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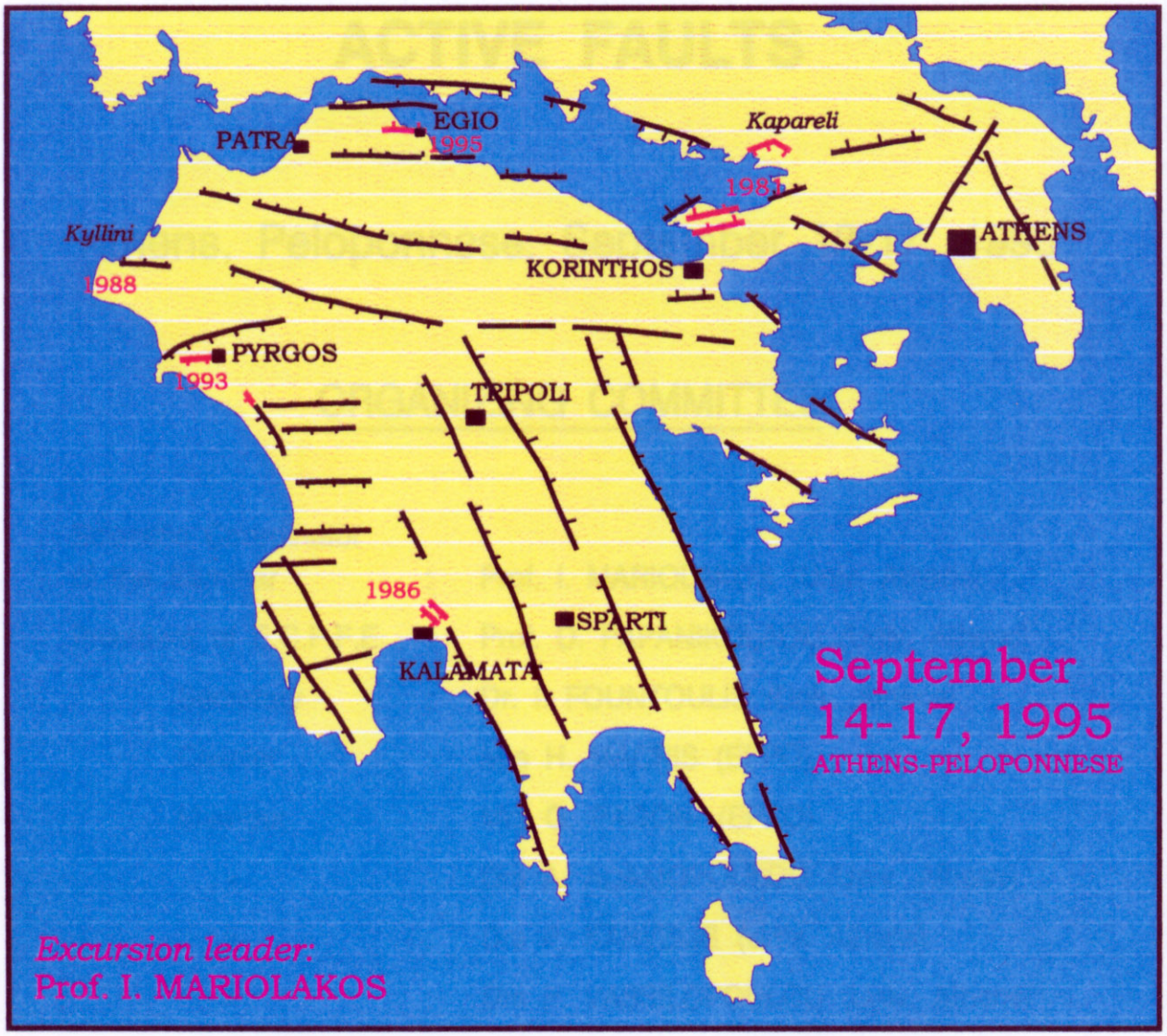

FIELDGUIDE

Pre-Congress Excursion A1 of the
XV Congress of the Carpatho-Balcan Geological Association

THE PYRGOS EARTHQUAKE - THE GEOLOGICAL AND GEOTECHNICAL CONDITIONS OF THE PYRGOS AREA (W. PELOPONNESE, GREECE)

by

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INTRODUCTION

The tectonic graben of Pyrgos, which extends over a large area, is characterized by complex lithostratigraphical structure and by neotectonic deformation which has been particularly intense during Holocene (HATZFELD et al., 1990, LEKKAS et al., 1992).

However, the prevailing conditions at the Pyrgos pleistoseismal area are relatively simple. Neotectonic structures are covered by recent geological formations (Allavial, Marshy deposits) which occur in the flat low land.

On March 26 1993 the major area of Pirgos was affected by an earthquake of magnitude Ms:5.2 (Fig. 1).

The main shock as well as the afterschock caused many damages at Pirgos and the surraending area.

The Pirgos earthquake, except the destructions to the buildings caused several other geodynamic phenomena such as liquefaction phenomena followed by and water's sharing off, landslides, fractures, soil fractures etc.

Seismic fractures

Seismic fractures were observed at the following two areas.

A. Pirgos: Several seismic fractures, were observed at the northeastern part of the city in a general direction E-W. They have en chelon arrangement. Their length varies from some meters up to 10 m, the opening (width) is 2-5 cm. Any vertical throw is not visible. On the other hand there is well defined right lateral component of the movement.

The seismic fractures cut the asphalt of the road as well as some particles of the coarse-grained clastic rock in the asphalt. It must be mentioned that in the area which seismic fractures were observed, the damages were more (or) dense even in new constructions.

B. **Lasteira village:** Seismic fractures were observed at the southern part of the village. Their strike is E-W and have en chelon arrangement. Their length's varies from some centimeters up to some meters. They cut the asphalt of the road as well as the soils of the cultivated area. In some the building damages were connected by these seismic fractures.

GEOLOGICAL GEOTECHNICAL CONDITIONS

The approach to the geological and the accompanying geotechnical conditions of the city of Pyrgos has been carried out through the use of existing data of previous extensive researches and mainly the

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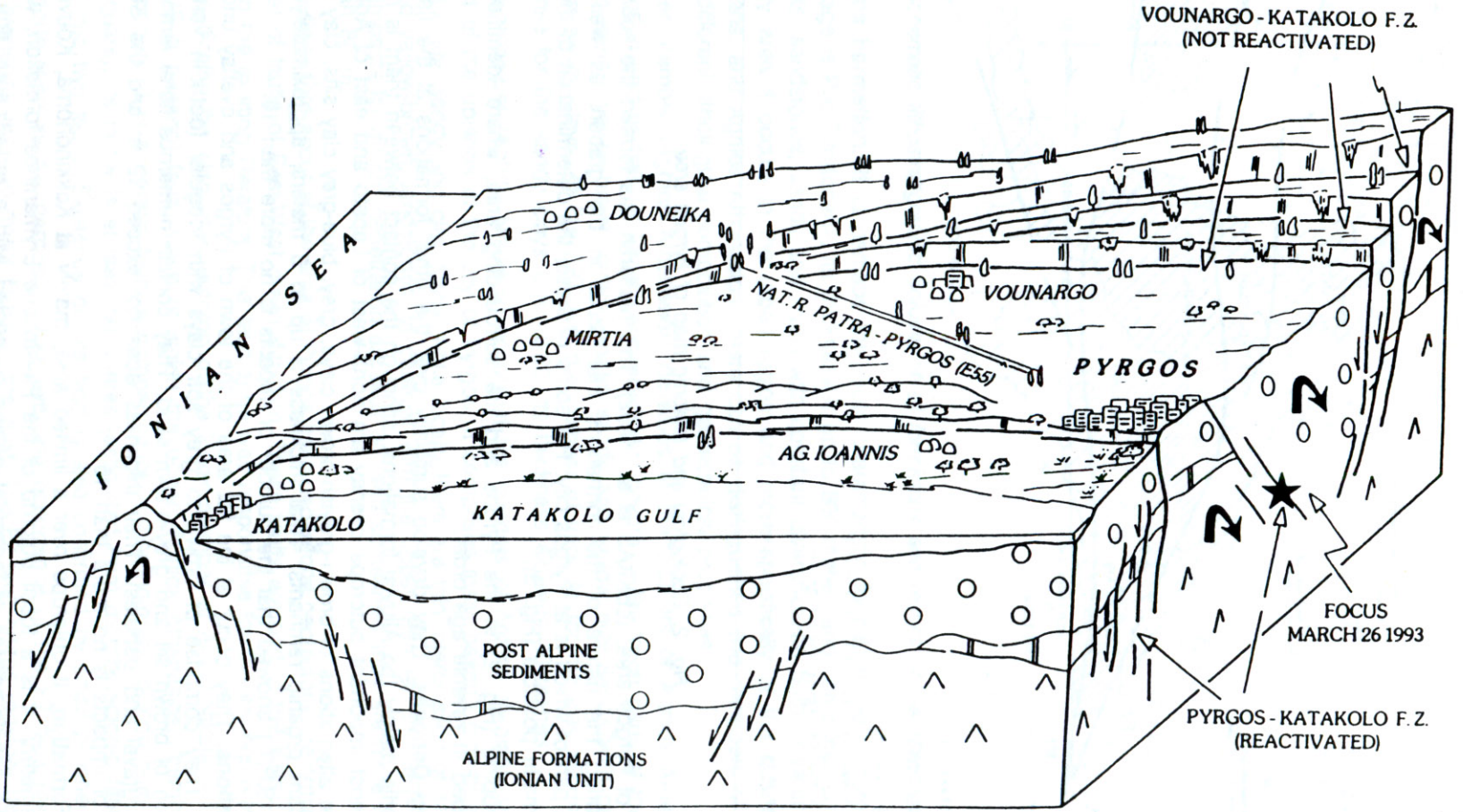

Fig. 1. Block-diagram depicting the geological and neotectonic structure of Pyrgos area.

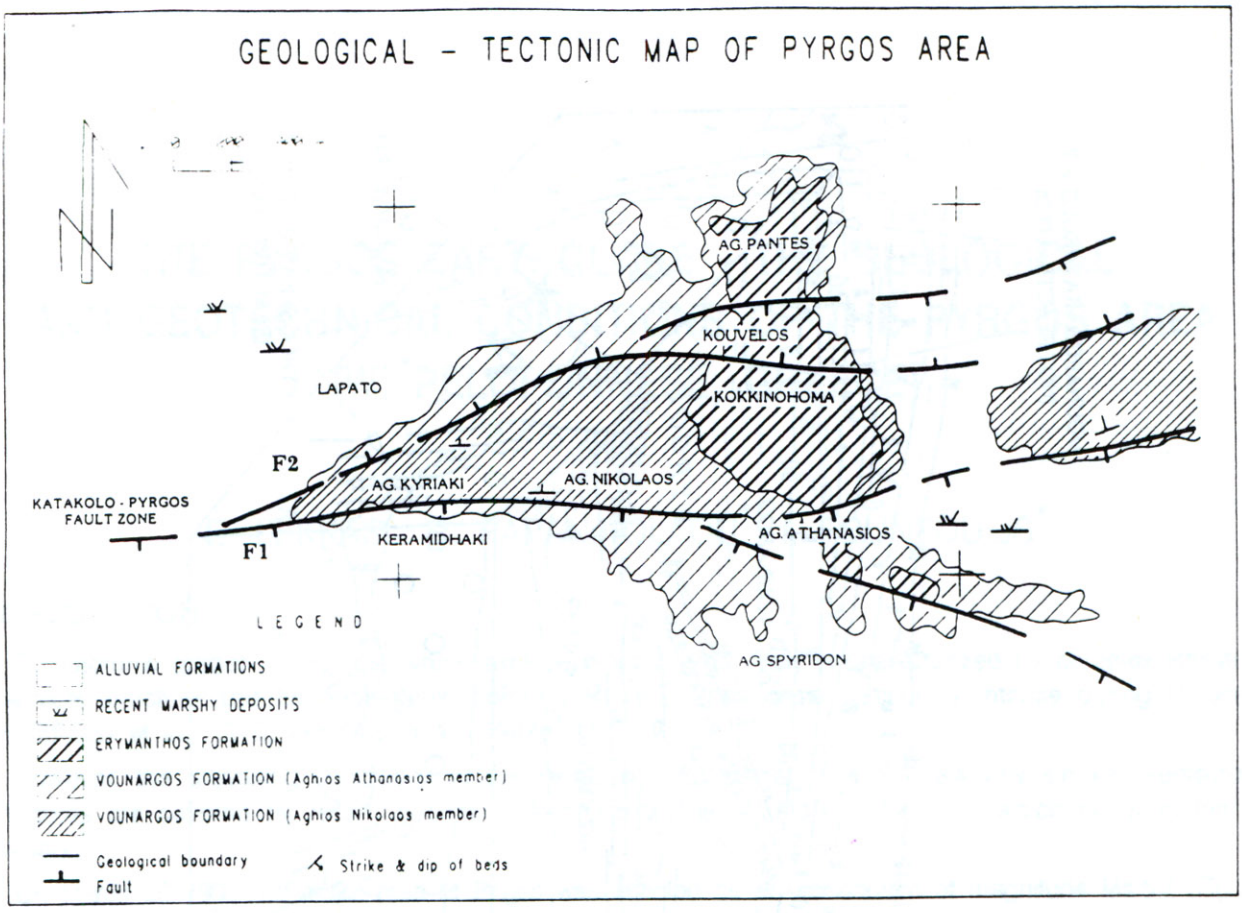

Fig. 2. Geological and tectonic map of Pyrgos area.

Neotectonic Map of Pyrgos area. (LEKKAS et al., 1992). This research has formed the source of data and information concering the nature of the formations that occur in the graben, as well as the active macrostructure, a part of which is at Pyrgos city. For some of these, the determination of their geotechnical parameters was made possible (Fig. 3).

Geological mapping (Fig. 2) in the Pyrgos and the surrounding area, where identified the following formations described in reverse age order.

Recent Marshy Deposits. They develop surficially over the other formations at the flat plane part of the area and overlie mainly the Alluvial formations, although the contact between them is not well defined very clear. The most important outcrops overlay are north-west of Lapato and east of Aghios Athanasios quarters. They are alternations of brown-greyish-brown clays, grey, blue-grey clay silts, clay and silty sands containing abundant organic remnants. Total thickness is up to 5 meters, approximately. The Standard Penetration Test (S.P.T.) showed that the number of impacts is no more than 10.

Alluvial Formations. They occur at the flat area of the town of Pyrgos and overlay unconformably the older formations. They comprise of brown to grey soft clays with irregular (both in vertical and lateral sense) intercalation of brown silt and grey-brown sand. They contain numerous floral remnants as well as coarser material (gravel and pebbles). Their thickness does not exceed 12 m and the SPT test showed that the number of impacts is no more than 15.

Erymanthos Formation. It outcrops over a limited area, mainly at Kokkinohoma, Kouvelos and at the Aghioi Pantes cemetery. It is a fossil outcrop of the Pleistocene Erymanthos formation, which comprises mainly polygenetic conglomerates of terrestrial origins connected with a red-siliceous fine unconsolidated formation. It corresponds to a huge paleo-talus cone with frequent lateral diversification and covers a large part of the graben of Pyrgos. At the research area in the city of Pyrgos it is represented by red to brown red clays and yellow brown sandy clays, loose horizontal sandy conglomerates and micro-conglomerates. It overlies unconformably on the Vounargos formations and its thickness varies form 2 to 8 metres. The SPT test showed that the number of impacts for a 30 cm penetration is no more than 15.

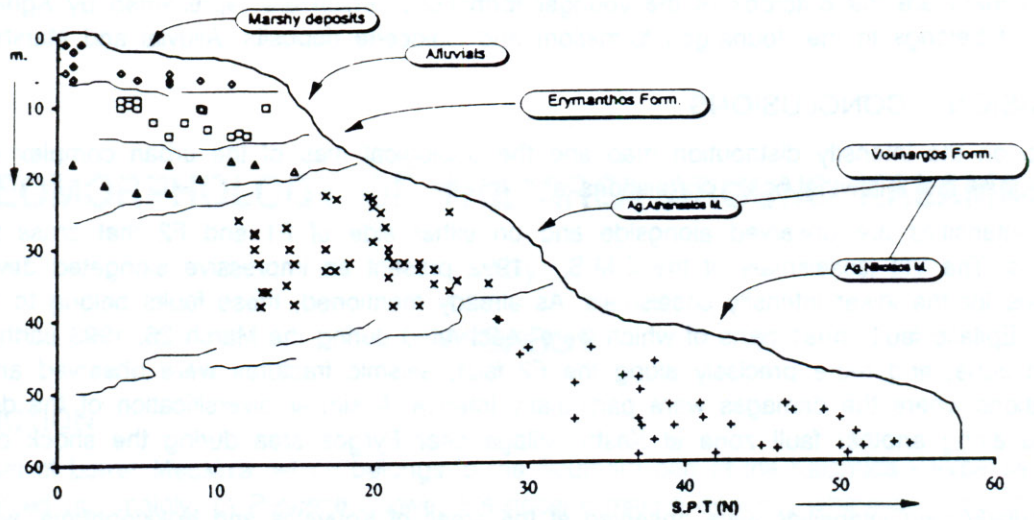

Fig. 3. Schematic lithostratigraphic column of all formations and results of the Standard Penetration Test.

Vounargos Formation. It is perhaps the most characteristic formation that outcrops in the graben of Pyrgos. Its age is Plio-Pleistocene, its thickness is up to 600 meters and comprises continuous intercalation of clays, silts, sandstones, sands and marls with constant diversification both in vertical and lateral sense. At the study area it occurs in the urban region and more specifically at the quarters of Aghia Kyriaki, Agios Nikolaos, and Aghios Athanasios. There can be distinguished two members of the formation which have both different lithological composition and geotechnical properties.

The upper member (Aghios Athanasios) develops at the quarters of Aghios Athanasios, Keramidhaki, Aghios Spyridon and partially at Lapato and practically covers all the lower parts of the uplands of Pyrgos. It comprises mainly yellow-brown cross-bedded sands and yellow silty sands with certain intercalation of yellow-brown sandy clays. At the SPT test the number of impacts for the clay sands and the silty sands is 15-30, while for the sandy clays it is 10-20. Its thickness exceeds 30 metres.

The lower member (Aghios Nikolaos) occurs at the quarters of Aghios Nikolaos and Aghia Kyriaki and covers most of the uplands of the city of Pyrgos. It comprises fossil bearing grey-blue-greysh marls which alternate with silty, sandy and clay marls, while locally there are thin intercalation of sand, sandy-silt, lignite horizons and yellow-brown sandstones. In contrast with the upper member, the SPT test showed that the number of impacts for 30 cm penetration exceeds 30, and sometimes they are more than 50. Its thickness is more than 80 m.

The formations that occur at the area of Pyrgos have undergone neotectonic deformation and are crossed by a number of faults of East-West mean direction. These faults are part of the Katakolo-Pyrgos fault zone, according to the existing literature. This fault zone was responsible for the earthquakes of March 26, 1993.

More specifically, the elongated outcrop of the lower member of Agios Nikolaos is abruptly terminated by the F1 (E-W bearing) fault, south of which the upper (Aghios Athanasios) member of the Vounargos formations occurs. It is a normal fault, accompanied by a morphological discontinuity (to the south of the city main square), its throw is at least 50 metres (estimated from morphotectonic features) and eastwards it branches into two faults. Existence of this fault is also confirmed by small polished surfaces.

To the north there is an identical picture with the occurrence of the F2 fault (av. direction NE -SW), which also branches into two minor faults to the east. The F2 fault brings together the outcrops of Aghios Athanasios and Aghios Nikolaos members, while it also crosses some outcrops of Erymanthos formation. Its throw is smaller, (20-30 metres) and all along it, we recognised seismic fractures caused by the shock of March 26, 1993.

One may distinguish, at the area of Pyrgos, an elongated horst of general East-West direction, which is pronounced by the ridge of the same direction. It consists of the lower (Aghios Nikolaos) member of

the Vounargos formation, as well as of a small part of Erymanthos formation. To the north and south of the horst there are the outcrops of the younger formations, which are represented by Aghios Athanasios member (it belongs to the Vounargos formation) and Holocene deposits (Alluvial and Marshy deposits).

DISCUSSION - CONCLUSIONS

Based on the intensity distribution map and the geological map of the urban complex of Pyrgos, we may propose the following basic correlations and results:

High intensities are observed alongside and on either side of F1 and F2 that cross the geological formations. The VIII isoseismals of the E.M.S. - 1992 present an impressive elongated development that also holds for the lower intensity coseismals. As already mentioned, these faults belong to the Katakolo - Pyrgos - Epitalio fault zone1 parts of which were reactivated during the March 26, 1993 earthquakes. Along this fault zone, and more precisely along the F2 fault, seismic fractures were observed and those were the locations where the damages were particularly intense. A similar diversification of the destruction was observed along another fault zone at Kastro village near Pyrgos area during the shock of October 16, 1985.

Particularly high intensities were observed at the areas of Kouvelos and Kokkinohoma, where the fossil outcrops of Erymanthos formation overlie unconformably the Vournargos formation. The low geotechnical properties of these outcrops and their small thickness seem to have been the crucial factors for the magnification of intensities, having created a disadvantageous geodynamic regime.

Some formations or parts of them have caused local isolated "islets" of high intensity coseismals north-west of Lapato and east of Aghios Athanasios, where Marshy deposits with poor geotechnical properties, occur. In addition are also observed high intensities, west of the Aghioi Pantes cemetery. They coincide with the presence of loose sands that belong to Aghios Athanasios member of Vounargos formation. At this very location, even antiseismic designed buildings (e.g. schools) underwent severe damages.