GEOLOGICAL RECORDS FOR PALEOSEISMISITY OF POPOVITSA FAULT IN A TRENCH NEAR POPOVITSA, SOUTHERN BULGARIA

Marlena Yaneva[1], Alexander Radulov[1], Gabriel Nikolov[1], Stefan Shanov[1], Thierry Kamelbeeck[2], Nikolai Nikolov[1], Asen Mitev[1], Konstantin Kostov[1], Kris Vanneste[2], Koen Verbeeck[2]

[1] Geological Institute BAS, Akad. G. Bonchev Str., Bl. 24, 1113 Sofia, Bulgaria
[2] Royal Observatory of Belgium, Ringlaan 3, 1180 Brussels, Belgium

Investigations on paleoseismicity are an important part of seismic hazard assessment in the Upper Thracian Depression as one of the most seismically active areas in Bulgaria. The surface rupture of Popovitsa M 7.1 earthquake on April 18, 1928 referrers to an oblique fault from Maritsa fault zone. Further in the paper, the activated part of this fault is named Popovitsa fault. The present study was carried out to clarify the past fault activity reflected in the geological record. For this purpose a trench across Popovitsa fault was excavated in cooperation between the Royal Observatory of Belgium and the Bulgarian Academy of Sciences in the spring of 2004.

The Popovitsa fault follows a slope 50-55 m high. Its position is marked by a change in the surface gradient on both fault walls. The fault scarp is slightly expressed or absent. Fault activity controls the alluvial sedimentation in the hanging wall and erosion in the footwall. In the upthrown block, Neogene alluvial sediments and Paleogene limestone crop out (Fig.1). Pleistocene and Holocene alluvial deposits of Maritsa River cover the downthrown block. The youngest (including Holocene) fault activity reflects in the morphology, i.e. the changes in width of the floodplain of Cherkezitsa River near the fault, the presence of erosion valleys in the footwall, young alluvial fans and colluvium.

The trench was excavated in the Holocene alluvial terrace at 15 m above the present level of Maritsa River (Fig. 1), near motorway E-80, west of Popovitsa Village, Plovdiv district. Trench dimensions are 36 m length, 2 to 4.80 m depth and 3.5 m width.

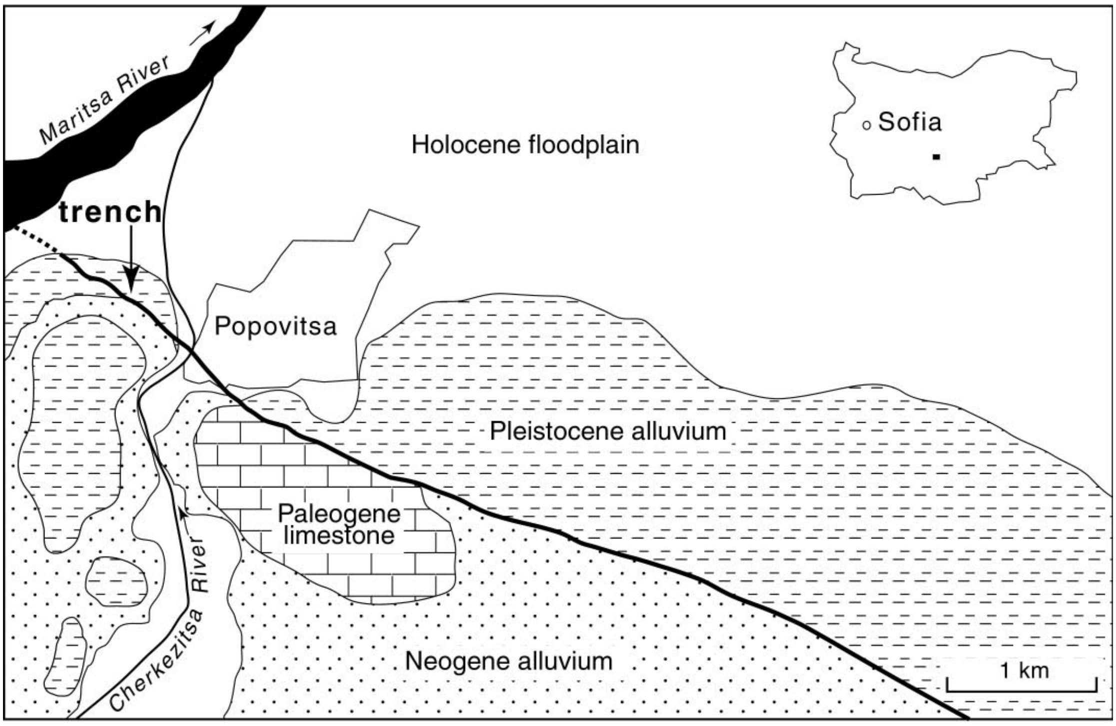

Fig. 1. Geological sketch of the area around the main faulting in 1928. Thick black line shows the trace of the faulting.

Trench walls cut alluvial deposits altered to a considerable degree by pedogenic processes. They were divided into units on the base of their sedimentological and pedological characteristics and marked by letters A, B, C, D, G, H, I, J, K, M, N, O, P and Q from the youngest to the oldest one (Fig. 2). Primary sedimentary textures and structures are better preserved in units D, J, O and Q.

Unit A is a plough zone of the agricultural activity after 1928. Unit C comprises sandy deposits, coarser in the lowermost part, and unit B is sandy too, but artificially reworked due to its nearness to the road. The top of both units B and C represents the surface during the 1928 earthquake. The humic horizon in unit C is denoted as subunit C1. It is better preserved in the hanging wall and eroded in the footwall. Unit C has been the humic and a part of illuvial horizon of the soil profile before the 1928 earthquake. An alternation of clayey silt and silty sand with thickness of a single layer about 5-10 cm, represents unit D. Sediments building units G and H show high clay content, and high indexes of rubification that characterize them as a well developed illuvial horizon in the modern soil profile. Unit H is a Bt horizon in the soil profile. The higher index of rubification than in unit C means that these units have been submitted to pedogenesis for a longer period of time than the upper unit C. Unit J is composed of carbonaceous coarse-grained sand in channel facies. Massive gray clayey sand builds up unit K. A carbonate horizon of the modern soil profile is observed in this unit near the fault zone and in the hanging wall (Figs. 2, 3). Unit M is composed of light gray clayey sand that is spotted in the footwall wall due to leaching of carbonate concretions. In the hanging wall this unit belongs to the carbonate horizon of the modern soil profile. Unit N is built up of red sand, stained in the footwall, with the highest indexes of rubification among all sediments in the trench. Thus, the unit could be interpreted as an old illuvial soil horizon, different from those in units G and H. Unit P has restricted distribution and crops out only in the footwall. It comprises clayey carbonate above the alluvial sand of channel facies of units O and Q. The last two units are composed of coarse grained to pebbly sand, and crop out only in the footwall, too. Similar deposits were established in one of the boreholes in the hanging wall (Fig. 2).

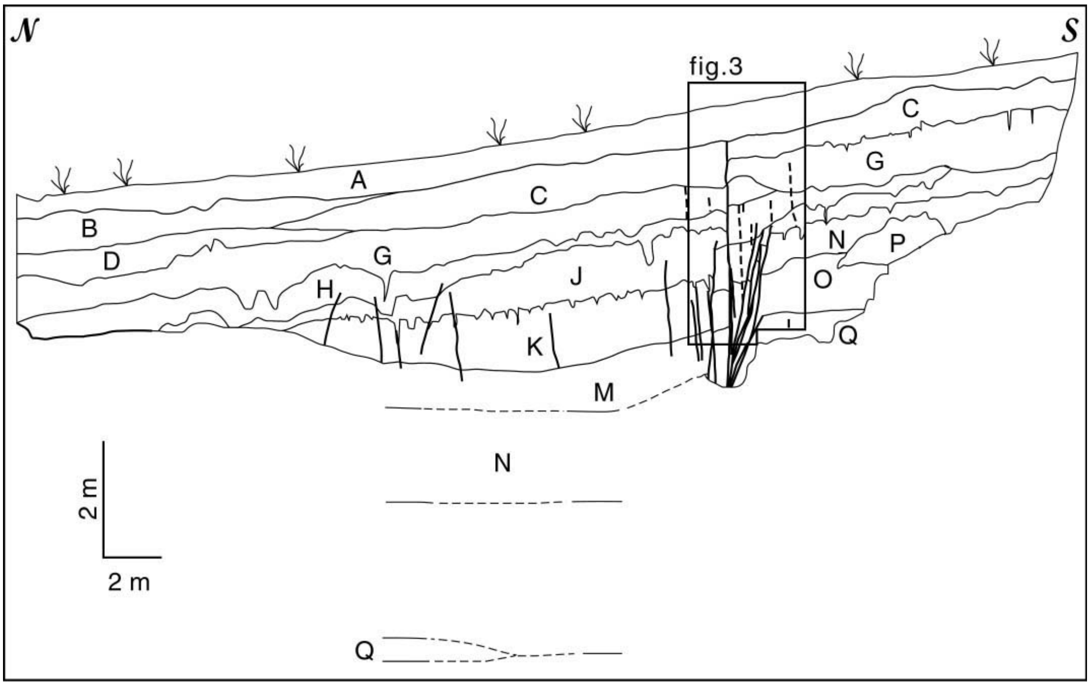

Fig. 2. Log of the eastern trench wall. Units are marked with letters. Vertical exaggeration 2 x. Data below the trench bottom are from boreholes.

The main deformations are located in a 8 m wide zone. Faults are marked by F1, F2, F3 and event horizons are marked by E1, E2 and E3 from the youngest to the oldest one (Fig.3). Three faults are observed on the eastern wall. Fault F1 is vertical. Fault F2 dips at an angle higher than 90°, which is a typical geometry of normal faulting close to the surface. Fault splay F3 dips at 65-70°. The three faults converge in depth at about 5 m.

Displacement of 0.70 m of the base of unit C and all units below it along fault F1 on the eastern trench wall indicates the 1928 earthquake (Fig. 3). The event horizon is the surface during the earthquake, which coincides with the top of unit C and B. This displacement represents only a part of the total slip. The displacement of event horizon E1 measured on long distance is 1.15 m; and this value should be the minimum displacement because the top of unit C in the footwall has been eroded and artificially removed after 1928. The humic horizon in the footwall before the event could not be thicker than the same horizon in the hanging wall so the maximum eroded part of unit C is 0.20 m. Taking into account this value, the maximum displacement is 1.35 m. Data from leveling survey before and after the earthquake show offset of 1.30 m (Мирков, 1932) on a road at 500 m from the trench. The established offset between 1.15 and 1.35 m in the trench is in good agreement with the data from leveling survey.

Evidence for a previous event is a displacement of unit J and lower units mainly along fault F2 of the eastern wall. Fissures observed into unit G do not pass into unit C. The event horizon E2, that is also the top of the humic horizon of the soil profile before the penultimate event, is not observed because the boundary G/C has erosional origin. Isolated remnants of this humic horizon are preserved in open cracks in the lower units. The offset of unit J base along fault F2 is 0.60 m (Fig. 3). The total displacement of the penultimate event is evaluated on the top of unit K, and is 1.20±0.35 m.

The displacement of units M and N along the fault splay F3 on the eastern trench wall records an earlier event (Fig. 3). The top of unit M is the event horizon E3. The top of unit M is preserved only in the hanging wall whereas it has been eroded in the footwall. The total displacement of the boundary M/N measured on long distance, obtained after extraction of the displacements from 1928 and the penultimate events, is 1.10

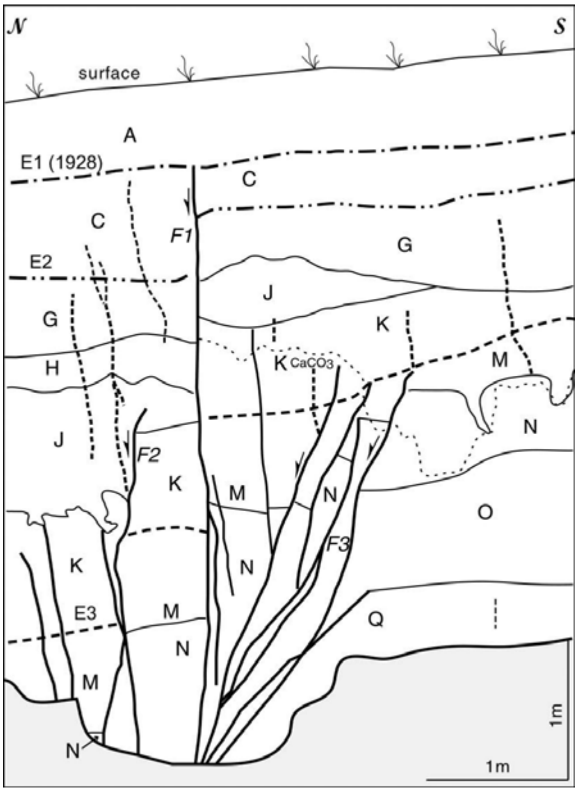

Fig 3. Fault zone in eastern trench wall.

+0.25/-0.15 m.

Unit N in the hanging wall is 1 m thicker than in the footwall (Fig. 2) and it suggests another event before the antepenultimate one. The exact value of the probable displacement could not be evaluated, but the difference in the thickness of unit N in both fault walls suggests a displacement comparable with that of the younger events.

Four events were established in the trench near Popovitsa. The offset of 1928 earthquake established in the trench shows the same value as it is known from the leveling survey after the earthquake. The offsets of penultimate and antepenultimate events are close to the 1928 offset suggesting

that the magnitudes of these events have been similar to the magnitude of 1928 event. Probably, the penultimate event occurred in Roman time according to the pottery remains in the trench. The presence of a well developed soil profile before each event leads to the assumption that the time interval between the last three events is between 1000 and 3000 years (Birkeland, 1999). A more precise timing of the earthquakes will be obtained after dating of samples by ^{14}C analysis and optical stimulated luminescence analysis.

The paleoevents established in the trench should represent past fault activity only for the fault section between Cherkezitsa River and the modern floodplain of Maritsa River. Additional trenching along the entire fault is needed for understanding the seismic history and the hazard in the area.

References

Мирков, М. 1932. Прецизни нивелачни измервания в южнобългарската земетръсна област. – *Годишник на Държавния географски институт, 34-51.*

Birkeland, P. W. 1999. *Soil and Geomorphology.* Oxford University Press, 430 p.