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Reconstruction of 2D velocity-depth model by using tomographic analysis from multichannel seismic reflection data in the Gulf of İzmir (Western Anatolia)

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Eastern Mediterranean tectonics is explained by the subduction of the African Plate beneath Eurasia accompanied by the collision of the Arabian Plate. This collision created a counter-clockwise rotational westward movement of the Anatolian Block through the Aegean Sea. This movement caused an extensional tectonic regime in the Western Anatolia indicating crustal thinning. As a result of this complex tectonism, this region is characterized by the E–W oriented grabens such as the Gediz, Buyuk Menderes and Kucuk Menderes Grabens and many magmatic intrusions. Boundary faults of these grabens are the main targets for the geothermal exploration activities.

In addition to high geothermal potential, western Anatolian grabens were investigated in the late 1970s and early 1980s in terms of hydrocarbon potential. Edremit-1 and Foça-1 offshore wells were drilled, however, no hydrocarbons were detected in these wells. Our study area, the Gulf of İzmir, is located at the western tip of the Gediz Graben. Previous studies have revealed that the area is under E-W compression, N-S extension, NE-SW, and NW-SE strike-slip deformation. The fault patterns that indicated E–W trending grabens of Western Anatolia do not continue towards to west. The system is changing its character here in the Gulf of İzmir. So, it is crucial to identify the basin structure of the gulf.

In this study, a dense square grid of 250 km multichannel seismic reflection data acquired in 2000 in the Gulf of İzmir, was considered to perform a tomographic analysis for the reflected arrivals providing a detailed velocity-depth model. For this purpose, a 2D seismic line from the grid data was re-interpreted stratigraphically in detail after Ocakoğlu et al. (2005) and five main seismic horizons (H1-H5), bounding four seismic units, were marked in the time migrated seismic section.

The interfaces interpreted on time sections were picked on common shot gathers. Travel times calculated by ray tracing were used in an iterative process to estimate the local interval velocities by minimizing the travel time residuals, using the SIRT algorithm (Simultaneous Iterative Reconstruction Technique). In each iteration, the geometry and the depth of the interfaces were estimated using these velocities in an algorithm based on the minimum dispersion of the reflection points. Tomogram revealed that the velocity-depth model of the sedimentary sequence is composed of four seismic units with a thickness of about 1 km in the offshore Foça that separated by five different interfaces (H1-H5). Top of the acoustic basement (H5) was interpreted as Upper Miocene unconformity while the upper units as Plio-Quaternary basin deposits onlap the basement surface. H5 also constitutes a basin geometry deepens to 800 meters from west to east and shallows up to 440 meters in the east forming a ridge. The sediment units in the basin deepen from west to east in accordance with the basin geometry. The interval velocities of these sedimentary sequences vary between 1.5-2.6 km/s. The investigation provided that the tomography analysis is a good tool to obtain stratigraphical properties of layers in depth and to estimate accurate velocity model of the seismic units.