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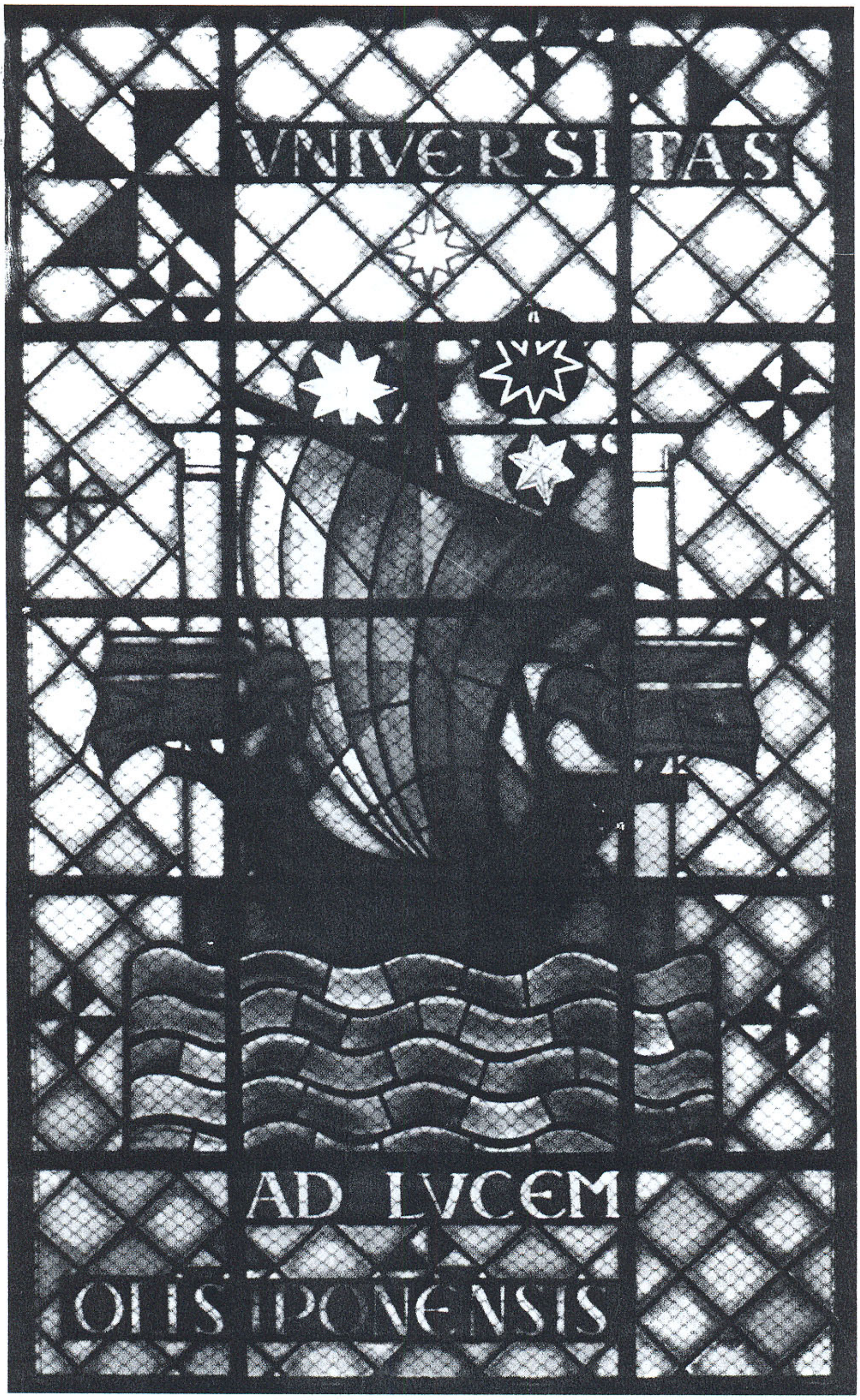

BOOK OF ABSTRACTS AND PAPERS

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GEOTECTONIC REGIME AND DAMAGE DISTRIBUTION AT THE CITY OF ANO LIOSIA (ATHENS, GREECE) DURING THE EARTHQUAKE OF SEPTEMBER 7, 1999

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ABSTRACT

The city of Ano Liosia suffered severe damage in the September 7, 1999 earthquake. Detailed geological and structural mapping showed that the intensity and distribution of damage was directly related to the tectonic setting of the area, which is governed by a alpine and neotectonic structural fabric, soil conditions and foundation formations.

INTRODUCTION

The September 7, 1999 earthquake sequence hit the northwestern part of the basin of Athens, causing a large number of deaths and injuries, as well as extensive damage to structures. The main feature of the shock, from the neotectonics point of view, was that the seismic fault did not reach the surface and only secondary superficial effects of it were observed; rockfalls, landslides, settlement, soil fractures and so on.
Based on (i) the location of the epicenter, the aftershock sequence and the focal mechanism solution (Stavrakakis 1999), (ii) the interferogram compiled after the earthquake (Parharidis & Papanikolaou, unpublished data), and (iii) the distribution of the secondary destructive effects (Fig. 1), it is concluded that the seismic fault had a mean ENE-WSW strike, SSE dip and was located under the mountain mass of Mt Parnitha.
This fault lies at the prolongation of tectonic features of the same strike, as the active faults of the Eastern Gulf of Corinthos (80 Km West of Athens), which are held responsible for destructive earthquakes since the historical times (Ancient Corinthos, Corinthos, Alkyonides, etc.)
In spite of the strike of the seismic fault, the damage distribution follows a NNE-SSW trend, coincident to that of the basin of Athens, and the strike of a large detachment fault, buried under the post-alpine basin fill (Papanikolaou et al 1999). This fault brings in contact metamorphic with non-metamoprhic alpine rocks (Fig. 1).

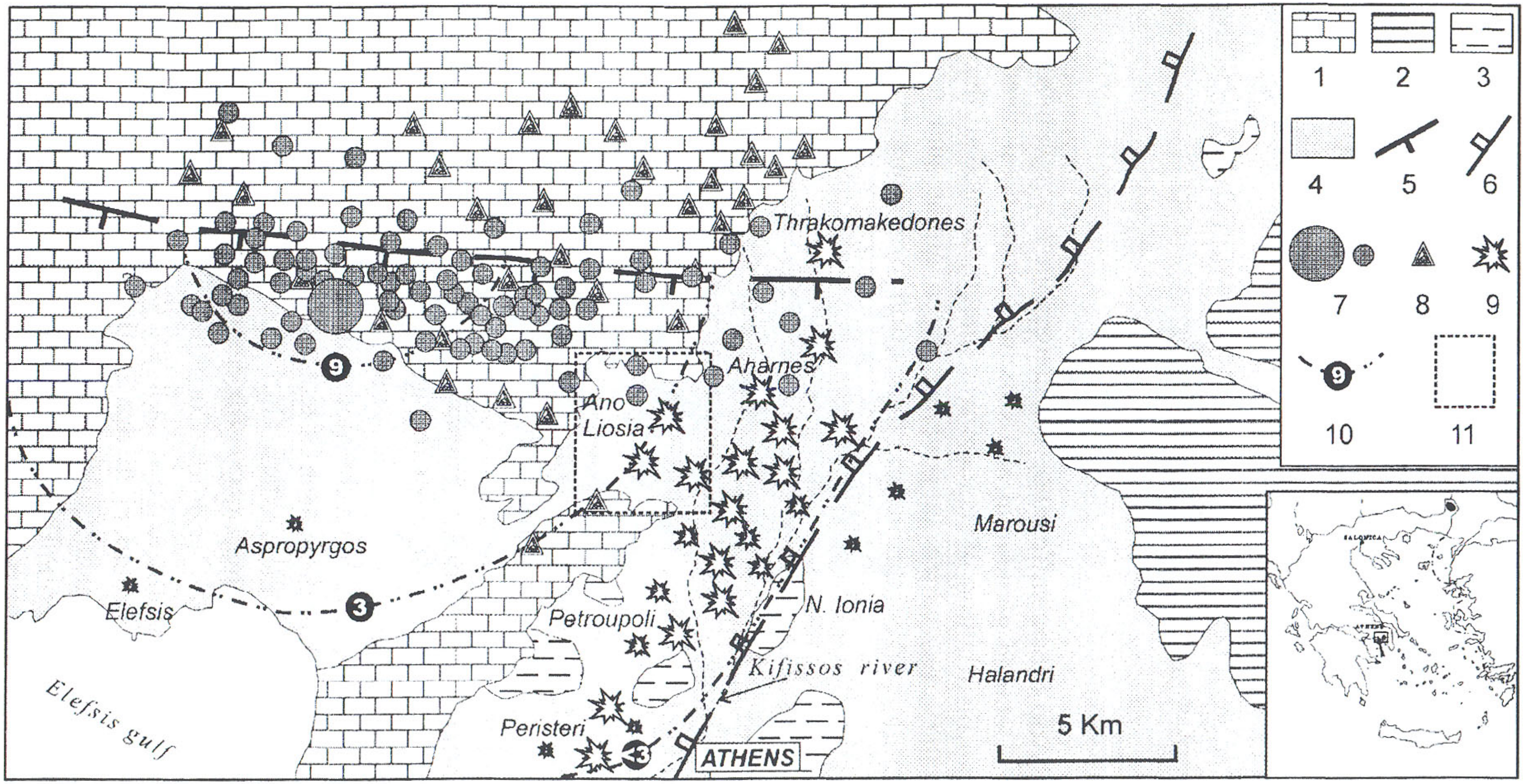

Fig. 1. Simplified geological map of the major area. 1: Sub-Pelagonian Unit (alpine non metamorphic rocks), 2: Attica Unit (alpine metamorphic rocks), 3: Athens nappe (melange), 4: Neogene and Quaternary sediments, 5: Probable trace of the seismic fault, 6: Detachment, 7:Main shock and aftershocks , 8: Rocfalls, 9: Damages, 10: Contours of subsidence (in cm according to the interferograme), 11: Study area (area of Fig. 2).

GEOLOGICAL SETTING OF ANO LIOSIA

The majority of the urban complex of Ano Liosia is founded on thick post-alpine formations, which are extended talus cones and, to a lesser extent, neogene lacustrine and fluvial deposits. The latter have been blanketed by the talus and the alluvial deposits at the north of the area. The city is flanked by a hill range, where the non-metamorphic alpine carbonates of the "Sub-Pelagonian" Unit and an allocthonous tectonic melange that belongs to the "Athenian nappe" outcrop (Fig. 2).
The talus cones, with a thickness that ranges from a few m. to 100 m., contain frequent lateral transitions alternations of cohesive or semi-cohesive scree and loose deposits –sand, pebbles, gravel, clay, etc. The alluvial deposits consist of clay, red soils and conglomerates is clay matrix and have a thickness between a few m. and 20-30 m. The neogene deposits comprise relatively compacted phacies of marls, marly limestones, clays and conglomerates. The alpine formations of both the autochton and the allocthon consist largely of carbonate rocks (limestones and marbles) and, to a lesser extend, of clastic deposits (sandstones, shales, schists, and graywackes)

TECTONIC STRUCTURE

The main tectonic feature in the area is the contact between the two alpine units, located at the eastern margin. It is a large-scale tectonic discontinuity that crosses the central and southern part of the city Fig. 2). Its dip is approximately 50° SSE.
Besides this tectonic discontinuity, numerous other faults were located, either at the basin flanks, or within the postalpine formations (Fig. 2). All these faults determined by a large number of boreholes. They are neotectonic structures that belong to two sets, one with NNW-SSE strike and 60°-80° WSW-ward or ESE-ward dips, and a second one with E-W strike and 60°-80° northerly or southerly dips. In fact, these faults are directly related to the creation and evolution of the small neogene basin, which is now buried under the talus scree and the alluvial deposits. It is a complex structure, since it incorporates smaller-scale horsts and grabens. The whole picture is in good accordance with the one we get from the greater area.

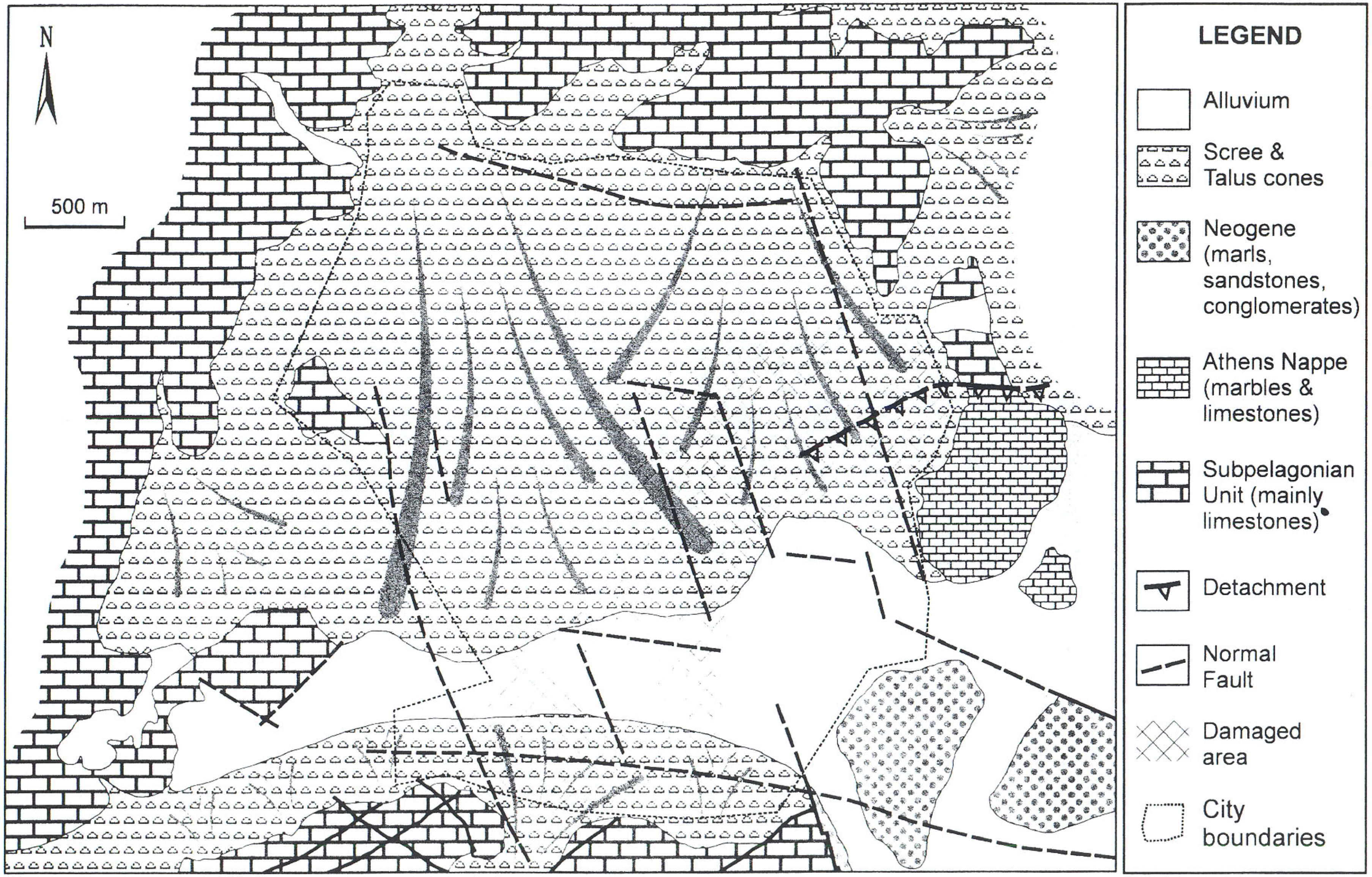

Fig. 2: Geological and tectonic map of Ano Liosia city.

DISCUSSION – CONCLUSIONS

The damage in the city of Ano Liosia is located within a broad, NNE-SSW trending zone that covers the central and eastern parts of the city (Fig. 2), an observation that holds for the greater area of the basin of Athens, as well (Fig. 1). The correlation of this picture with the geological and structural data from the studied area showed that the most serious damage took place on loose foundation formations, which were either the unconsolidated members of the talus cones, or the alluvial deposits.

However, this was not the only factor that affected the damage distribution, since the heaviest damage was located (i) along the trace of the tectonic contact between the two alpine units, (ii) at the areas with higher fault density, usually close to the basin margins, but also locally within the basin (Fig. 2). These faults were not reactivated in the September earthquake, but "channeled" the seismic energy into specific zones, which also holds, at a larger scale, for the greater meizoseismal area.

Hanging wall effects, effects of sedimentary basins, basin edge effects and focusing effects (Somerville 2000) are also probably to have played a significant part, at the locations where the fault geometry and the basin structure performed as reflectors, magnifying the effects of shaking and thus maximizing the strong ground motion values. Besides, the fact that the heaviest damage is located at the central and eastern part of the basin, where the fault fabric is denser and the faults better expressed, is not accidental.

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