ANALYSIS OF AN EARTHQUAKE BASED ON EXTENSOMETRIC AND SEISMOLOGICAL MEASUREMENTS OF HAS AND MFGI OBSERVATORIES

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Abstract

The rock-deformation data series collected by extensometers provide an opportunity for studying various changes in the geological, rock-physical environment, caused by earthquakes (e.g., displacement, deformation of rock mass). Hereby further information can be achieved about the nature of these effects, complementing the analysis of seismograms (as e.g. the frequency range embraced by extensometers can record changes with much higher time of periods). In order to investigate the appearance of effects of earthquakes in extensometric data, authors chose a registratum which was collected in the Matyashegy Gravity and Geodynamical Observatory in Budapest in the time of a significant M7.2 earthquake occurred in Turkey, and started its spectral analysis. Results of the examinations were compared to the spectrum of records of a typical, undisturbed lapse of time, as well as to the spectrum calculated from seismograms of Kövesligethy Radó Seismological Observatory in Budapest, nearby the gravity observatory.

Keywords: extensometer, deformation, seismogram, earthquake.

1. THE M7.1 EASTERN TURKEY REGION EARTHQUAKE

The investigated M7.1 earthquake occurred near the city Van (**Figure 1**), close to the Iranian border, in a broad region of convergence beyond the eastern extent of Anatolian strike-slip tectonics. The intensity in Van has reached IX in Mercalli-scale. At least 534 people killed, 2,300 injured and 14,618 buildings and homes destroyed or damaged in the Ercis-Tabanli-Van area. Several M>5 aftershock events followed. Telecommunications, electricity and water services disrupted. It was felt throughout eastern Turkey, Armenia, Georgia, Azerbaijan and northwestern Iran and parts of Iraq, Syria, Lebanon, Jordan and Israel.

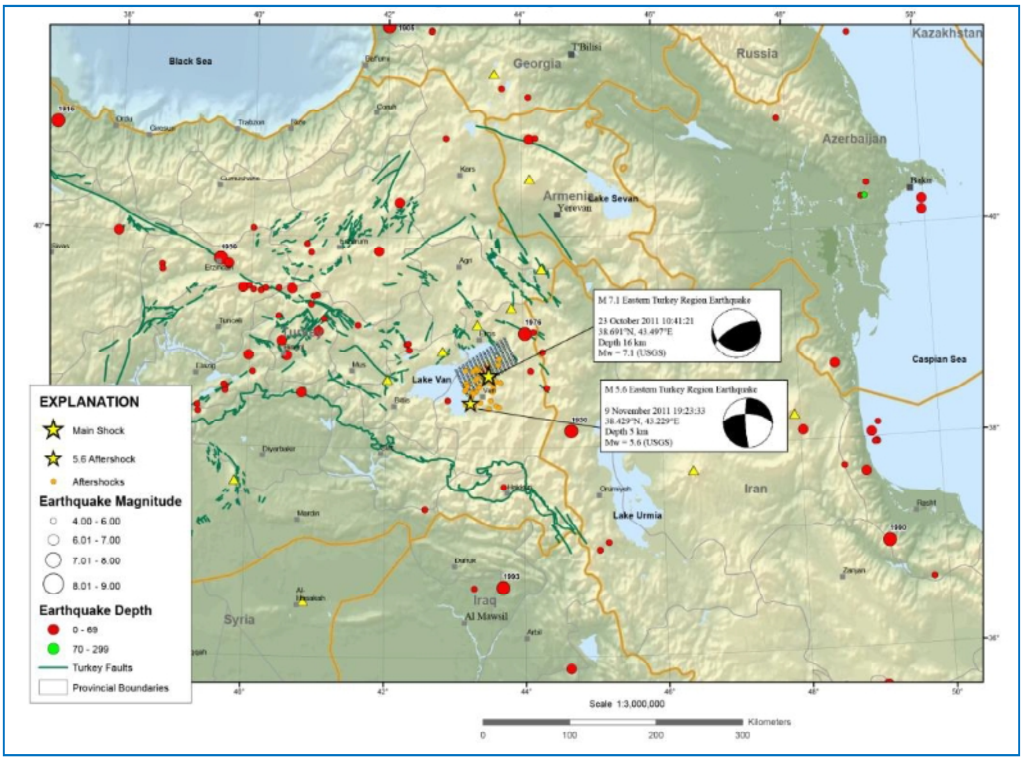

Figure 1: *Location and tectonic settings (USGS)*

Observations of the nm-scale accuracy extensometer at Budapest Mathiashill Gravity and Geodynamical Observatory and that of a three component STS-2 Streckeisen broad band seismometer at the Kövesligethy Radó Seismological Observatory can be seen on **Figure 2**. The distance between the gravity and seismological stations is less than 6 km.

2. METHOD OF INVESTIGATION

In order to compare the time series of teleseismic waves recorded by extensometer (located in the Mathyas-Hill) and that of horizontal components of seismograms recorded at BUD seismological station, the North and East seismogram components were rotated with a certain angle to align with the azimuth of the extensometer (**Figure 3**). The rotated component quantities R and T can be expressed by (**Eq. 1**)

$$\begin{bmatrix} R \\ T \end{bmatrix} = \mathbf{A} \begin{bmatrix} N \\ E \end{bmatrix} \qquad (1)$$

where **N** and **E** are the horizontal North and East components of the seismogram, respectively, and **A** (**Eq. 2**) denotes the“rotation matrix”

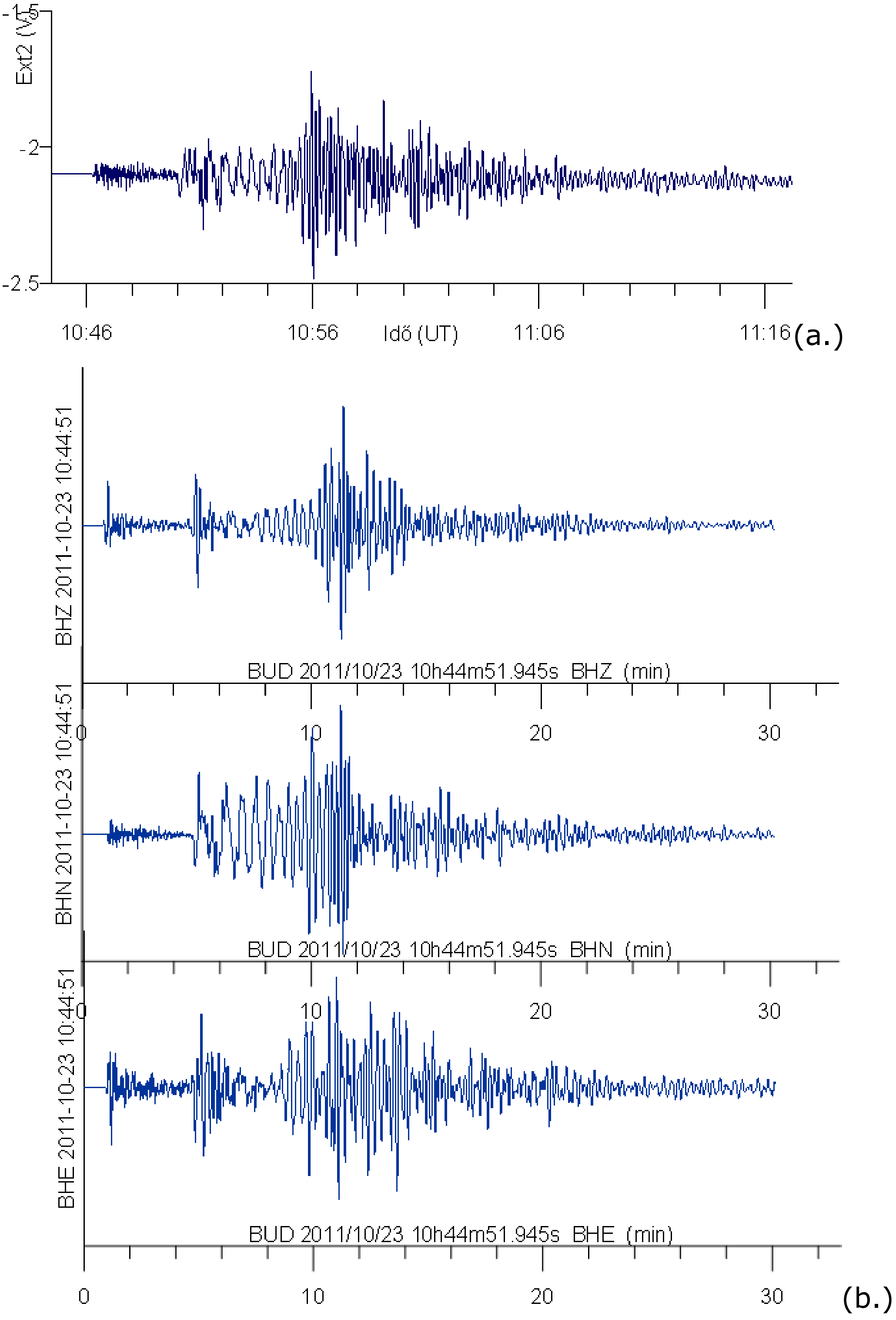

Figure 2: *Observations by extensometer (a.) and seismometer (b.)*

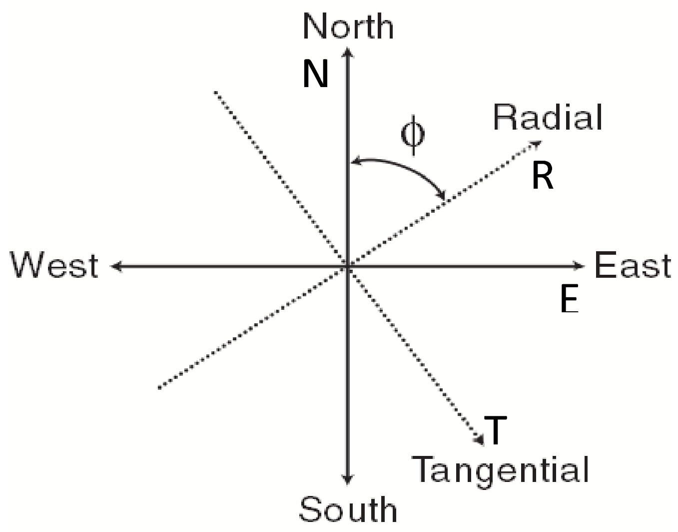

Figure 3: *Original and rotated components*

$$\mathbf{A} = \begin{bmatrix} \cos\Phi & \sin\Phi \\ -\sin\Phi & \cos\Phi \end{bmatrix} \quad . \tag{2}$$

3. SPECTRAL ANALYSIS

The registrations of BUD seismological station were rotated with certain angles, and FFT were performed to analyse the spectral content (extensometer: Fig. 4, seismometer /e.g. Φ=218°/: Fig. 5).

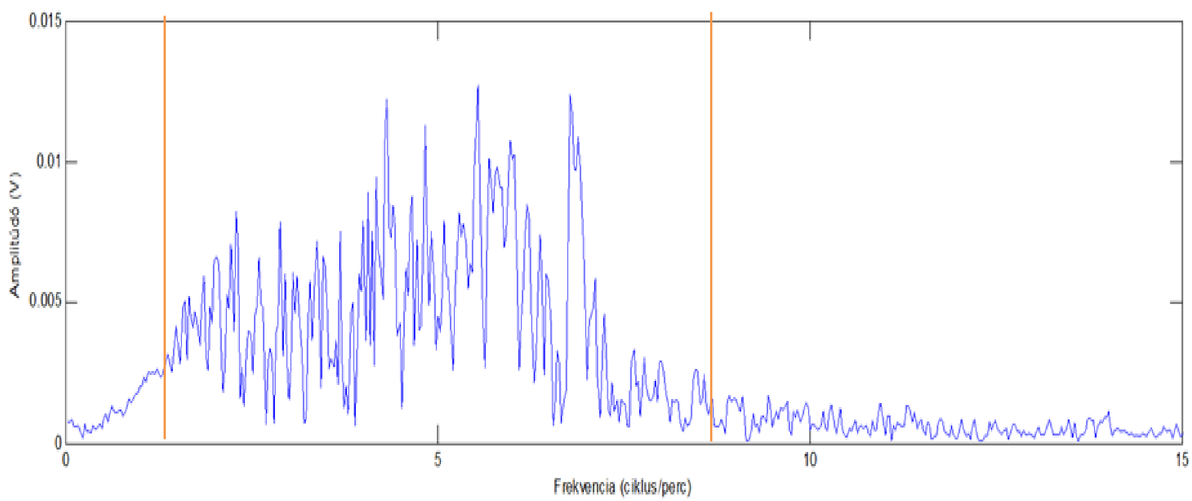

Figure 4: *Extensometric FFT spectrum of the Turkey earthquake (UT2011.10.23 10:45-11:20), azimuth of the extensometer: N 218°*

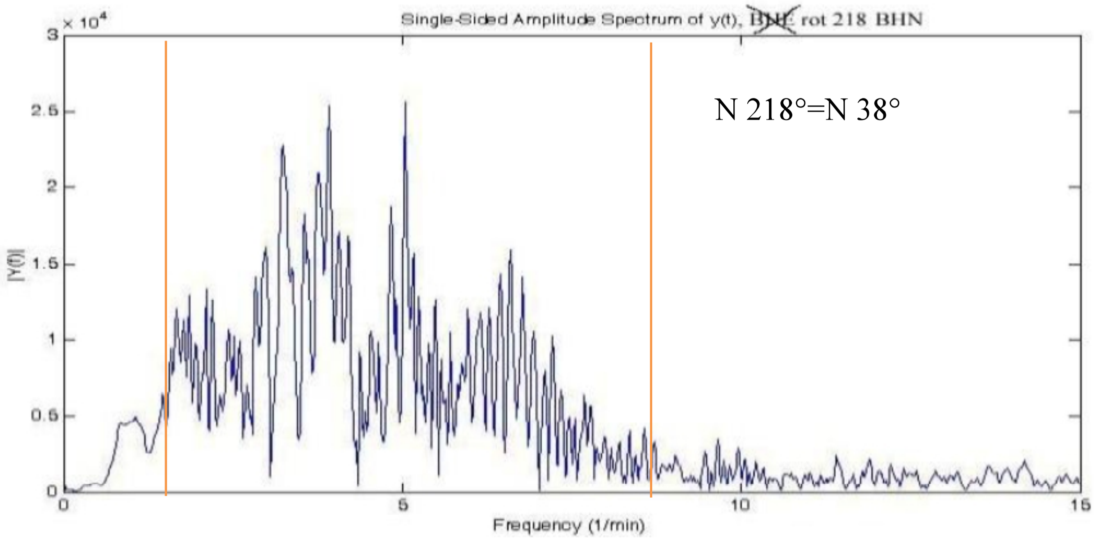

Figure 5: *FFT spectra of rotated (Φ=218°) radial components of seismogram calculated from BHE (horizontal East) and BHN (horizontal North) components (UT2011.10.23 10:38 -11:08, 20 Hz sample rate).*

Conclusion

Different types of rock-deformation measurements (seismogram and extensometric data) were compared in the analysis of a significant eartquake. It was concluded that there were some similarities between the times series and spectra registered by the different methods. The complemental analysis of extensometric data gives a chance for investigating various earthquake-originated changes in the rock-physical environment (deformation fields).

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