An Analysis of Strain Accumulation in the Western Part of Black Sea Region in Turkey

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Outlines

- Introduction
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- Investigation of Strain Accumulation by Finite Element Model
- Conclusions

Introduction

- **Turkish National Horizontal Control Network - TNHCN (ED50) until 2005**

Turkish Large Scale Map and Map Information Production Regulation

- **Turkish National Fundamental GPS Network -TNFGN (ITRF)**

Introduction

- Geological
- Geophysical

The evaluation of the coordinate and scale variations in a geodetic network

the coordinate variations and velocities of network points
the strains

↓

two different datum

the computation of velocities using the coordinate data of the ED50 and TNFGN → not accurate and reliable.

the analysis of strain from the coordinate differences → not reliable

However, due to the fact that the ratio of baselines in a geodetic network is independent from datum, the strains can be derived from scale variations accurately and reliably.

Turkish Geodetic Reference Networks

Turkish National Horizontal Control Network - TNHCN

- Early 1950s
- 1954
- ED50 – 8 European common stations

TNHCN

Turkish Geodetic Reference Networks

Turkish National Fundamental GPS Network -TNFGN

- Between 1997-1999
- ITRF 1996

TNFGN

Turkish Geodetic Reference Networks

Technical information about TNHCN and TNFGN

	TNHCN	TNFGN
Datum	ED50	ITRF96
Ellipsoid	Hayford	GRS80
Adjustment	1954	1999

Both TNHCN and TNFGN have hierarchical network structure. Also, TNFGN is a 4 dimensional network (Ayan et al. 2003).

Turkish Geodetic Reference Networks

In this study, 30 common points of TNHCN and TNFGN are taken as test network.

ED50 → TNHCN in 1954 epoch.
TNFGN → 2005 epoch.

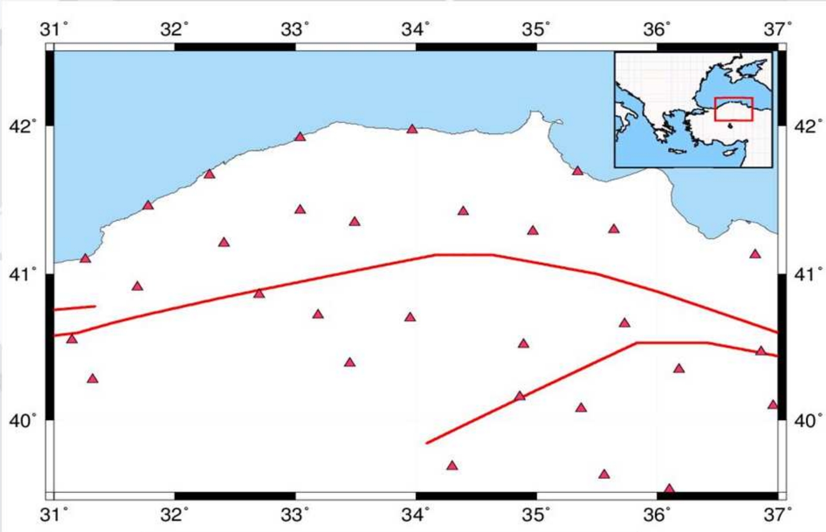
UTM → Lambert Conformal Conic Projection

Parameter values for Turkish Lambert Conformal Conic projection

Parameter	Value
Projection Type	**Lambert Conformal Conic**
φ_0	**38°**
λ_0	**34°**
South Standard Parallel φ_S	**40° 67'**
North Standard Parallel φ_N	**43° 67′**
False Easting E_0	**1000000 m**
False Northing N_b	**0 m**

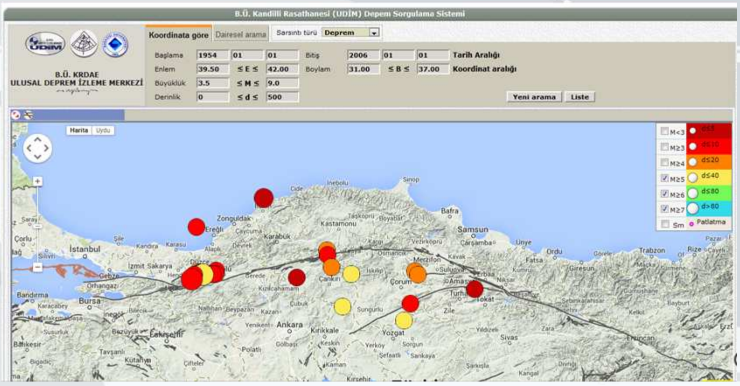
Turkish Geodetic Reference Networks

The distribution of 30 common points in the test area



Investigation of Strain Accumulation by Finite Element Model

Turkey is located in the collision zone between the African, Arabian and Eurasian plates, faces horizontal and vertical crustal movements. The North Anatolian Fault extends over 1500 km in the North of Turkey (Provost et al, 2003).



Investigation of Strain Accumulation by Finite Element Model

In order to estimate a strain accumulation, the finite element model was employed. It is the most appropriate method to determine strain accumulation owing to the fact that it was independent from datum. It uses ratio of baselines. Least square adjustment is applied to observations at two epochs separately (Deniz and Ozener, 2010).

Linear extension of a baseline in a network

$$\varepsilon = \frac{S^{'} - S}{\Delta t . S}$$

S : the baseline length at first epoch,
S' : the baseline length at second epoch,
Δt : the time interval between two epochs

Investigation of Strain Accumulation by Finite Element Model

Linear extension of the baseline ε,

$$\varepsilon = e_{xx} \cos^2 t + e_{xy} \sin 2t + e_{yy} \sin^2 t$$

e_{xx}, e_{xy} and e_{yy} : the strain tensor parameters
t : the azimuth

Delaunay triangulation method

$\Delta = e_{xx} + e_{yy}$, dilatancy

$\gamma_1 = e_{xx} - e_{yy}$, principal shear strain

$\gamma_2 = 2e_{xy}$, engineering shear strain

$\gamma = \sqrt{\gamma_1^2 + \gamma_2^2}$, total shear strain

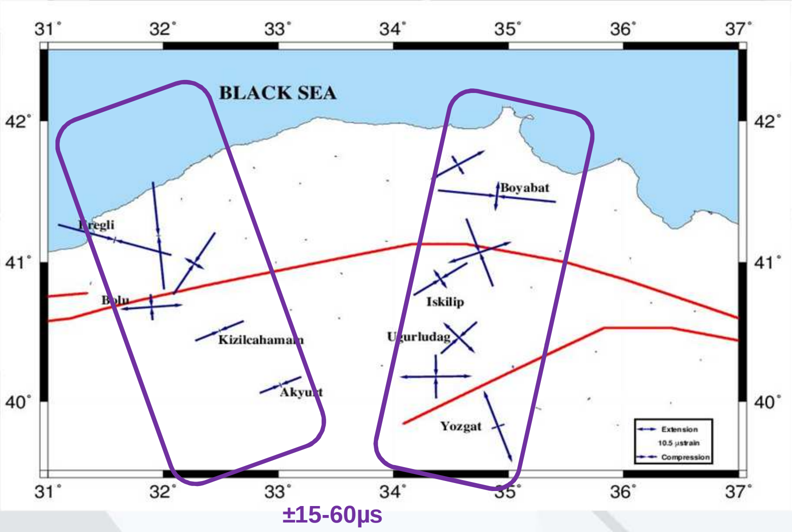
$E_1 = \frac{1}{2}(\Delta + \gamma)$, maximum principal strain

$E_2 = \frac{1}{2}(\Delta - \gamma)$, minimum principal strain

$\beta = \arctan\left(\frac{e_{xy}}{E_1 - e_{xy}}\right)$, direction of maximum principal strain arc

Investigation of Strain Accumulation by Finite Element Model

Strain rate parameters of the test area



±15-60µs

Investigation of Strain Accumulation by Finite Element Model

The precision of I., II., III. order of TNHCN and III. order Turkish National Densification Network,

Turkish Large Scale Map and Map Information Production Regulation – 1988 ➤ **±20ppm** *(CSCE, 1988).*

The precision of C1 order in accordance with Turkish Large Scale Map and Map Information Production Regulation – 2005 ➤ **±5 ppm**

Investigation of Strain Accumulation by Finite Element Model

According to the precision values mentioned above, the strain precision of the transformation between two networks (TNHCN and TNFGN) ➤ **±21ppm**

The calculated strain values should be examined according to this limit. If the strain value is bigger than 21ppm, |strain|>21ppm, it will be considered as significant (CSCE, 2005).

Conclusions

Maximum values of strain rate were around Eregli-Bolu-Kizilcahamam-Akyurt and Boyabat-Iskilip-Ugurludag-Yozgat. Those areas have mean strain rate values of ±15-60µs. Also, the minimum values of strain accumulation were calculated around 17µs.

It is observed that there isn't a direct relationship between the derived strain rate and the faults. However, it should be considered that strain rate is dependent on the geological structure.

More detailed geodetic and geological research will be conducted in the study area.

THANK YOU…

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