Paleoearthquake correlation in three trenches along Orizovo – Chirpan active fault segment

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Introduction

One of the most devastating earthquakes on the Balkan peninsula in XX century, April 14, 1928 M_S 6.8 (I_0 = IX MSK) earthquake, is attended with surface rupturing of the Chirpan Fault in the Upper Thracian Depression, southern Bulgaria. The Chirpan Fault is an E-W striking normal fault at the northern border of a Pliocene-Holocene graben. The great thickness of young infillings in the graben next to the fault and the high compound tectonic scarp suggests repeated surface rupturing events at least in Pleistocene and Holocene time. The Chirpan Fault can be subdivided into three main fault segments of different seismic history on the base of morphology and differences in hanging wall and footwall composition. The westernmost segment passes between Shishmantsy village and Orizovo village mainly trough Holocene alluvium. The middle segment between Orizovo village and Chirpan town corresponds to a high compound scarp up to 30 m that separates Holocene deposits in the hanging wall from Neogene sand and Eocene marl and limestone in the footwall. The easternmost segment cuts mainly Neogene deposits between Chirpan town and Trakiya village.

The contemporary descriptions of the April 14, 1928 surface rupture (Bonchev, 1928; DIPOZE, 1931) contribute the main surface offset to the Orizovo — Chirpan fault segment. In order to study faulting history of the Orizovo — Chirpan segment we excavated two trenches and described one excavation along a highway construction. Paleoseismic record in trenches provides information for faulting parameters as time of previous events, recurrence interval, slip per event, and slip rate. Herein, we correlate events recorded in the three trenches along the central section of the Chirpan Fault.

Time of surface-rupturing events

Cherna Gora trench

This trench has been excavated north of Cherna Gora village (fig. 1). A single normal fault juxtaposes Pleistocene alluvial sand in the footwall against compound soil profile developed in Holocene alluvial silt in the hanging wall. The pollen content of the sedimentary units in the hanging wall indicates that deposits have formed since the Atlantic climatic phase (Yaneva, Lazarova, 2004). The uppermost units are partially spread in the footwall. Direct faulting in simultaneous units and colluviums related to fault scarp degradation indicate four surface rupturing events (Vanneste et al., 2006). The youngest event (event 1 on fig. 2) corresponds to the 1928 event. The times of the earlier events have been determined on the base of pollen stratigraphy. The penultimate event (event 2 on fig. 2) occurred in Subatlantic time. The lower time limit for that event is the beginning of the Subatlantic, which is 2602 ± 126 years BP (Ravazzi, 2003). We assume the upper time limit for the penultimate event to be the year of a large historical earthquake in the Upper Thracian Depression before 1928 event. Although the epicenter of 1750 M_S 7.4 event (Babachkova, Rizikova, 2000) is relatively far from the 1928 epicenter and therefore that event most probably does not correspond to the penultimate event in the trench, we assume the upper time limit to be 1750 AD. The antepenultimate event (event 3 on fig. 2) in the trench occurred in Subboreal time (Vanneste et al., 2006) between 5742 ± 85 years BP and 2602 ± 126 years BP (Ravazzi, 2003). The oldest event (event 4 on fig. 2) occurred during the early Atlantic, after 8890 ± 114 years BP and before establishment of the first human culture in the region around 6850 years BP

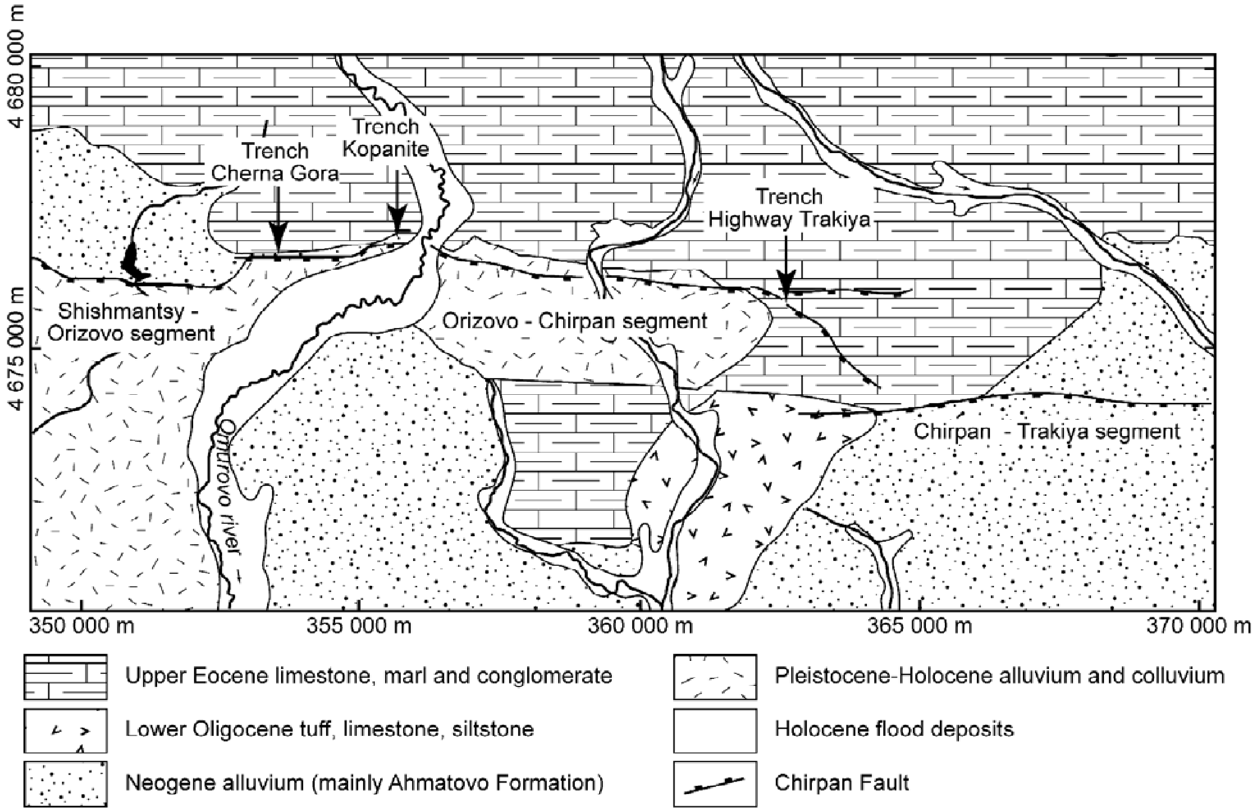

Fig. 1. Geological sketch of the area around the Orizovo — Chirpan fault segment. Arrows indicate locations of trenches.

(Vanneste et al., 2006). In addition to the four events, some indirect evidences suggest a possible event between event 3 and event 4.

Kopanite trench

Kopanite trench is situated on an alluvial fan west of Omurovo River (fig. 1). Two normal faults affect alluvial sediments and a paleosol. Three events are recorded on the southern fault. Radiocarbon dating and pollen stratigraphy are used to determine the time of events. Displaced base of the resent humic horizon and open fissures in the resent soil indicate 1928 event (event 1 on fig. 2). Faulted alluvial deposits along the main southern fault record a penultimate event (event 2 on fig. 2). The radiocarbon age of a charcoal piece found just below the event horizon is 2185 ± 30 years BP. The penultimate event occurred between 2185 ± 30 years BP and 1750 AD. We found evidence for an antepenultimate event (event 3 on fig. 2) in faulted lower part of a Subboreal soil. This event occurred between the beginning of Subboreal (5742 ± 85 years BP) and the time of alluvial deposition over the affected Subboreal soil. The radiocarbon age of the oldest charcoal sample from that alluvium is 3540 ± 35 years BP.

Highway Trakiya trench

This trench is located near the eastern termination of the Orizovo — Chirpan fault segment, north of Chirpan town (fig. 1). The trench wall exposes a soil profile in Holocene alluvium and fault scarp related colluvial deposits, both affected by faulting. Two colluvial units and a paleoscarp prove a faulting event (event 2 on fig. 2). The paleoscarp erodes a soil of Subatlantic age (Radulov and Yaneva, 2006). Similarly to the penultimate event in Cherna Gora trench, the time of this event is between the beginning of the Subatlantic (2602 ± 126 years BP) and the last large historical earthquake in the region (1750 AD). Faults propagating through the colluvial units and affecting the paleoscarp record a younger event (event 1 on fig. 2), most probably corresponding to 1928 earthquake.

Correlation of events

Evidence for 1928 event has been found in the three trenches. Cherna Gora trench and Highway Trakiya trench are situated on the two ends of the Orizovo — Chirpan segment and the presence of 1928 event in the both trenches indicates that the 1928

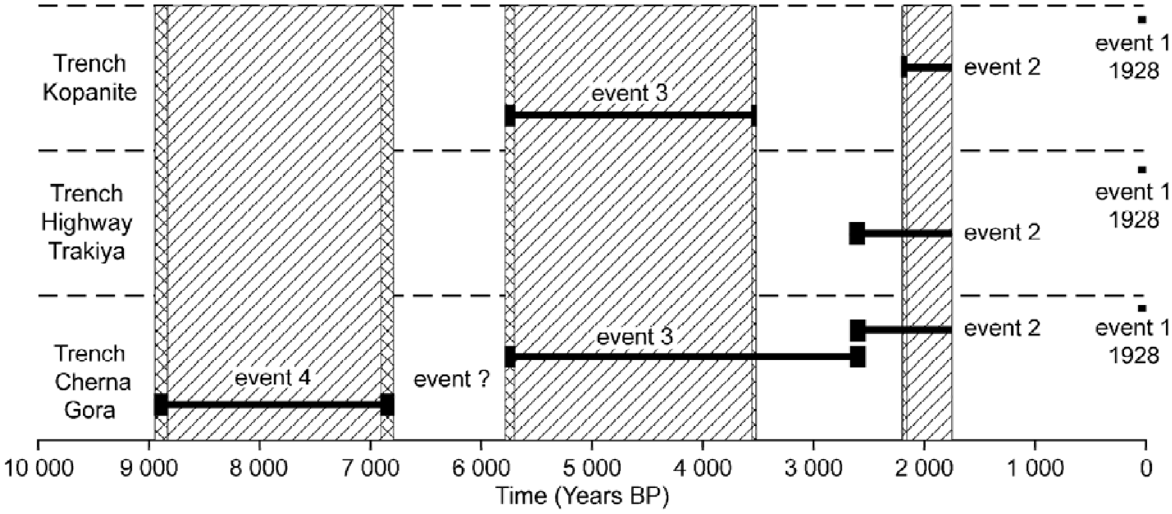

Fig. 2. Correlation of events in three trenches along the Orizovo — Chirpan fault segment. Time span of each event is shown by solid line. Black boxes present error.

surface rupture propagates along the entire segment length. The penultimate events in each of the three trenches correspond to a surface-rupturing event of the entire fault segment during the Subatlantic. The radiocarbon age of the affected sediments in Kopanite trench shorts the time span between 2185 ± 30 years BP and 1750 AD. Record of the antepenultimate event on the fault segment has been found only in Cherna Gora trench and Kopanite trench. Although the dated sediments from Kopanite trench limited the antepenultimate event between 5742 ± 85 years BP and 3540 ± 35 years BP, its time span still remains large. Evidence for the event 4 and the possible event between event 4 and event 3 from Cherna Gora trench is not found in the two others trenches.

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Корелация на палеоземетресенията в три канави на Оризово – Чирпанския активен разломен сегмент

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Абстракт. Едно от най-разрушителните земетресения на Балканския полуостров през XX век, земетресението на 14 април 1928 с M_S 6.8 (I_0 = IX MSK), се свързва с повърхностно разломяване на Чирпанския разлом в Горнотракийската депресия. Въз основа на морфологията и различията в лежащото и висящото крило, Чирпанският разлом се разделя на три главни разломни сегмента. Максималните стойности на повърхностното разместване през 1928 засягат средния разломен сегмент между село Оризово и град Чирпан. С цел установяване на разломната история на сегмента Оризово — Чирпан ние разкопахме две канави и описахме едно разкритие, изработено при прокарването на автомагистрала Тракия. В настоящото проучване се прави корелация на повърхностно разломяващите събития, установените в трите канави.

Сведения за земетресението през 1928 са установени и в трите канави. Предишните деформации в тях се отнасят към едно разломяващо събитие по цялата дължина на сегмента Оризово — Чирпан. Радиовъглеродната възраст на засегнатите седименти в канава Копаните стеснява времевия интервал на събитието между 2185 ± 30 години BP и 1750 г. Данни за едно по-предишно събитие са установени само в канава Черна гора и канава Копаните. Събитието се случва между 5742 ± 85 години BP и 3540 ± 35 години BP. Сведения за едно по-ранно събитие в началото на атлантическата климатична фаза и за едно непотвърдено събитие между по-предишното и това в началото на атлантика са намерени сама в канава Черна гора.