SEISMICITY OF SOUTHERN APUSENI MOUNTAINS

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South Apuseni Mountains represent the suture of the Western Carpathian rift zone. Although this zone is analogous to the central Carpathian rift zone, the western Carpathian has a peculiarity that differentiates of the first area by the presence of large masses of ophiolites, due to limited consumption of the crust by subduction; has developed a wild flysch and deformations of the crust were modest because the zone of the South Apuseni rift evolved as labile area intra microplate unlike the area of the Central Carpathian rift whose development was continental intraplate (Mutihac et al., 2007).

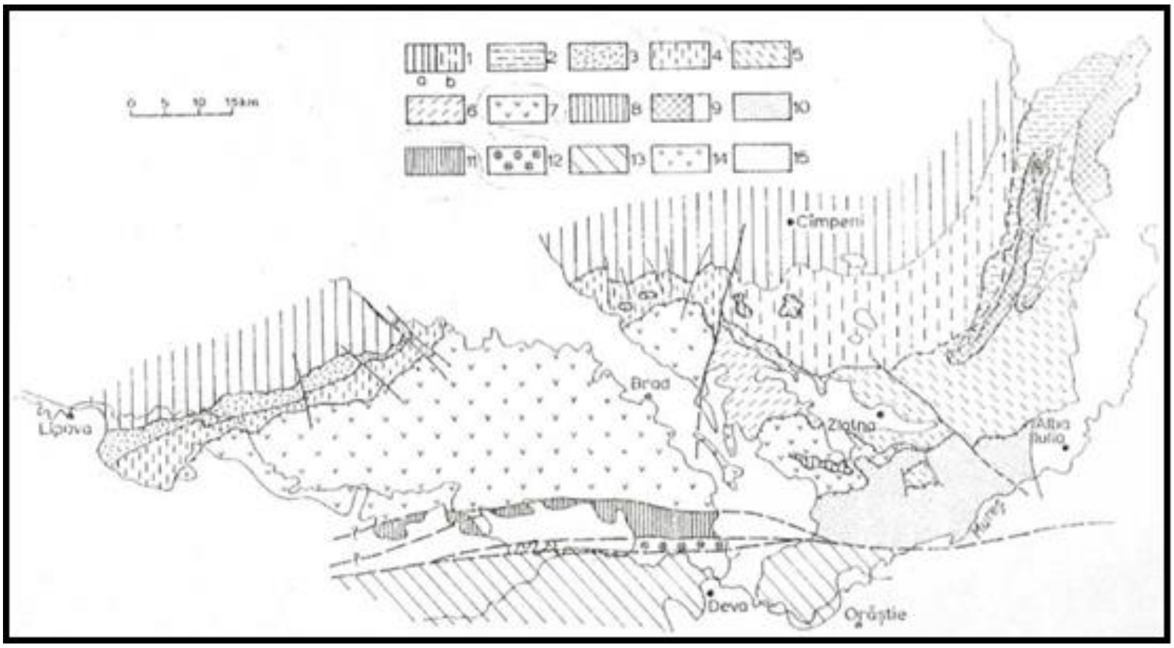

Fig. 1. Tectonic map of the Southern Apuseni Mts. (Sandulescu 1984)
1.Biharia nappes system: a. metamorphic formations b. sedimentary formations from Bucium zone; 2. Vidolm nappe; 3. Groşi nappe; 4. Criş nappe; 5. Feneş nappe; 6. Curechiu-Stănijaş nappe; 7. Techereu- Drocea nappe; 8. Ardeu nappe; 9. Trascău(Bedeleu) nappe; 9a. Fundoaia nappe (s. str.);10. Bozeş nappe; 11. Căbeşti nappe; 12. Bejani unit; 13. Supragetic nappes; 14. Remeşi strata; 15. Post tectonic depressions .

The catalog of earthquakes includes 2379 earthquakes with magnitude greater than 1.9 (Mw). In the studied areas are well represented quarry blasts so we removed all earthquakes smaller than 1.9 (Mw), produced in the daytime believing that having a high probability of being explosion in the quarries. Thus eliminating all suspected seismic events, 792 events remained as credible earthquakes.

Concerning the earthquakes fault plane solutions catalog, 18 earthquakes were considered. For these earthquakes the number of stations was higher enough to get a solution with a high degree of confidence.

In the northern part of the Southern Apuseni Mts., prevail compressive character of the tectonic regime, meanwhile along Mures Valley (South Transylvania Fault, known also as Mures Fault) prevail extensional and strike slip tectonic regime.

From Gutenberg-Richter formula results that the value of b, earthquakes distribution slope is 1.65, which presume a great number of earthquake with low values for magnitude. From all earthquakes only 9 have a greater magnitude than 3 (M_w).

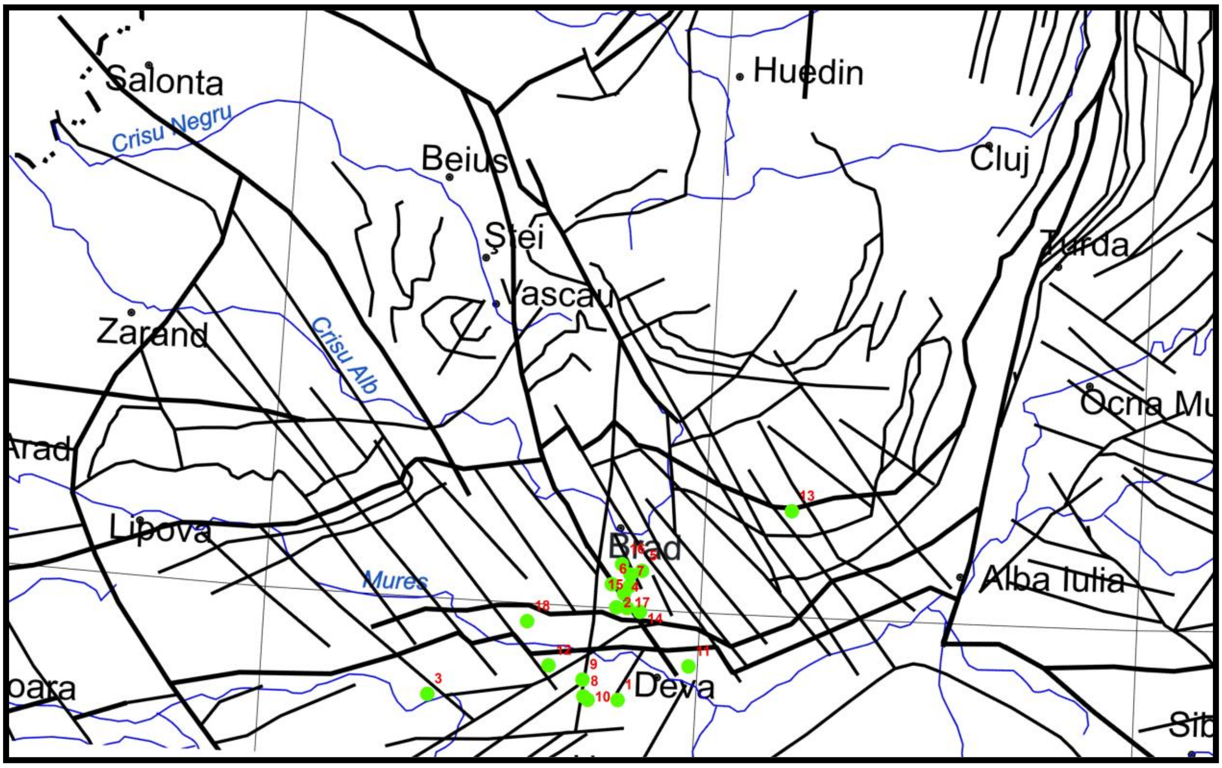

Fig. 2. Epicentral distribution of the earthquakes with focal mechanism. Tectonics compiled after Săndulescu, 1984; Polonic 1980; Răileanu et al., 1992

Estimating the focal mechanism solution (Oros et al., 2016):

1. First step: estimation of focal mechanism solution using only polarities. To investigate the stability of solutions different algorithms and software have been applied; e.g. FOCMEC (Snoke, 2003), FPFIT (Reasenberg and Openheimer, 1985), HASH Hardebeck and Shearer, 2002; 2003) and PINV (Suetsugu, 1998).
2. Second step: amplitude and s/p amplitude ratios were used to better constrain and to improve the solutions based on polarities.
3. Third step: full waveform inversion when few polarities were available or multiple

The stress field and tectonic regime is investigated by the formal inversion of focal mechanisms. The stress axes S1, S2 and S3 and stress ratio factor (R= S2-S3/S1-S3) have been computed with TENSOR program by Delvaux and Sperner (2003). The programme uses the Right Diedre and Rotational Optimization methods that minimises the slip deviation (angular misfit) between theoretical and actual slip directions on the fault plane. It is also described the stress regime (R' number derived from R) as a valuable tectonic regime index. For the whole Intra-Carpathian region Oros et al., (2016) obtained the following data S1=234/45, S2=72/44 and S3=333/9 and R=0.48 (R'=0.48) that describe an oblique extensive stress regime (normal fault cf. World Stress Map) having Shmax=60^O and Shmin=150^O, very well correlated with first order stress in the region induced by Adria pushing (Bada et al., 2007).

For Mures zone we obtained S1=119/47, S2=250/32 and S3=357/25, R=R’=0.90, data that describe a strike-slip extensional (transtensive) to oblique extensional stress regime having SHmax=88^{O} ±10^{O} and Shmin=179^{O}. The average misfit angle of the parameters is 33.5 degree meaning that the stress field is spatially heterogeneous since it cannot be accurately represented by only one stress tensor.

Shmax in the Mures zone is oriented parallel to the South Transylvanian Fault and thus is oblique to the direction of the Shmax regional and is almost perpendicular to the Neogene fault systems. The earthquakes seem to be concentrated at the intersections of the Neogene active faults systems with the older ones that border the major geotectonic units, Internal Dacides and Transilvanides.

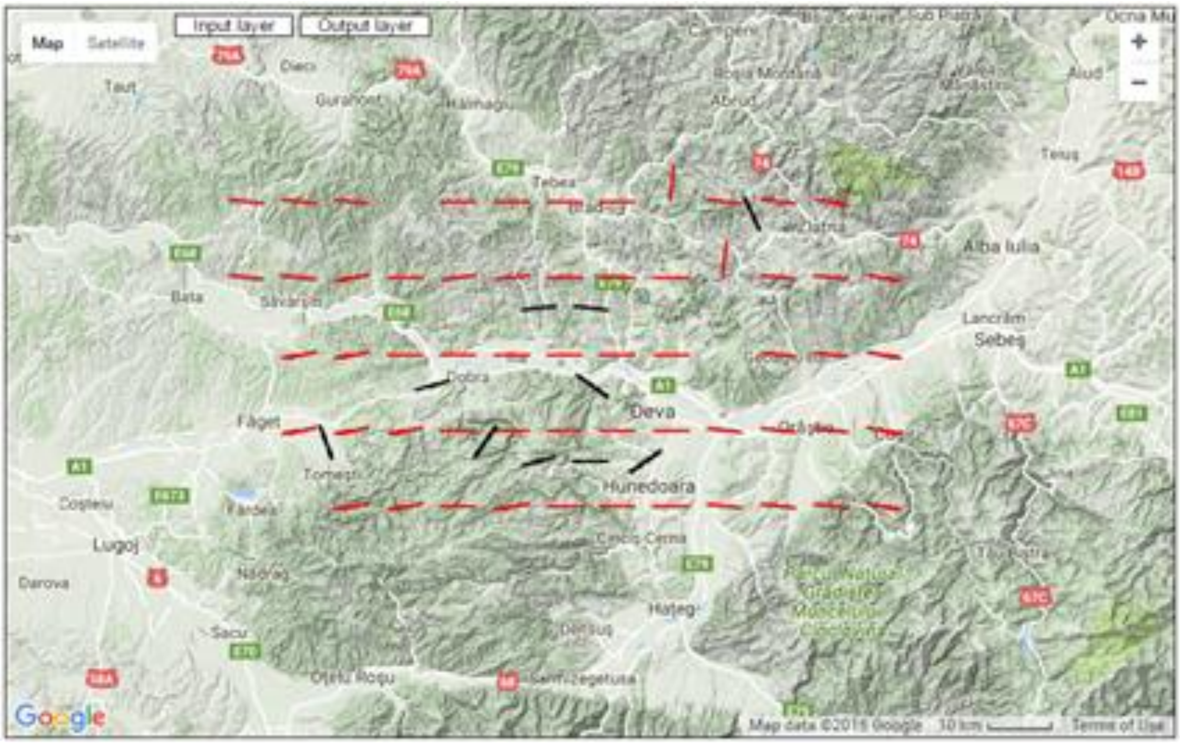

Fig. 3. Map with interpolates values of the Shmax. Red line –Shmax distributions; black line Shmax distribution on earthquakes clusters

With SHINE (Carafa et al., 2015) we estimated the stress field using the available focal mechanisms solutions. It has a E-W direction along the South Transylvanian Fault system The programme resolves simultaneously the scatter in SHmax orientations, the uneven sampling of stress data, and the correlation of stress orientations with distance. SHINE applies the method described by Carafa and Barba (2013), which modified and extended the clustered data analysis technique used by Bird & Li (1996).

The parameters used by Shine are i) geographical setting longitude: 22.15°/23.53°; latitude: 45.74°/46.19°, grid spacing: 0.1 degree and ii) the strategic parameters: searching radius: 2, minimum cluster: 3, 90% confidence bounds: 35°.

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