The Importance of Tuzla Fault and a Study on Deformation Monitoring in the Aegean Region, Turkey

Haluk OZENER, Turkey

Key words: crustal deformation, Tuzla fault, GPS

SUMMARY

The Aegean Region, which comprises the Hellenic Arc, the Greek mainland and Western Turkey is the most seismically active region in Western Eurasia. Active N-S extensional tectonics of the Aegean region has been related to two main motions: westward escape at a rate of 20-25 mm/yr of the Anatolian plate and N-S extension of the western Anatolian and the Aegean plates with a rate of about 30-60 mm/yr. There are very valuable geodetic, geological and geophysical studies at that region but yet they are insufficient in detail or small scaled to determine active faults individually. In order to determine the relative displacements and perform strain analysis by using GPS technique, a micro-geodetic network with 13 points scattered around NW-SE trending Tuzla fault-Izmir has been established.

This project differs from previous projects in terms of its large scale, dense geodetic network and high precision. The project increases its precision with additional observation technique-precise leveling that supports vertical component of the GPS position. Observations in this study focus on a single fault that is to be an active fault near a very high populated city, Izmir. Thus, this project is planning to perform GPS observations in four episodes and determine the displacements vectors and strain parameters in order to contribute the tectonics of the study area. Deformation monitoring using micro-geodetic network is quite useful method for 42 km long strike-slip Tuzla fault. This paper gives an overview about the study and the first period GPS observations from the network.

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1. INTRODUCTION

The Aegean Region and Western Anatolia are one of the most seismically active and deforming parts of the Alpine-Himalayan orogenic belt. An extensional deformation regime has led to subsidence of the continental crust over all regions behind the south Aegean. The region is mainly under pure shear stress from an internally deforming counter-clockwise rotation of the Anatolian Plate relative to the Eurasian one. Aegean Region comprises the Hellenic Arc, Greek mainland and western Turkey (Figure 1).

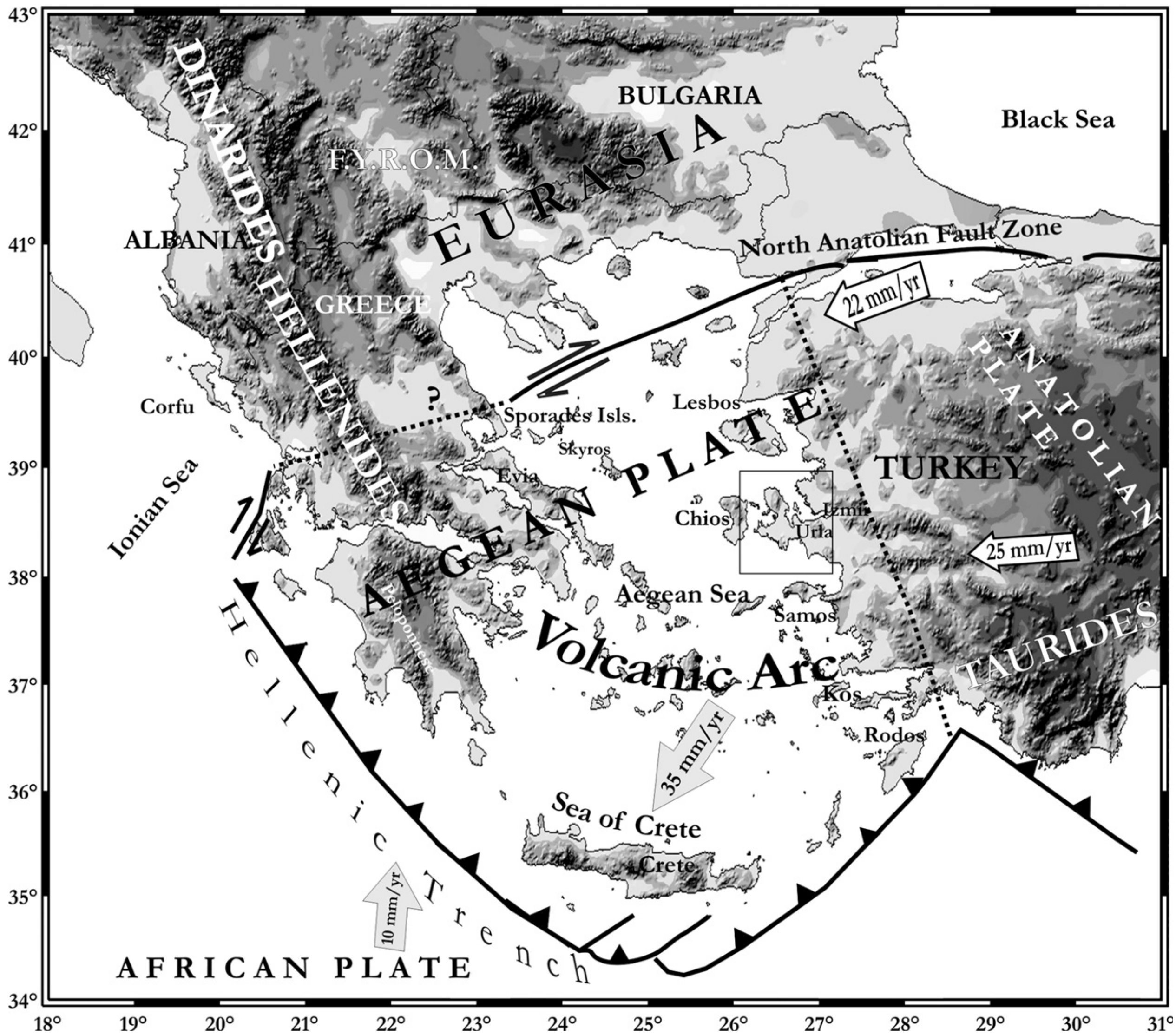

Figure 1. Tectonic setting of Aegean region and the study area

Izmir is a large city in this region in Turkey with a population of about 2.5 million that is at great risk from large earthquakes. The Tuzla Fault, which is aligned trending NE–SW between the town of Menderes and Cape Doganbey, is an important fault in terms of seismic activity and its proximity to the city of Izmir (Figure 2).

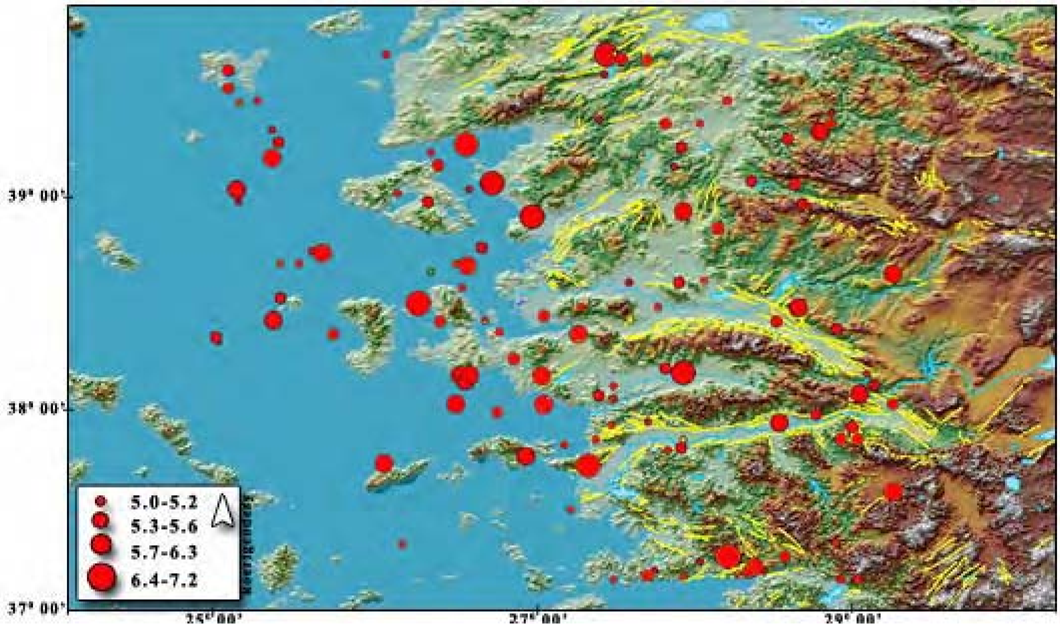

Figure 2. Earthquakes between 1900-2009

Tuzla Fault is 42 km long through the land side and longer than 50 km with under water segments. It has 3 right-lateral strike slip segments (Figure 3).

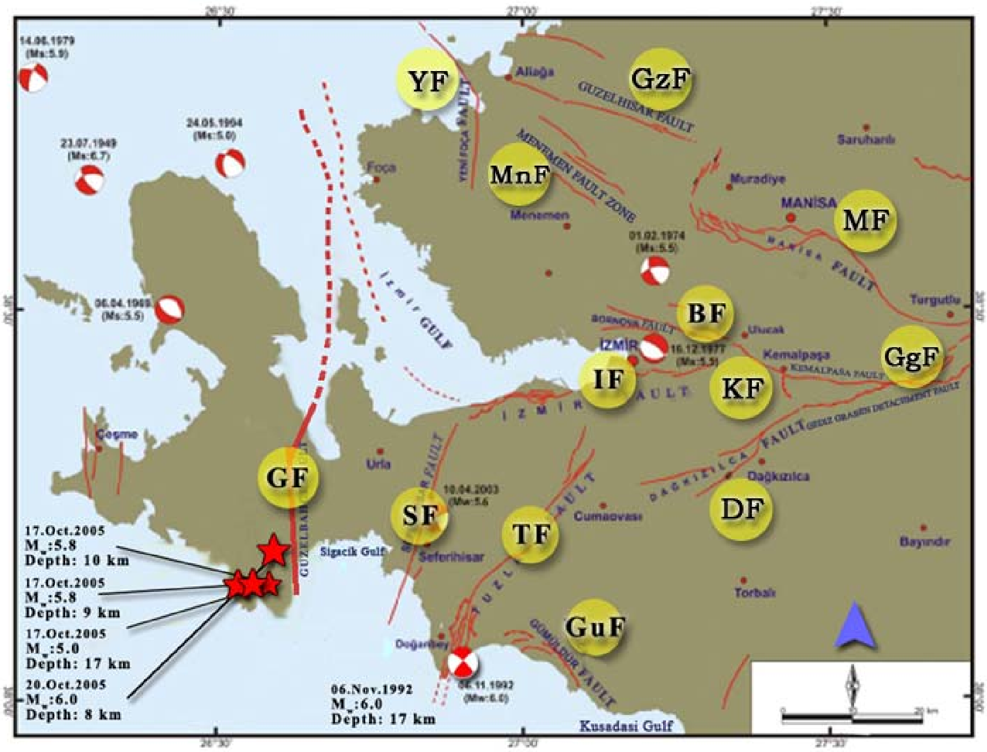

Figure 2. Active faults in the region and focal mechanism solutions of the earthquakes (modified from Emre, 2005)

The study aims to perform a large scale investigation focusing on the Tuzla Fault and its vicinity for better understanding of the region's tectonics. The study area covers 30km x 50km. In order to investigate the crustal deformation along the Tuzla Fault and Izmir Bay, a geodetic network has been established and observations of first GPS campaign and leveling measurements were performed (Figure 4).

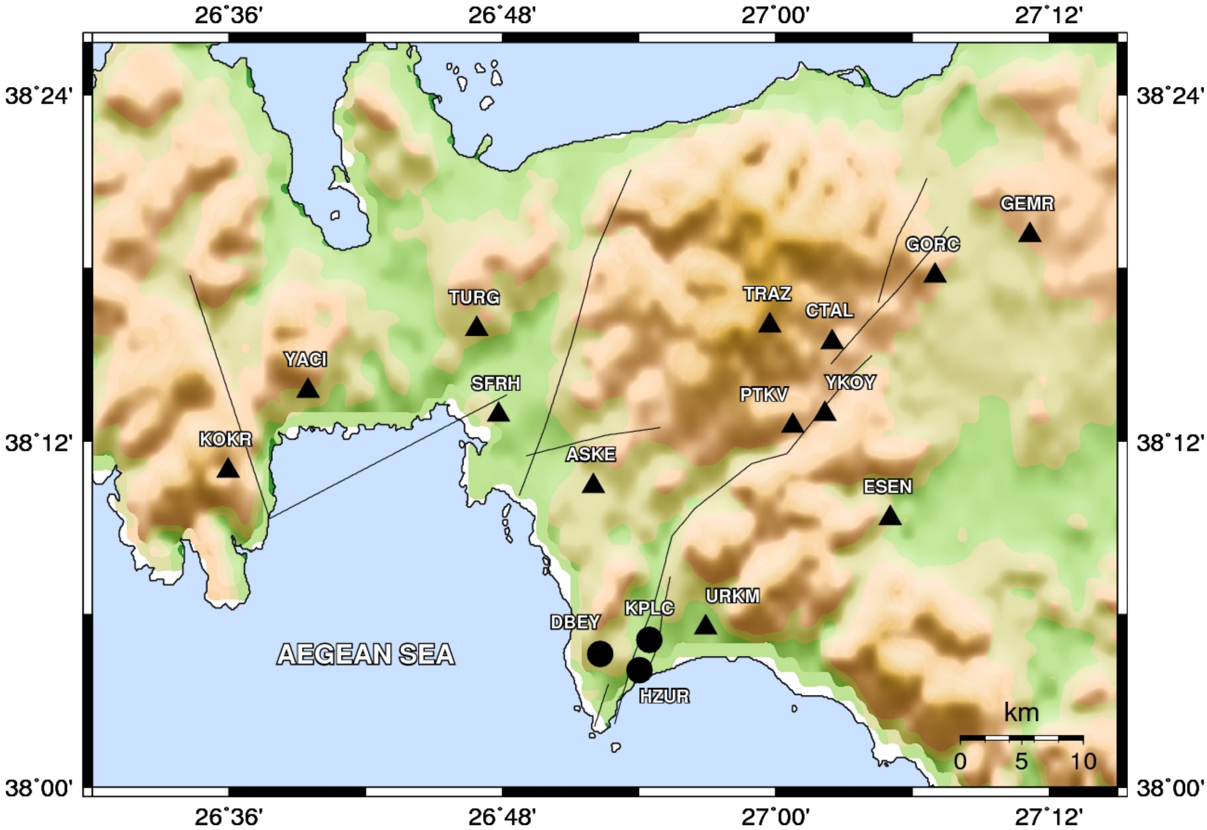

Figure 4. GPS stations (triangles) and leveling points (circles) in the study area

Table 1. Coordinates of stations

Station	Station ID	Latitude (E) WGS84	Longitude (N) WGS84
Askeriye	ASKE	38^0 10' 27"	26^0 51' 60"
Catalca	CTAL	38^0 15' 26"	27^0 02' 29"
Doganbey	DBEY	38^0 04' 37"	26^0 52' 18"
Esenli	ESEN	38^0 09' 21"	27^0 05' 01"
Gaziemir	GEMR	38^0 19' 08"	27^0 11' 09"
Gorece	GORC	38^0 17' 45"	27^0 06' 60"
Huzur Sitesi	HZUR	38^0 04' 04"	26^0 54' 01"
Kokar	KOKR	38^0 10' 59"	26^0 35' 58"
Kaplica	KPLC	38^0 05' 07"	26^0 54' 27"
Petek Vadisi	PTKV	38^0 12' 33"	27^0 00' 45"
Seferihisar	SFRH	38^0 12' 56"	26^0 47' 50"
Tirazli	TRAZ	38^0 16' 04"	26^0 59' 34"
Turgutlu	TURG	38^0 15' 54"	26^0 46' 53"
Urkmez	URKM	38^0 05' 33"	26^0 56' 55"
Yagcilar	YACI	38^0 13' 45"	26^0 39' 28"
Yenikoy	YKOY	38^0 12' 57"	27^0 02' 10"

2. GPS OBSERVATIONS

The first step was the evaluation of the active faults using aerial photographs and maps at 1/100.000 scale to select the appropriate locations of geodetic control points for detecting crustal movements. After this study, a field reconnaissance was realized in the working area and 13 new stations were established. Figure 5 shows the structure of the network.

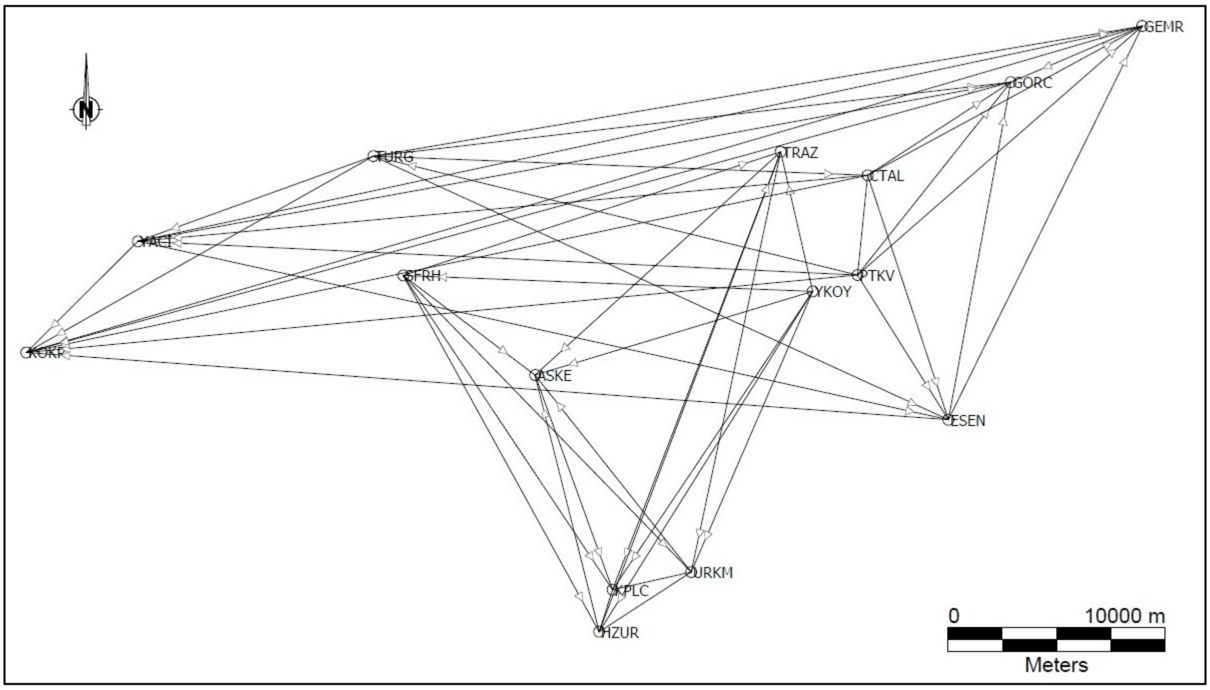

Figure 5. Geometry of the geodetic network

The tectonic significance and the GPS requirements were taken into account at the site selection. From the reconnaissance to the analysis of data collected including observation planning and measurement method, each step of GPS campaigns has basic importance in GPS geodynamics. GPS points possibly were established in optimum number and gradually in distance (1, 2, and 6 km away from active faults). GPS points were required not to be affected by surface movement (such as landslide) and transportation possibilities and the owners of the lands were also considered. GPS sites were placed into bedrock using high quality geodetic monuments. Selection of session lengths, receiver and antenna distribution are necessary in order to avoid the systematic biases.

Figure 6. A snapshot from the GPS campaign at SFRH station

10-hour/day observation was performed at each station. The first measurement campaign was performed in August 2009 at GPS stations in the region. The sites were occupied with Trimble 4000 SSI and 4000 SSE receivers. GAMIT (King and Bock, 2004) / GLOBK (Herring, 2004) software package is used for processing and evaluation of the GPS campaigns.

There are valuable geodetic, geological and geophysical studies at the region of interest but yet they are insufficient in detail or small scaled to determine active faults individually. This study differs from previous projects in terms of its large scale, dense geodetic network and high precision. The study increases its precision with additional observation technique-precise leveling that supports vertical component of the GPS position. Precise leveling method is the most preferred method when high precision results needed and today, instrumental development of the levels used in this method has been continuing parallel to the current technology. Episodic GPS observations are capable to determine the high precision position information depending on the observation time, repeatability of observations and processing techniques. At the end of the GPS and precise leveling observations, it is going to be evaluated whether there is any meaningful results coincide with geological and geophysical results for the same region.

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BIOGRAPHICAL NOTES

Prof. Dr. Haluk Ozener was born in 1967. He graduated from Istanbul Technical University in 1988 as Geodesy and Photogrammetry Engineer. He obtained M.Sc. Degree in Geodesy in 1992 and Ph.D. degree in 2000, both from Bogazici University. He is currently working at Geodesy Department of Kandilli Observatory and Earthquake Research Institute of Bogazici University.

CONTACTS

Prof. Dr. Haluk Ozener
Bogazici University
Kandilli Observatory and Earthquake Research Institute
Geodesy Department
34680 Cengelkoy
Istanbul
TURKEY
Tel. +90 216 5163264
Fax + 90 216 3320241
Email: ozener@boun.edu.tr
Web site: www.koeri.boun.edu.tr/jeodezi