ANALYSIS OF FEATURE OF RECENT SEISMICITY IN VLORA-ELBASANI-DIBRA SEISMOGENIC ZONE

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The Vlora-Elbasani-Dibra transversal fault zone of ENE extension, which dislocates the Albanides along all their width is marked out by diapiric cupola of Dumrea, the Quaternary Depression of Elbasan, the belt of trasversal structure of Labinot which continue with the trasversal flysch elevation of Golloborda (Figure 1). The results of the analysis, based on the parameters of events and some features of seismicity that have occurred in the Vlora-Elbasan-Diber seismogenic zone during period of time 2001-2014, are presented in this paper. The goal of this study is to determine typology of seismicity, the source parameters of the mainshocks and their aftershocks in order to shed light on the seismotectonics of the area on the stress field and to evaluate the seismic hazard. The data used in this study were recorded by permanent broadband seismological stations that are part of the Albanian Seismological Network as well by neighboring seismic networks NOA, MSO, INGV and MEDNET. The epicenters were located using P and S onsets, a local velocity model (Ormeni, 2011) and the Hypoinverse program (Klein, 2002). A complete and homogenous catalog of the earthquakes is provided. The focal mechanism solutions using the Focmec routine in the Seisan package (Haskov and Ottemoler, 2008).The number of events forecasted and probability of one or more aftershocks has been defined based on the combination of modified Omori and Gutenberg-Richter models (Gutenberg an Richter, 1944). On the Vlora-Elbasan-Diber seismogenic zone during period of time 2001-2013 854 earthquakes were located with M_L>1.0 (Richter), of which 301 of magnitude M_L>3 , 20 of magnitude M_L>4.0 and one event with magnitude M=5.0 (Figure 1, left). Focal depth analysis reveals that this seismicity was mainly generated in the upper und middle crust under the tectonic conditions described previously. We determined the focal mechanisms of 6 September 2009 (M5.4), 16 April 2007 (M4.5), 9 July 2010 (M4.6) and of the compound earthquakes of 24 October 2008 (M4.5), 21 May 2014 (M5.2), using first-onset polarities. The focal mechanism solution of the 6 September 2009 mainshock has an active plane striking (strike) 219.5° NE, an inclination of the hanging wall (dip) of 40° and a hanging wall displacement (rake) of -90° (downward motion), in good acordance with field observations (Fig 1, center).

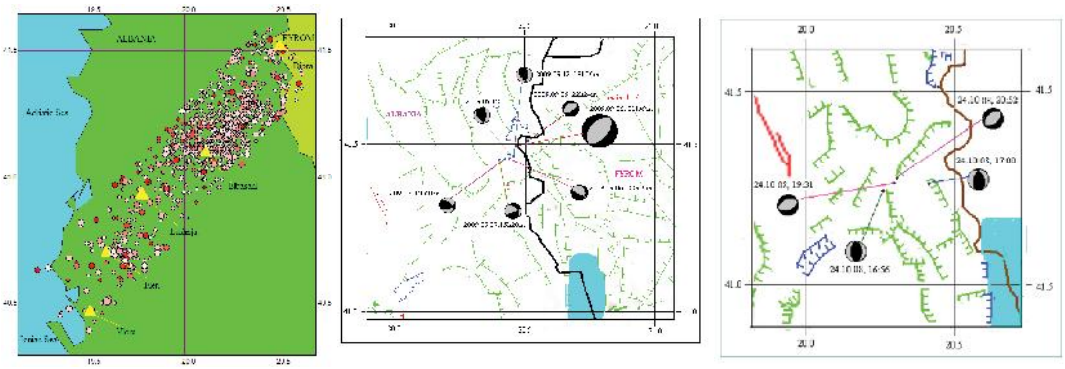

Figure 1. The map of earthquake epicenters occurred in Vlora-Elbasan-Dibra zone during period 2001-2014 (left) seismotectonic map of Elbasani-Dibra and the focal mechanism of the 6 September 2009 mainshock and its aftershocks (center), and focal mechanisms of compound earthquakes 24 October 2008 (right)

Some aftershocks did not occur along the same fault plane as the mainshock; they occurred on faults with different orientations, reflecting the activation of secondary structures in the Elbasan-Dibra transverse fault zone and demonstrating a variety of geologic structures in the area with heterogenous stress state and the stress axes may often undergo rotations. These earthquakes highlight the increased seismic activity of the Elbasani-Dibra seismogenic zone. The focal mechanisms solutions for compound (fourplet) earthquake are: for the first shock, Strike=180°, Dip=50° and Rake (Slip) =90° that was triggered from a pure thrust fault with an W-E stress direction (Figure 1, right) (Ormeni et al., 2009). The fault plane, has a dip 50° and and is associated with the activation of the Elbasani-Dibra deep fault zone. The focal mechanism solutions of this earthquake demonstrate an ongoing horizontal extension (thrust faulting) along the fault in the direction of N-S. The solutions for the second shock are: Strike=190.2°, Dip=52.8° and Rake (Slip) =-64°. From the focal mechanism solution results that the earthquake of time 17h00m was triggered from a oblique thrust fault with an N-S stress direction. The third shock 19h31ms the strongest and the fourth time 20h52m have solution respectively: Strike = 249º, Dip = 40°, Rake (Slip) = -90^0 and Strike = 229.3º, Dip = 40° and Rake (Slip) = -90^0. (Figure1, right). From the focal mechanism solution results that the third and fourth earthquakes were triggered from a normal active fault with an NW-SE extensional stress direction (Ormeni et al., 2013). The associated seismic hazard has a direct connection with the geology of the location (Aliaj et al., 2001). Within the epicentral zone, strong rocks such as limestones and ultrabassic deposits result in a lower seismic hazard than in areas with weaker rocks such as flysch and molasse. Significant damages were observed along the contact between the limestone and ultrabassic formations and the areas containing flysch and molasse as well. Geologically, the Cereneci-Gjorica area contains Paleocene-Eocene-Maastrichtian flysch formations. The flysch formation form a folded anticline that is composed of intercalations of thin clay-siltstone-sandstone layers. Generally, the flysch formations are covered by Quaternary silts, silty clay depositions and mixtures of gravels and sands. The September 6, 2009 earthquake and earthquake of 21 May 2014 caused more damage in the flysch/molasses area of the villages of Gjorica and Qerenec and the Shupenza municipality in the Dibra district and in Cerrik and Belsh municipality in the Elbasani district. The fact that the epicentre of the 2009 event is close to the previous 30 November 1967 Mw6.7 earthquake probably reflects the genetic relation of these two events through the ideas of static stress changes, which is not tested in this work. While the seismic hazard resulting from a normal fault earthquake with strike-slip and oblique component and NNW-SSE extension is well recognized and discussed, little attention has been given to quantifying the subsequent aftershock activity and its potential impact on communities in the region. The aftershock probability evaluation method is an effective way to analyze the aftershock activity of the mainshock-aftershock sequence. Focal depth analysis reveals that this seismicity was mainly generated in the upper and middle crust. The Elbasan-Dibra Fault zone has produced earthquakes in the past, and is expected to continue to be active in the future. This study of recent seismicity emphasizes many geologic and seismotectonic characteristics of the areas constituting a threat for nearby urban areas of Albania and the FYROM.

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