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Detection of Pardisan fault zone around Milad Tower using morphotectonic investigations and ambient vibrations HVSR technique

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Extended Abstract

Summary

Investigation of geometric and morphological properties of active faults, as seismic sources, is one of the most fundamental steps for assessing seismic hazard in urban areas. Due to the tectonic setting of Tehran metropolis and its location at the southern foothills of the Central Alborz, as part of the Alpine-Himalayan seismic belt, it has experienced several large and moderate earthquakes in the past. Therefore, identification of active faults and collection of information about them in this urban area are essential. Since some of the fault zones in this area are buried in the Quaternary alluvial deposits, implementation of subsurface techniques, such as seismography, remains inevitable to identify the geometric characteristics of these faults and trace them at depth. The operational complexities and costs of seismic operations in urban areas enforce us in this study to utilize ambient vibrations along the lines of microtremors and microseisms as one of the passive seismic methods. In this study, we first identify surface deformations related to the activity of faults by conducting morphotectonic investigations to detect blind fault zones around the Milad Tower. Then, seismic profiles have been designed and collected according to the perceived position and strike of fault structures and the Pardisan anticline. Ambient vibrations are processed along the seismic profile using the horizontal to vertical components spectral ratio (HVSR) method to estimate dynamic parameters of the Quaternary sediments. The dynamic parameters of the sediments include predominant frequency and resonance amplitude of waves in deposits, and determination and visualization of them in a two-dimensional (2D)cross-section eable us to estimate the thicknesses of the sediments and depths of anomalies. As a result of examining the anomalies in the subsurface structure and their coherency with the morphotectonic investigations, evidence of the activity of the Pardisan blind fault zone has been identified and presented.

Introduction

The active deformation along the southern margin of the Central Alborz and in Tehran piedmont is partly accommodated by fault-related folded structures. According to morphotectonic investigations, some of these structures are controlled by the activity of blind thrust faults. Since the Pardisan fault is buried in thick Quaternary deposits, in this study, we have used the passive seismic ambient vibrations method to locate and specify its subsurface geometry.

Methodology and Approaches

In this study, ambient vibrations are processed using HVSR or Nakamura method, which is a powerful tool to study subsurface structures and site response, especially in the region with low-to-moderate seismic activities. Dynamic parameters of sediments such as predominant frequency and resonance amplitude are estimated by the HVSR method, and then, are visualized in a 2D cross-section using the Geopsy and the openHVSR-processing toolkit software.

Results and Conclusions

Three anomalies have been identified in the subsurface structures, which are coherent with the morphotectonic signals at the ground surface, indicating the location and geometry of the Pardisan blind fault zone around the Milad Tower. Beside the quick procedure and cost-effective implementation of the HVSR method, the results of this study imply the efficiency of this technique in detection of blind faults above the bedrock. One of the limitations of this method is its inability to identify subsurface structures beneath the bedrock. Therefore, it is necessary to use a supplementary technique such as microseismic sounding method (MSM) to detect subsurface structures below bedrock.