Paleoseismological investigation across the Gyrtoni Fault, Tyrnavos Basin, Central Greece

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Abstract: *We present the preliminary results of a paleoseismological investigation carried out along the Gyrtoni Fault, Tyrnavos Basin (Central Greece), whose occurrence and recent tectonic activity was previously based only on mapping, remote sensing analyses and electrical resistivity tomographies. The two paleoseismological trenches exposed evidence of 2 paleoearthquake displacements in the past ~4.0 ka. An ongoing dating of the collected samples, using the Optically Stimulated Luminescence (OSL) methodology, is expected to permit us to constrain the timing of the* linear morphogenic earthquakes observed in the trench and thus reconstruct the recent seismotectonic behaviour of the fault.

Key words*: Gyrtoni Fault, paleoseismology, trench, OSL dating, Greece*

INTRODUCTION

The Middle-Late Quaternary Tyrnavos Basin (Fig. 1) has a general E(SE)–W(NW) orientation and it is bordered by two antithetic sets of normal faults, both showing a partial overlapping right-stepping geometry. To the north, are the south-dipping Rodia and the Gyrtoni faults, while to the south are the antithetic Tyrnavos and Larissa faults (Caputo et al., 2003). The ESE-WNW trending Gyrtoni Fault (GF) is a 12-13 km-long, south dipping normal fault and is located at a distance of ~10 km north from the Larissa city (Caputo et al., 2012).

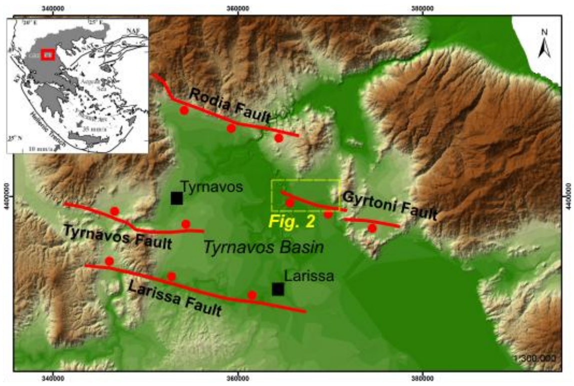

Fig. 1: Simplified tectonic map of the Tyrnavos Basin (faults adapted from Caputo et al., 2003).

The fault controls an approximately 10 m-high and 50-110 m-wide degraded composite fault scarp. As the fault scarp is developed in poorly cemented lacustrine deposits it is largely, but irregularly eroded, and the precise location of its trace is not evident in the field (Fig. 2). The possible maximum magnitude associated with this fault is Mw 6.1 (Caputo et al., 2012). The occurrence and recent tectonic activity of the fault, was previously based only on mapping, remote sensing analyses and electrical resistivity tomographies (Caputo et al., 2003).

In this work we present the preliminary results of a paleoseismological investigation carried out along the GF, aimed at documenting the seismotectonic behaviour of this tectonic structure.

PALEOSEISMOLOGICAL TRENCHES

Two single-slot (California-style) trenches were excavated across a 10-m-high south facing fault scarp at the central section of the west fault segment of the GF (Fig. 2). The first trench (Gyrtoni 1) was dug, in 2012, as an exploratory trench. The trench was 27 m long, 2 m wide and up to 4 m deep (Fig. 2). The second trench (Gyrtoni 2) was 9 m long, 2 m wide and up to 3 m deep, and was dug during 2014 at about 1 km to the west from the first trench (Fig. 2).

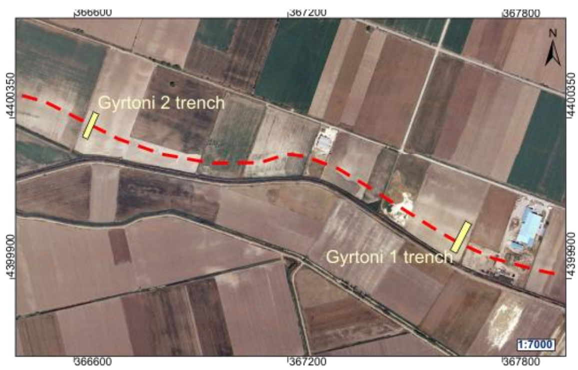

Fig. 2: Location of the two paleoseismological trenches. The dash line marks the trace of the Gyrtoni Fault.

The walls of the trenches were cleaned, gridded with a 1 m x 1 m string grid, sedimentary boundaries and

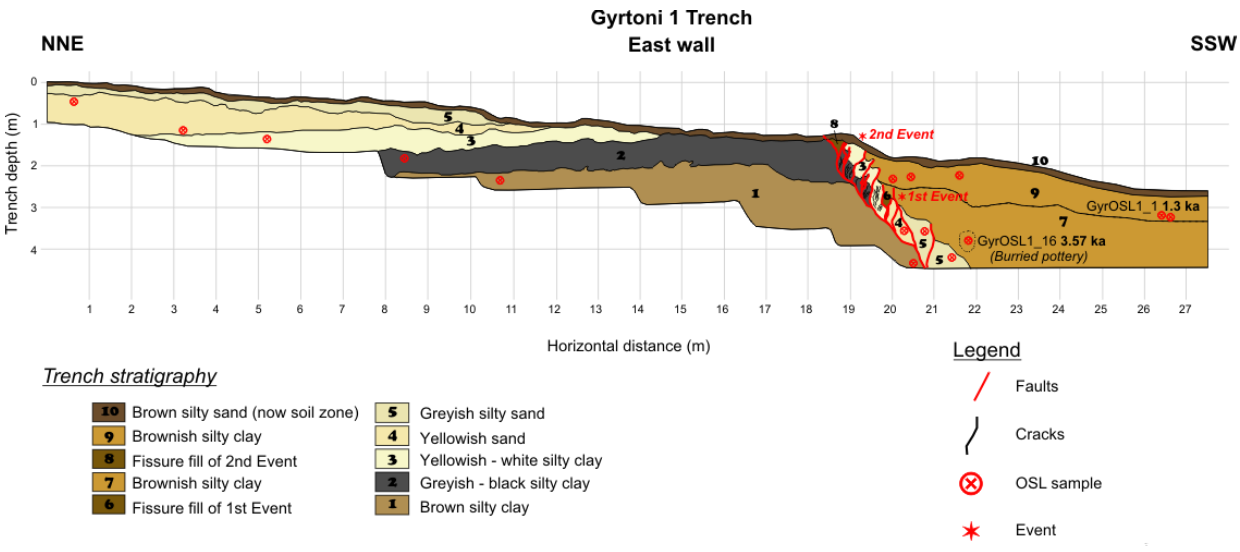

Fig. 3: Simplified log of the east wall of the Gyrtoni 1 paleoseismological trench.

structural features mapped in detail and photographed; samples were collected for age determination. Therefore, in Fig. 3 the east wall of the first trench, while in Fig. 4 the east wall of the second trench are presented.

Both trenches intersect the fault zone which separates a series of well stratified, thick to very thick beds of fluvial-lacustrine deposits exposed on the upthrown block from colluvial deposits of the downthrown block.

In both the excavated trenches the fault zone exposed as a complex, 2-m-wide zone of stepped normal fault strands. The fault strands are merged toward the base of the trenches into a single shear zone dipping 60-70° to the south (Figs. 3 and 4). The fault zone is composed of displaced blocks, relatively intact and occasionally rotated (e.g. subunits 2a, 2b and 2c in Fig. 4), of sedimentary units from the upthrown block.

LUMINESCENCE DATING

Totally, twenty six samples for Optically Stimulated Luminescence (OSL) dating were collected from the sedimentary units exposed on the walls of the two trenches. Sediment samples, one for each lithologic unit, were collected from the upthrown fault block in order to establish a reliable chronological framework; sediment and pottery samples were collected from the downthrown fault block of the trenches to constrain the timing of the displacements observed in the trench and thus reconstruct the recent seismotectonic behaviour.

Sample preparation and luminescence measurements were carried out at the luminescence dating laboratory of the Archaeometry Center of the University of Ioannina. The grain-size fraction of 63-100 μm, for samples from Gyrtoni 2 trench, and 125-250 μm, for samples from Gyrtoni 1 trench, were extracted by wet-sieving. The extracted grains were treated with HCl, H_2O_2, HF and concentrated HCl to separate quartz subsamples. The purity of the quartz extract was checked using the OSL-IR depletion ratio (Duller, 2003). Following sample preparation, luminescence measurements were performed on a Risø TL/OSL-DA-20 reader (Bøtter-Jensen et al., 2003) and signals were detected using a 7 mm Hoya U-340 optical filter in front of an EMI 9235QA photomultiplier tube. Measurements of OSL were made on chemically purified coarse-grained quartz, using the Single-Aliquot Regenerative-dose (SAR) protocol of Murray & Wintle (2000; 2003).

The environmental dose rates were calculated from radionuclide concentrations, measured by high-resolution gamma spectrometry (Murray et al., 1987), at the Nuclear Physics Laboratory of the University of Ioannina, using the conversion factors of Adamiec & Aitken (1998).

PRELIMINARY RESULTS

The detailed analysis of the trench walls allowed as identifying at least two faulting events. The minimum age of the two faulting events are derived by samples GyrOSL1_1 (in Fig. 3) and GyrOSL2_5E (in Fig. 4), and GyrOSL1_16 (in Fig. 3) and GyrOSL2_2E (in Fig. 4), respectively. The preliminary results of the 4 OSL ages are in stratigraphic order and indicate that unit 9 (in Fig. 3) was deposited about 1.3 ka. The colluvial deposits unit 7 (in Fig. 3) and unit 6 (in Fig. 4) were deposited before ca. 3.7 ka. The two identified paleoearthquakes produced a total displacement of about 1.6 m with an average displacement of about 0.8 m each. According to our preliminary interpretation, the first event occurred before

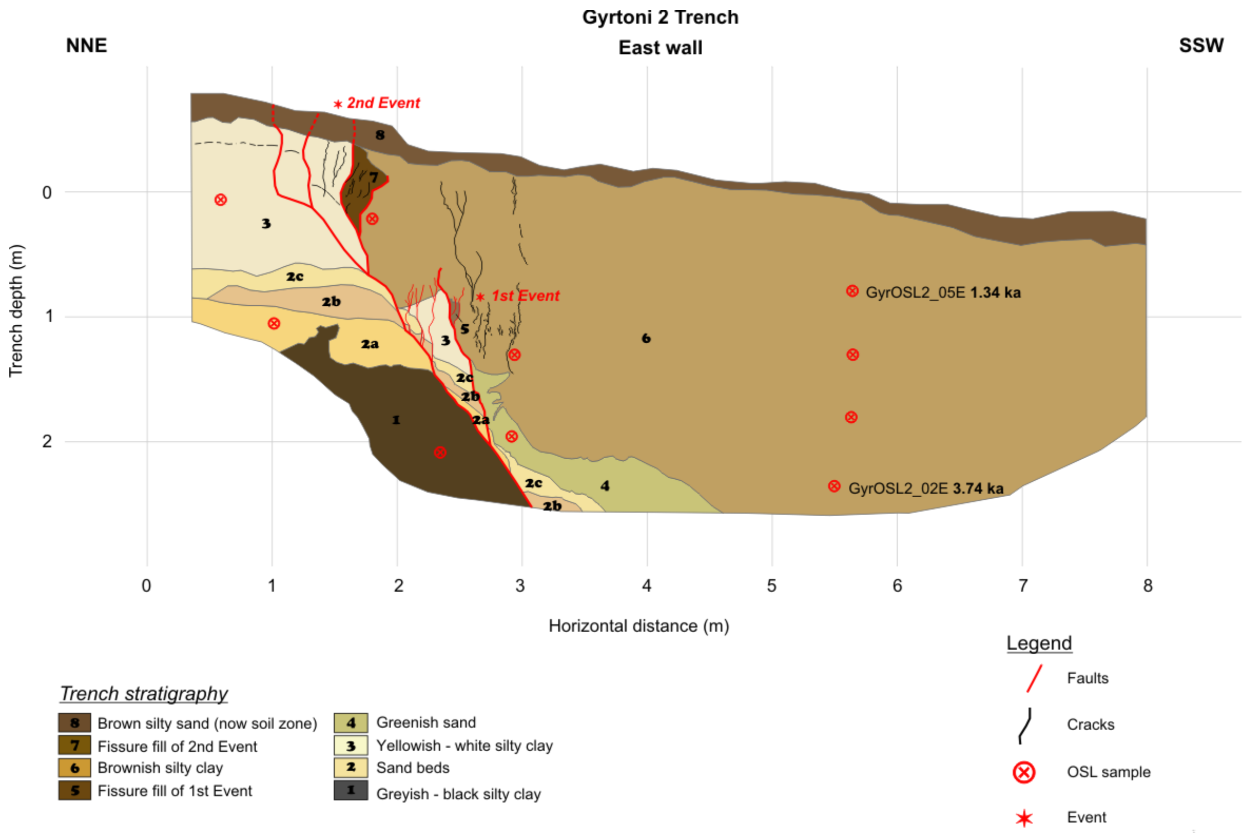

Fig. 4: Simplified log of the east wall of the Gyrtoni 2 paleoseismological trench.

3.7 ka, while the most recent event (2nd Event) occurred before 1.3 ka. These OSL ages defines a recurrence interval between the two events of about 2.4 ka. In the past 3.7 ka there have been 2 paleoearthquakes but only 1 complete seismic cycle to calculate a slip rate. Considering this we can estimate a slip rate between the two events of 0.33 mm/yr.

The seismic history of the Gyrtoni Fault was completely unknown and thus our data offer new results for improving our knowledge on the Holocene tectono-stratigraphy of this structure and for better evaluating the seismic hazard potential of Larissa.

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