RECENT SEISMOTECTONIC IMPLICATIONS OF THE EAST ANATOLIAN FAULT ZONE, EASTERN TURKEY BY THE STRESS TENSOR ANALYSES

DOĞU ANADOLU FAY ZONU'NUN GERİLME TENSÖRÜ ANALİZİ İLE GÜNCEL SİSMOTEKTONİĞİ

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ABSTRACT:

One of most prominent and active faults in eastern Turkey is the NE-SW oriented left-lateral strike-slip East Anatolian Fault Zone (EAFZ) with a length of approximately 500 km. In this study, we have examined the recent seismicity of EAFZ that was obtained from the records of 34 3D broad-band earthquake stations established around the fault zone within TURDEP project since 2006. Further the seismicity and fault mechanism solutions of EAFZ, eastern Turkey have been examined. The new fault mechanism solutions in addition to previously published 220 earthquakes that occurred on the EAFZ between 1951 and 2010 were studied to understand the principal stress field and the seismo-tectonic characteristics along the fault zone. The new mechanism solutions of the earthquakes, with a magnitude of M_L=2.0 or more were determined by a local moment tensor solution and P-wave first motion data. It is suggested that the recent tectonic deformation of EAFZ south of Turkoglu is taken up by the left-lateral strike-slip active faults in between Amik and Adana Basins where young trans-tensional stress regime is also active.

ÖZET:

Doğu Anadolu' daki en önemli ve aktif faylardan biri, yaklaşık olarak 500 km uzunluğundaki, KD-GB uzanımlı sol yönlü doğrultu atımlı Doğu Anadolu Fay Zonu (DAFZ)'dur. Bu çalışmada, 2006'dan beri TURDEP projesi kapsamında fay zonu çevresinde kurulan 34 tane 3 boyutlu geniş-bant deprem istasyonlarından elde edilen DAFZ'ın güncel sismisitesini araştırdık. Ayrıca Doğu Anadolu'daki Doğu Anadolu Fay Zonu (DAFZ)'nun depremselliği ve fay mekanizma çozümleri araştırılmıştır. 1951 ve 2010 arasında DAFZ üzerinde oluşan, önceden yayımlanmış 220 depreme ek olarak, yeni fay mekanizma cozümleri fay zonu boyunca asal gerilme alanını ve sismotektonik karakteristikleri anlamak icin calışılmıştır. ML=2.0 veya daha büyük magnitüdlü depremlerin yeni mekanizma çözümleri, lokal moment tensör çözümü ve P-dalgası ilk hareket verilerinden tanımlanmıştır. Türkoğlu' nun güneyinde DAFZ'ın güncel tektonik deformasyonunun, aynı zamanda aktif olan, genç sıkışmalı-genişlemeli gerilme rejiminin olduğu Amik ve Adana Basenleri arasındaki sol yanal doğrultu atımlı aktif faylar tarafından harekete geçtiği önerilmiştir.

KEYWORDS: East Anatolian Fault Zone, Earthquake, Fault Mechanism Solution, Stress Tensor Analyses

1. INTRODUCTION

The East Anatolian Fault Zone (EAFZ) is a left-lateral strike slip fault and 500 km in length. The fault starts at the Karlıova triple junction, where it meets the North Anatolian fault to the NE and continues to the Türkoğlu junction (T)(Fig. 1) where it divides into several splays to the SW. The continuation of EAFZ at the southwestern end to the Dead Sea Fault (DSF) or the Cyprus Arc (CA) are doubtful. Various views are proposed (Rojay et al., 2001):

a) the EAFZ continues in southwestern trend from Karlıova to north of Cyprus and is not directly connected to the DSF
b) the Türkoğlu–Amik segment (Karasu fault zone) is interpreted as a separate fault,
c) the EAFZ continues until Samandağ (Mediterranean Sea) in splay or left-stepping pattern,
d) the EAFZ interpreted as a northward continuation of the DSF
Cilicia region constitutes a wide left lateral shearing zone that indicates a diffuse plate boundary between the African, Arabian and Anatolian Plates (Ergin et al., 2004; Westaway, 2004). Ökeler and Eyidoğan (2003) analyzed stress tensors and showed that the entire region is under control of the left-lateral strike-slip faulting with minor normal component. The stress tensor for the Osmaniye region showed the area is affected by E-W oriented extensional stress. Distribution of earthquakes implies that the splay fault extending from Türkoğlu junction through Andırın to Osmaniye appears to be active in this century. The Dead Sea Fault and its junction with the southern segment of the East Anatolian Fault Zone, despite their high tectonic activity have been relatively quiescent in the last two centuries (Ambraseys, 2004).

In this study, the seismicity and fault mechanism solutions of EAFZ, eastern Turkey, have been examined. The recent seismicity of EAFZ has been monitored using the records of 34 3D broad-band earthquake stations established around the EAF zone within TURDEP Project since 2006 (http://www.mam.gov.tr/english/YDBE/projeler/Makes-Major.html). The error margins of the coordinates of recently relocated epicenters are less than ± 2 km. Some epicenter clusters display parallel and conjugate fault activity to EAFZ.

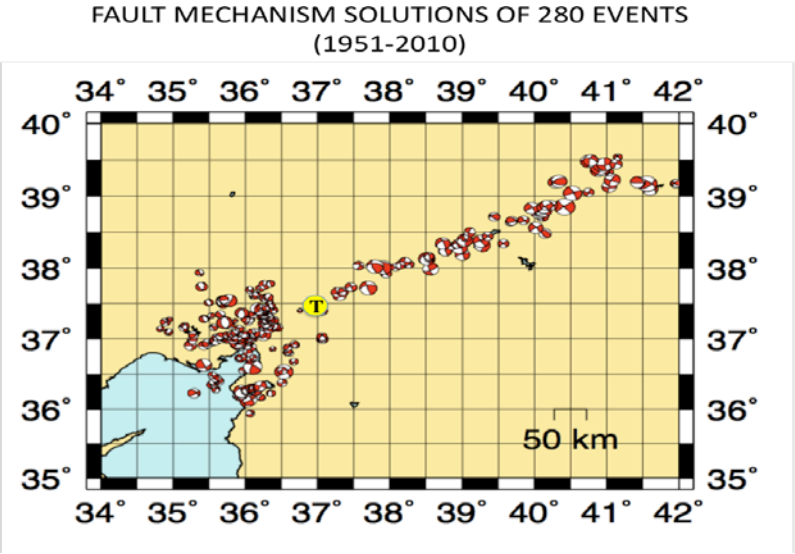

Fig. 1. Fault mechanism solutions of 280 events (1951-2010)

2. FAULT MECHANISM SOLUTIONS

The new fault mechanism solutions of 60 earthquakes in addition to previously published 220 earthquake mechanism solutions (total 280) that occurred on and around the EAFZ in the time period between 1951 and 2010 were studied to understand the principal stress field and the seismo-tectonic characteristics along the fault zone. The magnitude range of the data varies between 2.0 and 7.0. The new mechanism solutions in this study were determined by a local moment tensor solution (46) and P-wave first motion data (16) and have the magnitude range of M_L=3.5 or more.

3. METHOD FOR STRESS TENSOR ANALYSIS

The fault mechanism solutions have been divided into sub-regions in order to analyze the tectonic stresses along the EAFZ. We have used improved classical Right Dihedron method (Delvaux and Sperner, 2003) to estimate the range of tectonic stress regimes using the EQ mechanism solutions and geological field data. The Right Dihedron method is particularly well adapted for the stress inversion of focal mechanisms, as it also uses two orthogonal planes to define compressional and extensional quadrants. Delvaux et al. (1997) defined a stress regime index R' which expresses numerically the stress regime as follows:
R' = R when S1 is vertical (extensional stress regime)
R' = 2 - R when S2 is vertical (strike-slip stress regime)
R' = 2 + R when S3 is vertical (compressional stress regime) where R is the stress ratio R = (S2-S3)/(S1- S3). R'ranges from 0.0 to 3.0 (Fig 2.)

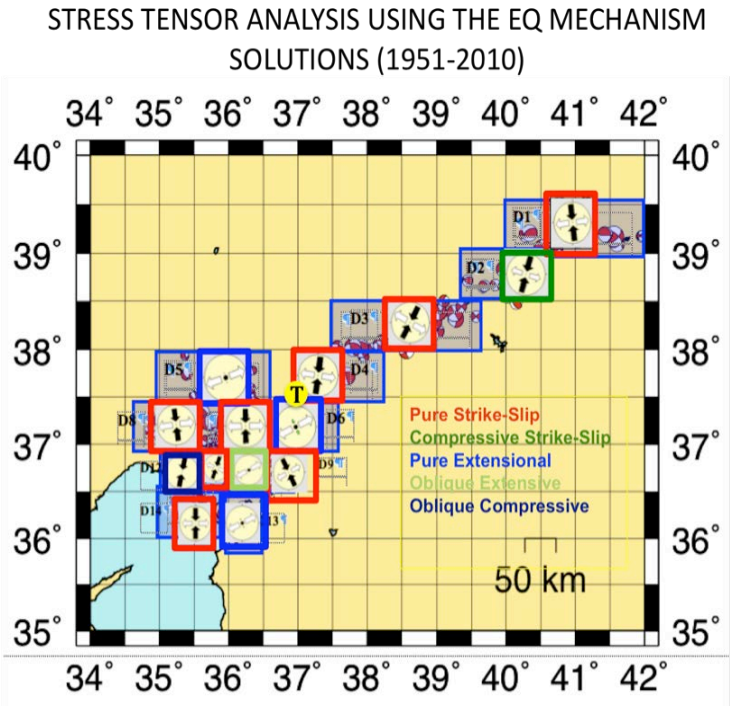

Fig 2.Stress tensor analysis using the earthquake mechanism solutions (1951-2010).

4. CONCLUSIONS

•A pure-strike-slip stress deviator characterized by N-S-trending σ1 and E-W-trending σ3 axis for the area between Karlıova and Turkoğlu along the EAFZ (D1, D2, D3, D4). R'≈ 1.48-1.57 (Fig 2).
•A pure extensional and oblique extensive stress deviator characterized by NE-SW trending σ3 for the area between Turkoğlu and northern tip of DSF along the western segment of EAFZ (Maraş and Karasu Basin) (D6, D10, D13). R' ≈ 0.45 -1.73
•A pure strike-slip stress deviator characterized by N-S-trending σ1 and E-W-trending σ3 axis for the area west of Turkoğlu-Osmaniye zone (D7, D8, D9, D11, D12, D14). R'≈ 1.38 -1.67.
•Cilicia region constitutes a wide left-lateral shearing zone that indicates a diffuse plate boundary between the African, Arabian and Anatolian Plates.
•The present-day stress regime is extensional and/or trans-tensional in the southern region of the EAFZ between Turkoğlu and Antakya. The strand of the Karasu fault zone in this region forms a linkage zone between DSF and EAFZ.
•The recent tectonic deformation of EAFZ south of Turkoğlu were taken up dominantly by the left-lateral strike-slip active faults in between Amik and Adana Basins where young trans-tensional stress regime is also active.
•Left lateral strike-slip character of EAFZ zone is more dominant at west of Maraş-Antakya, south of Turkoğlu joint implying that the continuation of EAFZ zone toward DSF further Turkoğlu is debatable based on the recent fault mechanism solutions.

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