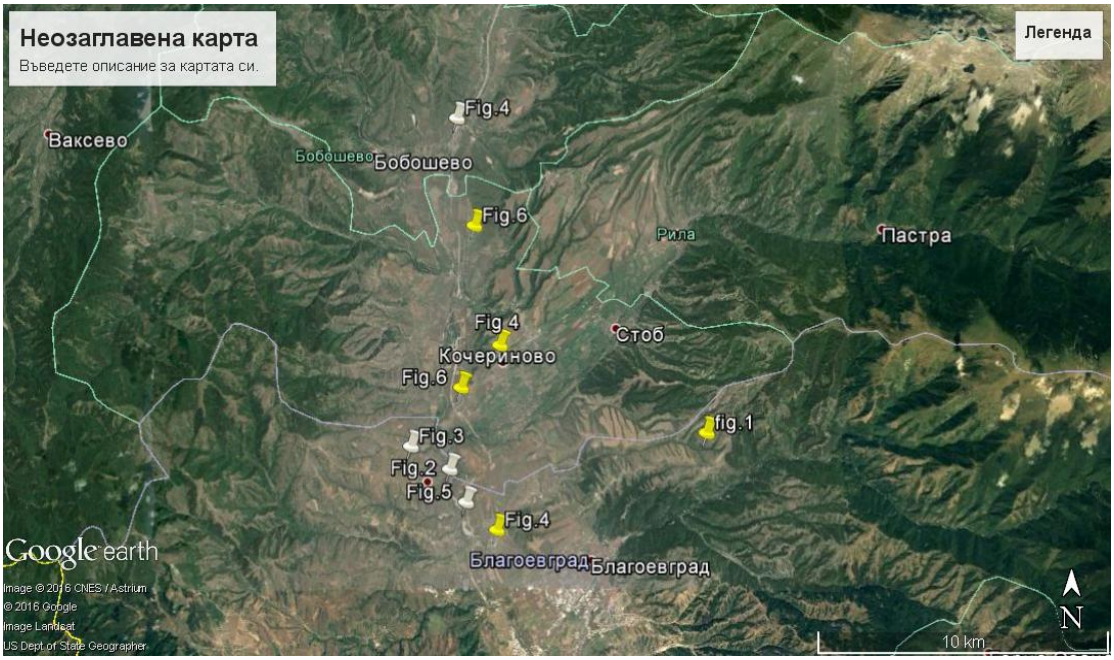

Map 1. Geographical location of the sediments cuts along Blagoevgrad graben, with yellow are the Neogene and with white the modern sediments.

Results

Case 1

The first sediment cut (Fig. 1) is situated near Dabrava village and represent de fossilized sediments consists of not well rounded blocks of gneisses and other mainly metamorphic rocks, that represent the geology setting in the proximity of the deposition area. The petrographic feature and the stage of roundness suggesting short distance of transport, by river in it's youth stage with under developed longitudinal profile in area subject of recent vertical uplift. Where the vertical erosion, has great rate, rather than the lateral.

Fig.1
De fossilized Neogene sediments near Dabrava village

Fig.2
Modern alluvial fan sediments near Buchino village, Blagoevgrad

The sediments on (Fig.2) are deposited at the spot where the transporting current is subject of sudden lose of energy typical for alluvium fans. They are not well sorted which is exactly the case also in the first picture. Also they are not well rounded again as in the first case the petrographic composition is similar to geology setting in the proximity of the deposition area. When examine the facial feature of sediments in the vicinity of actuality method, in both case a lot of similarities have been found and the case that

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the deposition condition back in the Neogene and in nowadays presented in (Fig.2) is really strong. As a matter of fact, few differences are also observed for example the size of the boulders, which is great in the first case as well as the stage of roundness, which is also great with the Neogene sediments. As it was stated, in the first chapter, even the lack of similarities or small differences can be used as analytical approach and as a part of the actuality method. The bigger size can be evidence of greater rate of uplift or higher river discharge or the both. Again if we compere the present day vertical dislocation of after early Pleistocene accumulative surface(Tzankov at all, 2002; Ivanov, 2015) along South-West Rila mountain foot hills and the same reddish cobbles and pebbles in low foot hills of Vlahina mountain, grater rate of vertical dislocation in the reach of Rila mountain foot hills can be observed. As a conclusion the river that deposit the Neogene sediments in (Fig.1) should posses the following features as in (Fig.3), which deposited the modern sediments in (Fig.2). At the picture in (Fig.3) can be observed evidences for modern erosional cut of river, in it's young stage with under developed longitudinal profile situated in area subject of recent vertical uplift. Where the vertical erosion has greater rate, rather than the lateral. Also the sediments in (Fig.1) are part of the upper body of former alluvial-proluvial fan situated close to the Rila mountain South-West foot hills and presumably are connected with the initial up lift of the Rila dome morphostructure.

Fig.3. Small river close to Buchino village, which is the transport agent of the sediments in fig. 2

Case 2

Subject of investigation in this case are sediment cuts in upper Neogene deposits 10-15 km north of Blagoevgrad city, near the villages of Mursalevo and Belo pole (Fig.4) and modern alluvial deposits along the rivers Struma and Dzerman

Fig. 4. Neogene sediments near village of Mursalevo on the left and near the village of Belo pole on the right

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The facial features of the sediments are presented by parallel alternation of sandy clays to pure sands separated by pebbles and cobbles layers. The thickness of the beds is varying between 1-1.5 m.. Very fine lamination transformed to cross bedding is presented in the fine grained layers. The pebbles and cobles are well sorted, with average size of the individual spacemen around 5-10 sm. in diameter, separate mostly by sandy fills. Petrographic content of the last consists mainly of Gneisses, Quartz, Schists and rarely Granites and red Sandstones. Some of the pebbles are covered with dark layer of fossilized remains of organic substance, which is presumably algae, that covered the pebbles along the ancient river canal. Such sediment sequence is typical for the middle part of the catchment areas in neutral or negative tectonic stress field and represent alternation, of river canal alluvial and flood plain deposits. Method of actuality was applied and the facial features of the sediments in (Fig.4) are compered, with the modern sediment deposits from erosional cut of first river terrace above the flood plain along the rivers Struma and Dzerman, that are presented on (Fig.5). When facial features of the sediments of (Fig.4) are compered, with those of the modern alluvium in (Fig.5) is obvious that it resemble the modern sediments along Struma river with big percent of coincidence. The only difference observed is the size of the pebbles in the coarse layers that represent river canal alluvium. Taking in account, that the geographical positions of the two pictures are very close to each other the difference in grain size is maybe due to more elevated relief in nowadays. The resembles with Dzerman river modern alluvium is also very high, but there is also some minor differences and features at some spots parallel alternation is substitute, with lens of sandy clays and sands as well as cross bedding, such sediment sequence correspond with different morphological type of river pattern-Braided rivers disclosed in case 3. As conclusion can be summaries that the deposition environments associated with the sediment sequence in (Fig.4) are very similar with the deposition condition along now days mid Struma, with strait to slide meandering pattern of the river channel. The reddish color of the sediments in (Fig.4) suggesting warmer climate and alternation of river canal above flood plain alluvium and again flood plain suggesting negative to stable tectonic stress field opposite to nowadays predominantly positive tectonic setting capture in (Fig.5).

Fig. 5. Modern river alluvium along Struma river on the left and along Dzerman river on the right

Case 3

In this case emphasis will be put not on the similarities but rather on the observed differences in the examined sediments cuts. In (Fig.6) are presented the sediment deposits subject of investigation, in this case they are located 10 km north of Blagoevgrad city close to town of Kocherinovo and further north close Boboshevo city.

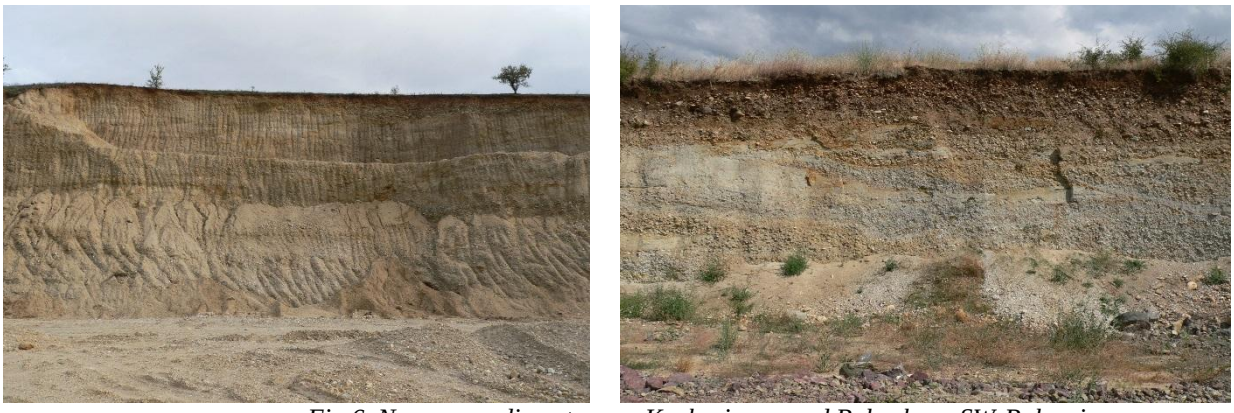

Fig 6. Neogene sediments near Kocherinovo and Boboshevo SW-Bulgaria.

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Alternation of sandy-clays and pebbles lens and crossed bedding are typical facial features observed in the presented sediments profiles. Those sediments, are white to light yellow colored with traces of reddish rich of iron oxides laminations. The average size of the individual pebbles is between 2-3 to 10 cm in diameter, it consist predominantly of Gneisses, Quartz, red Sandstones, Amphibolite, Schists and other predominantly metamorphic rocks. The lens with the fine grained materials are built mainly of Quartz sands with less presentation of clay materials. On the top, the sediment complex is covered by well rounded, reddish cobbles with big presents of Granite, Diorite, Gneisses, Quartz, Amphibolite and Biotite-Mica Schists and other rocks types that resemble the geology settings of surrounding areas. This (Fig. 5) sediment sequences has little to any resembles, with the facial feature of the modern alluvium along Struma river in the area, but posses some similarities with the modern alluvium along Dzerman river, where sandy lenses (Fig.5) and cross bedding (Fig.7), exactly as in (Fig.6) can be observed. Only the size of the individual lens is different, which are much bigger in Neogene sediments than in the modern river alluvium probably due to difference in the river discharge.

Fig.7. Cross bedding in modern alluvium sediments –Dzerman river on the left and satellite image of the river at same spot with braided pattern

As it is disclosed in (Fig.6) and (Fig.7), the size of the lenses and the cross bedding is beyond comparison, but the facial features are similar, further more on the right in (Fig 7) it is easy to detect the braided pattern of Dzerman river at the spot of deposition connected with the sediment cut in (Fig.7). Because of that, based on facial features and the actuality method a conclusion can be made, that the depositional environments of the Neogene sediments in (Fig).6, are similar to this in (Fig.7). The only difference is the size of the transport agent, which is bigger in (Fig.6) and probably is the paleo river Struma, and the most important thing is that this paleo river had Braided pattern (Leopold at all, 1995). This pattern can be used as evidence of sudden lost of energy in the transport agent as well as for a current with great load of sediments transported from an elevated terrain subject of erosion. Further more, the size of the pebbles and the stage of roundness suggest, that they were transported from substantial distance. As a support for this also can serve the fact that the rock types of some pebbles are not matching the petrographic setting in the nearby areas, that are subject of substantial modern vertical dislocations.

Conclusion

Actuality method and facial analyze can be use as reliable method for reconstructing paleo geographic environments and relief evolution. Based on the three cases presented above, a conclusion is made that the Neogene deposits subject of investigation in this enquiry represent alluvium deposits of an evolved landscape shaped from one side by the direction of tectonic stress field and from another by paleo rivers that possess different morphology and river pattern. In case one, for example the river is in it's young stage with under developed longitudinal profile and running through an area subject of recent vertical uplift, where the vertical erosion has greater rate, rather than the lateral. They probably are connected with the initial up lift of the Rila dome morphostructure as well as, with the initial stage of the development of Blagoevgradska Bistrica river. The sediments in case two and three are deposited by paleo river Struma and they are evidence for alternation and transformation of the river pattern from braided (Leopold at all, 1995) to strait with slight meanders connected with the predominant sign of tectonic stress field. For the first time the idea for braided river pattern in the area is presented by Tzankov at all (2002), also Ivanov (2015) developed a theory for existence of such pattern along South-West Rila foot hill between city of Dupnica and Blagoevgrad city. The significant break trough of this research represent the fact that, by using actuality method and facial analysis the existence of braided pattern of paleo Struma along Blagoevgrad graben was proved and now based on this we can trace it through new sediment cuts on a distance more than 20 km long and 2-3 km wide.

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