SEISMIC UNDERGROUND CHARACTERISTICS BENEATH IZMIR GEOTHERMAL AREA

Caglar Ozer[1,2] and Orhan Polat[1,*]

[1] Division of Seismology, Department of Geophysics, Dokuz Eylul University, Izmir-Turkey (caglar.ozer@deu.edu.tr, orhan.polat@deu.edu.tr)
[2] Geophysics Programme, Graduate School of Natural and Applied Sciences, Dokuz Eylul University, Izmir-Turkey

Abstract

Izmir shows high micro earthquake activity and presents important geothermal areas in the Aegean region of Turkey, Western Anatolia. We bring a new perspective of velocity structure of the study area using local earthquake tomography (LET). We investigated crustal features and velocity perturbations along the vertical profile benefiting from IzmirNet (Gok and Polat 2014, Polat et al. 2009) local accelerometric array. More than 1000 earthquake data recorded between 2012 and 2015 were analyzed using the LOTOS (Koulakov 2009) algorithm to reveal the Vp and Vp/Vs characteristics for geological, geothermal and tectonic models owing to high quality tomographic images. We have detected four main crustal layers ranging in depth from the surface to 30 km. A sharp increase in Vp velocities is evident starting at 25 km depth called as bottom of lower crust. Hence, we estimate mantle boundary at ~25 km depth as undulated shape. The thickness of the brittle crust slightly increases towards to North and East in the study area.

Introduction

Until this time; many studies are published in earth sciences around the Izmir region where is the western part of Turkey has under seismic risk and lives four million people. Western Turkey, as a natural laboratory for geosciences, shows a typical horst-graben system and has numerous normal and strike-slip faults. Turkey is compressed between Arabian and Eurasian plates and this pressure cause orientation towards to westward and this movement create N-S extension regime and W-E normal faults. (Dewey and Sengor 1979, Sengor and Yilmaz 1981, McKenzie 1978)

The Izmir basin and its surroundings are one of the important areas that have high seismic activity and rich geothermal fields in western Anatolia (Kaypak 2012). In order to enlighten 3 – D P and Vp/Vs velocity structure in the crust along Izmir region in the western part of Turkey; we were investigated by local earthquake tomography which uses inversion of local P and S wave travel times. Performed LET studies; we selected ~500 earthquakes that have occurred from 2012 to 2015 recorded by 44 permanent stations and operated by AFAD (Prime Ministry Disaster and Emergency Management Authority), IzmirNET (Dokuz Eylul University (DEU)) and ISC

* Corresponding author

(International Seismological Center) earthquake phase catalogue. In this study three-dimensional Vp and Vp/Vs structure of the Izmir basin have been determined by using LOTOS algorithm for one profile (Fig. 1).

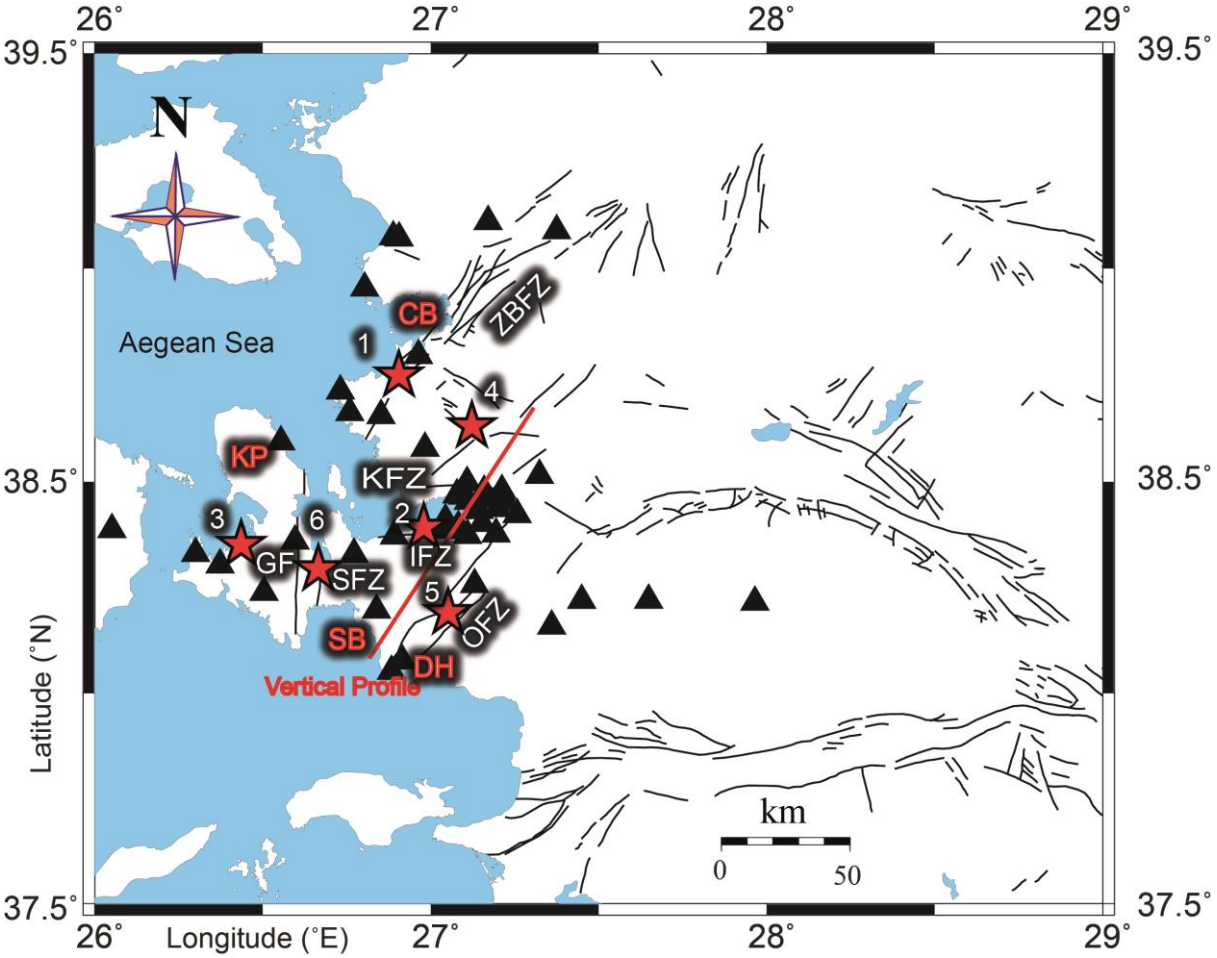

Figure 1. Main tectonic features and station distribution around Izmir geothermal region. Abbreviations; CB: Candarli Bay, DH: Doganbey horn, GF: Gulbahce fault zone, IFZ: Izmir fault zone, KFZ: Karsiyaka fault zone, KP: Karaburun peninsula, OFZ: Orhanli fault zone, SB: Sigacik Bay, SFZ: Seferihisar fault zone, ZBFZ: Zeytindag-Bergama fault zone. Main geothermal systems 1: Aliaga geothermal system (AGS), 2: Balcova geothermal system (BGS), 3: Cesme geothermal system (CGS), 4: Menemen geothermal system (MGS), 5: Seferihisar geothermal system (SGS), 6: Urla hot spring (UHS). Red triangles show main geothermal areas.

Izmir Geothermal Area

Izmir has important geothermal areas which are transferred the main fault zones (GF, IFZ, OFZ, SFZ). These areas can be imaged by tomographic methods which were given in Figure 2.

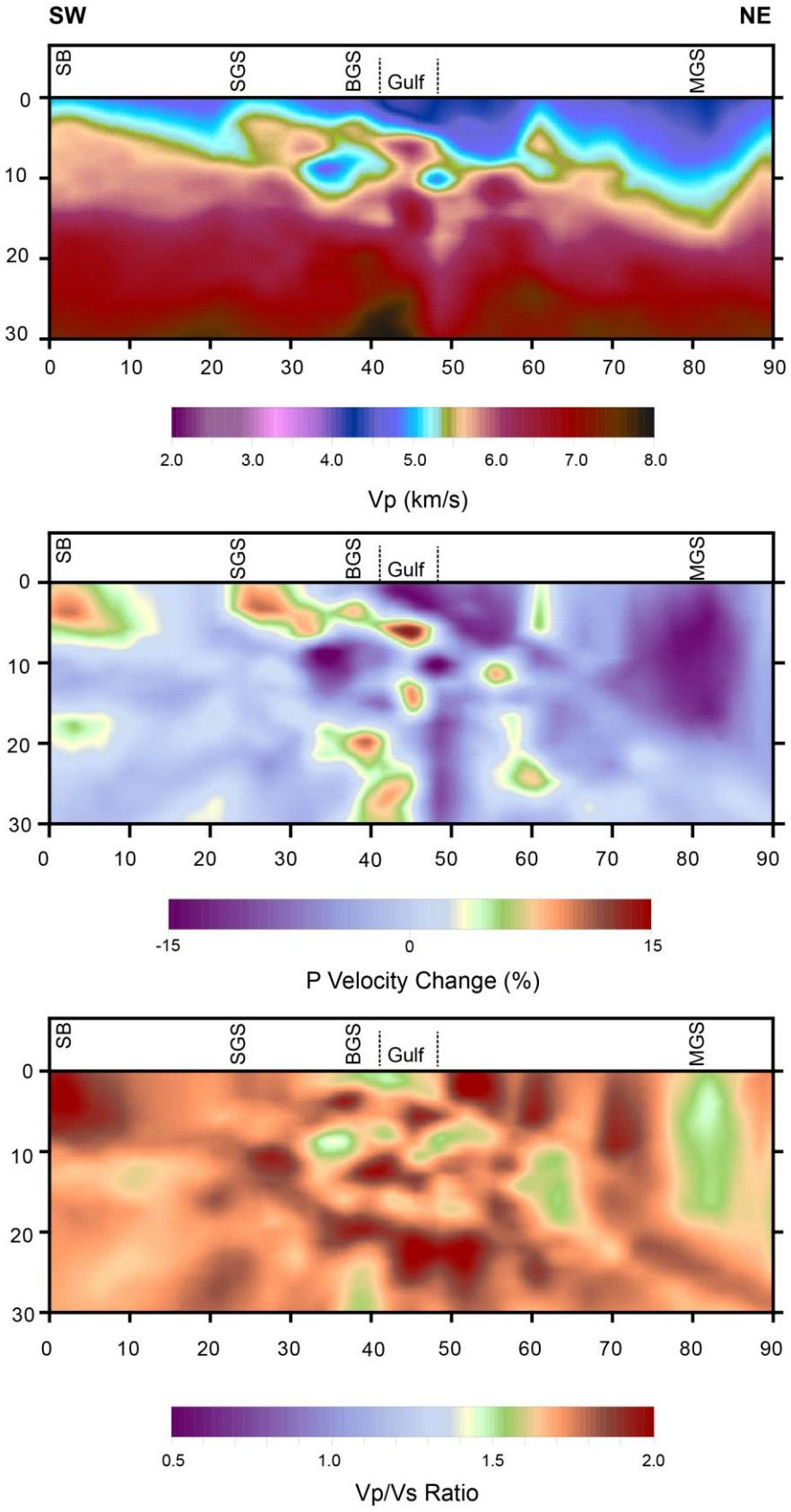

Figure 2 Depth cross-sections of selected ~700 earthquakes along the N-S directions deployed by the DEU, AFAD and ISC.

We obtained high-resolution 3-D Vp and Vp/Vs velocity models for the upper 30 km of the crust beneath Izmir and its vicinity and evaluated the results of section in the view of tectonic and geological information. While P velocity results characterized geological units, Vp/Vs results symbolized weakness zones, contain of gas or fluid and high pressure zones (Kaypak 2012). Especially in geothermal areas; low P wave velocity and low/high Vp/Vs values observed. The roots of the major faults have been identified in vertical section and along the fault zone, low Vp values observed. These low velocity anomalies indicate that some region may be contain hot water and this liquids transform along the fault zone notedly in geothermal areas.

Results

We exhibit new 3D velocity structure of region and enlighten the tectonic regime. The top of absolute Vp model illustrate clearly the Neogene sediments ant Quaternary alluvial deposits at down to ~7 km. There are four main seismic layers and deeper part of cross-section, absolute Vp values are reach 7.8 km/s. We guess crust-mantle boundary (moho discontinuity) at 25 km especially beneath BGS. The low Vp and low Vp/Vs values were observed around MGS and SGS. This case generally related to presence of gas. BGS shows complex velocity characteristics. While we observed high Vp and high Vp/Vs in shallow depths beneath BGS, low Vp and high Vp/Vs ratio were observed in deeper part of BGS.

Acknowledgements

This study is a part of the PhD thesis of Caglar Ozer at Institute of Natural and Applied Sciences in Dokuz Eylul University. We thank to the Earthquake Department of the Disaster and Emergency Management Presidency (AFAD), Seismological Laboratory (DEU) and ISC for earthquake catalogue. Tomographic calculations were conducted by using LOTOS (Koulakov 2009) algorithm. Some images were generated by GMT software (Wessel and Smith 1998). This study was funded by the Earthquake Engineering Association of Turkey (TDMD) and support DEU-BAP project (Project Request Nr. 2016/25).

References

Dewey, J.F. and Sengor, A.M.C. 1979. Aegean and surrounding regions: Complex multiplate and continuum tectonics in a convergent zone. Geological Society of America Bulletin, 90, 84-92.

Gok, E., Polat, O., 2014. An assessment of the microseismic activity and focal mechanisms of the Izmir (Smyrna) area from a new local network, IzmirNET. Tectonophysics 635, 154-164.

Havskov, J. and Ottemoller L., 1999, SeisAn Earthquake analysis software, Seis. Res. Lett., Cilt 70, No 1, 532-534.

Kaypak, B., Gokkaya, G., 2012. 3-D imaging of the upper crust beneath the Denizli geothermal region by local earthquake tomography, western Turkey. Journal of Volcanology and Geothermal Research 211-212, 47-60.

Koulakov I., 2009. LOTOS code for local earthquake tomographic Inversion. Benchmarks for testing tomographic algorithms, Bull. Seism. Soc. Am. 99 (1), 194-214.

McKenzie, D.P., 1978. Active tectonics of the Alpine- Himalayan beIt: The Aegean Sea and surrounding regions. Geophysical Journal of Royal Astronomical Society, 55,217-254.

Polat, O., Ceken, U., Uran, T., Gok, E., Yilmaz, N., Beyhan, M., Koc, N., Arslan, B., Yilmaz, D., Utku, M., 2009. IzmirNet: A Strong-Motion Network in Metropolitan Izmir, Western Anatolia, Turkey, Seism. Res. Lett. 80 (5), 831-838.

Sengor, A.M.C. ve Yilmaz, Y. 1981. Tesyan evolution of Turkey: A plate tectonic approach. Tectonophysics, 75, 181-241.

Wessel, P. and Smith, 2004, W.H.F. GMT Version 5.1-Generic Mapping Tools Graphics, Laboratory for Sattelite Altimetry, NOAA/NESDIS/NODC, 123 p.

Web: International Seismological Centre, On-line Bulletin, http://www.isc.ac.uk, Internatl. Seis. Cent., Thatcham, United Kingdom, 2013.

Web: Earthquake Department of the Disaster and Emergency Management Presidency (AFAD), http://www.deprem.gov.tr, Ankara, Turkey.