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DEFINING SHALLOW STRUCTURE PROPERTIES BY COMPOSING AMBIENT NOISE AND GEOLOGICAL DATA FOR SITE RESPONSE ANALYSES: THE CASE OF XANTHI TOWN (NE GREECE)

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The subsurface soil structure study for site response evaluation is an important step in seismic risk mitigation, since adequate knowledge of the subsoil, geophysical and geotechnical and properties can lead to realistic seismic hazard estimation through appropriate modeling of strong seismic motion. In this framework, ambient noise measurements and analysis have been performed for the town of Xanthi (Northeastern Greece) in order to study both the subsurface soil structure, as well as, its expected effect on seismic motions. The Horizontal to Vertical Spectral Ratio (HVSR) method was implemented on an almost uniform grid of more than 30 single station ambient noise measurements inside the urban area, while the noise array technique was applied at three selected representative sites of the study area. The majority of HVSR curves show high amplitudes mainly in low frequency content (f<1.5Hz) indicating corresponding influence on ground motion of recent deposits that overly a stiff conglomerate formation.

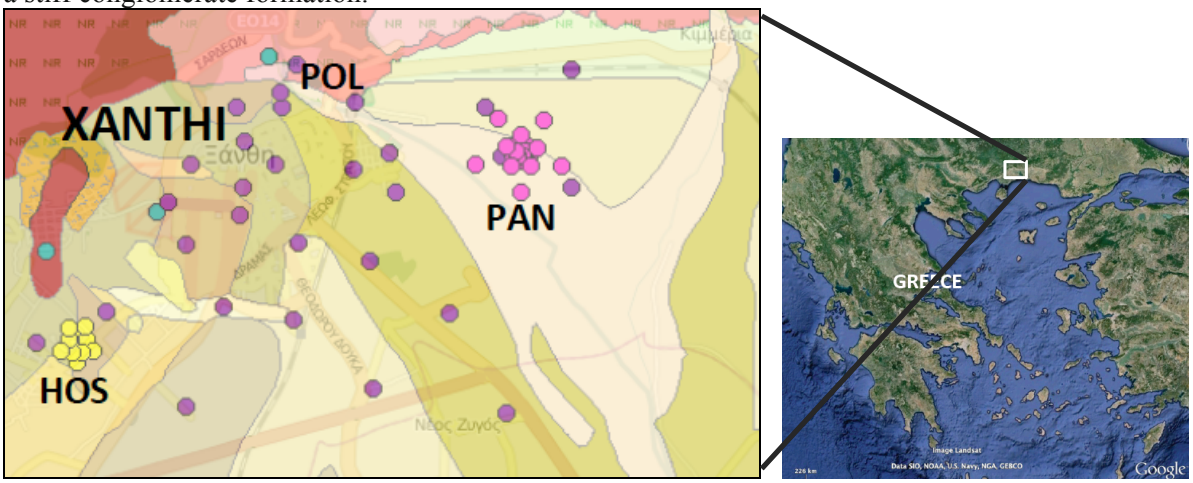

Figure 1. Geological map of the Xanthi town; circles indicate single station ambient noise measurements as well as array measurements in three selected sites HOS, PAN, POL.

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Based on a relatively well distributed borehole data set, detailed geologic mapping and existing geotechnical data a 3D geologic model of the broader study area was proposed (Fig. 2).

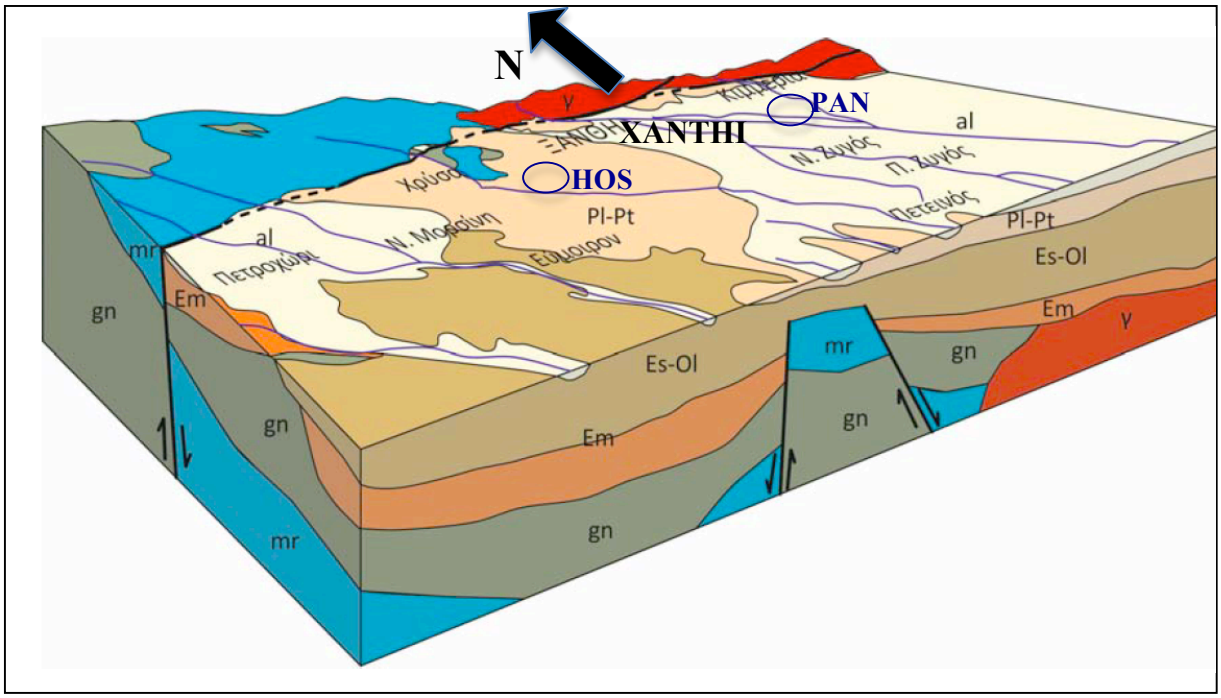

Figure 2. Geological 3D map of the broader Xanthi area; circles indicate ambient noise array measurements in two selected sites HOS and PAN (see Fig. 3).

Horizontal to Vertical spectral ratios were calculated following the SESAME Project (2004) guidelines. In Fig. 3 HVSR results for the sites HOS and PAN are presented. From the spectral shape, fundamental frequencies and their corresponding amplitudes it becomes obvious that these sites belong to different ground categories in terms of soil dynamic properties. The site HOS exhibits fundamental frequency at 1.3Hz and a second less clear 'peak' at around 4Hz. To the contrary, the site PAN is characterized by a fundamental frequency at around 0.4 Hz with a second 'peak' at 0.8Hz.

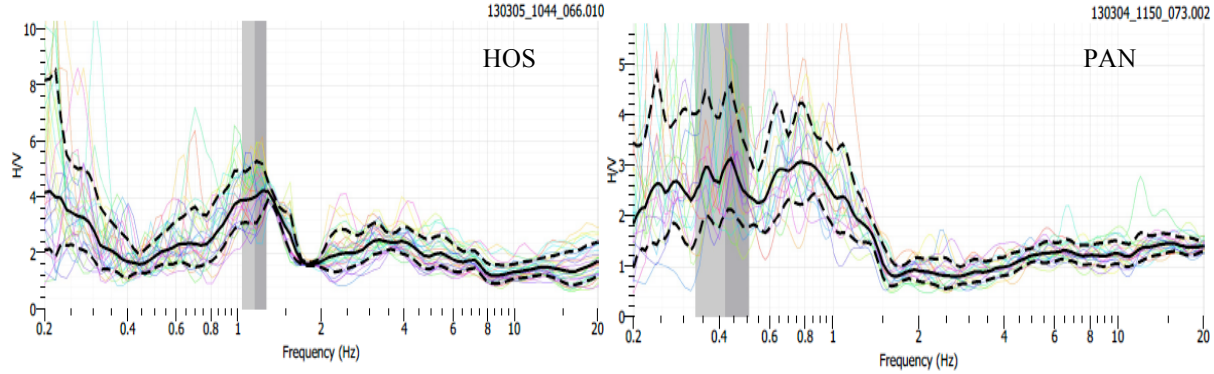

Figure 3. Ambient noise Horizontal to Vertical (H/V) spectral ratio for the sites HOS and PAN.

Based on the results of single station HVSR technique and the available geological data, three sites were selected for ambient noise array measurements deemed as representative of the upper layer formation properties in the study area. For these three sites, 1D shear wave velocity profile was inverted from calculated dispersion curves and was extended down to 'bedrock'. For the ambient noise array analyses the GEOPSY (2004) tools were used.

In Fig. 4 results of these analyses are shown for the sites HOS and PAN, overlain Pleistocene and alluvium deposits, respectively. In all three sites, 'seismic bedrock' velocity contrast, extending down to the 'seismic bedrock' is in sufficient agreement with that of local geology model (Fig. 2). Based on the aforementioned results, 1D profile as well as 2D cross sections in the area of Xanthi were produced for seismic response analyses.

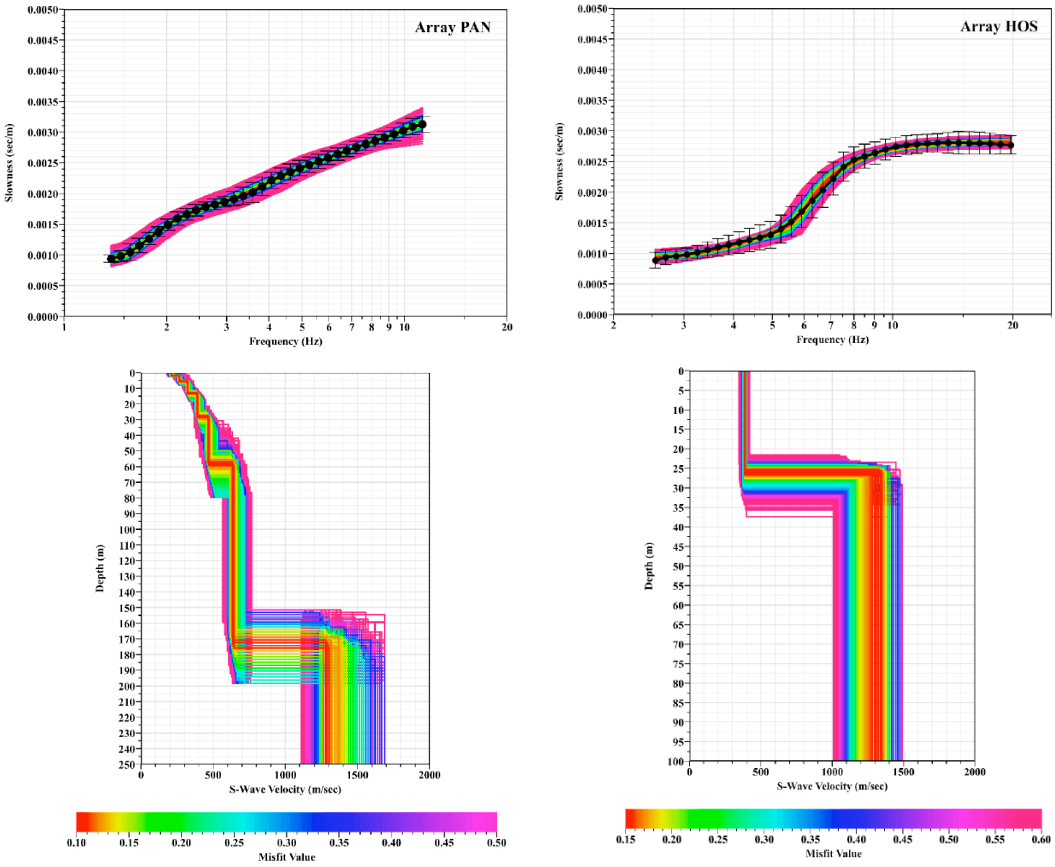

Figure 4. Dispersion curves and shear-wave velocity profiles deduced from ambient noise arrays for the sites PAN and HOS in Xanthi (see Fig. 2).

Taking into consideration seismic sources and faults in the broader study area, seismic hazard on "rock", for various mean return periods as well as corresponding synthetic ground motion for the Xanthi town was assessed. This ensemble of recordings was used as input motion for 1D or/and 2D simulations to study site response analyses for selected sites of the town leading to reliable microzonation results as well as to future shakemaps scenarios in the broader area of Xanthi.

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GEOPSY Tools (2004) www.geopsy.org