Identification of tectonically active areas in the Panonian basin: a combination of DEM based morphometric and structural analysis of Bilogora Mt. area (NE Croatia)

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I. INTRODUCTION

Integration of available and newly obtained geomorphic, geological and geophysical data sets into the CRDTEC project database (GIS platform) represent principal research strategy used to correlate subsurface fault geometrical properties and their possible expressions at the surface in Croatia. With focus on delineation of neotectonic and recently active faults and fault zones, quantitative description of their orientation, reconstruction of their kinematic history, and the assessment of their recent seismic potential our goal is to present here results of DEM based morphometric analysis combined with structural analysis of 2D seismic reflections in Bilogora Mt. area (NE Croatia). In addition, we present here results of computations of empirical geometrical fault-scaling relationships and estimation of seismic potential for active faults that cut across in construction of structural depth model of Bilogora Mt. area comprising 6 stratographic horizons and more than 50 faults active during the Neogene and Quaternary times (Fig. 10 & 11).

II. NEOTECTONIC EVOLUTION & GEOLOGICAL SETTINGS

Bilogora Mt. as part of SW Pannonian basin, represent low hilly terrain with average elevation distribution less than 200 m. Pliocene-Quaternary sediments variable in thickness (500-1500 m) which is conditioned by significant paleorelief and structural control of present day relief. It is dominated by NE-SW and NW-SE structural trends, which developed during the Miocene-Cenozoic extensional tectonic regime and some Cenozoic tectonic reactivation (Šimunić et al., 1994; Đurđevac, 1994). The area is well drained by numerous small rivers and gorges, which are most prominent on NE flank of Bilogora Mt. (Fig. 1). In the studied area, the prominent Quaternary structural features were identified and correlated with documented active faults using seismic images of near surface data. The most significant features are the NE-SW striking Drava basin boundary faults, which develop NE-SW strike-slip faults and also reverse faults that cut across the base of the Quaternary sediments. These features are interpreted as part of ongoing tectonic activity (Fig. 4).

III. SEISMOTECTONIC SETTINGS

Tectonic activity is documented by historical seismology reporting several rare and moderate earthquakes (M≥4.5) with intensity of VI–VII MCS in vicinity of towns Koprivnica, Đurđevac and Virovitica (Fig. 3). Greatest horizontal stress direction determined from fault plane solutions of the instrumentally recorded earthquakes (3.5 S 5.6) is characterized by NE-SW orientation, indicating steady NE-dipping, and S-W dipping seismogenic structures with predominantly strike-slip and reverse motions (Prelögović et al., 1998 & Herak et al., 2009).

IV. DEM MORPHOMETRIC ANALYSIS

Quantitative DEM based morphometric analysis has been widely used in identification of ongoing tectonic activity and its surface expression. Landscape features have been identified by DEM raster with 10 m cell resolution. Using ESRI ArcMap & Hillshade functions, a new morphometric framework of study area (after Prelögović et al., 2009 and Herak et al., 2009).

V. STRUCTURAL INTERPRETATION OF 2D SEISMIC SECTIONS

Possible correlation between delineated morphometric parameters and on-going tectonic activity was analyzed using Schlumberger Petrel Seismic to Simulation software (Fig. 5). Set of 72 reflection 2D seismic sections were used published recently for northern and western part of Pannonian basin. Seismically active faults within the Pannonian Basin were delineated using Petrel 3D «skeleton» and pillar grid modeling. Schlumberger Petrel Seismic to Simulation software, new empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement for those faults are in the range 0.07–1.46 m (Fig. 1).

VI. ASSESSMENT OF ACTIVE FAULTS SEISMOGENIC POTENTIAL

In estimation of seismic potential (1) and possible max. magnitude (2) of Pannonian active faults we used publishedrasekural map (1994) and possible max. magnitude (2) of Pannonian active faults we used published

VII. CONCLUSION

1. Possible on-going tectonic activity in Bilogora Mt. is recognized for following drainagebasins: NW part - Nos. 4, 5-7, 14, 17, 19, 23, 32-36 and 41; Central part - Nos. 44-49, 52 and 56; SE part - Nos. 89, 95-97
2. Tectonically active areas correlate well with subsurface fault-related folds formed in hangwalling of either normal-inverted or younger reverse faults that cut across the base Pannonian-Horatian horizon and propagates towards the surface.
3. Calculated vertical offset along these faults indicate slip rates of 0.1 mm/year during the Pannonian-Quaternary times.
4. Pannonian active faults are capable to generate earthquakes with magnitudes up to 6.8. Possible maximum vertical surface displacement for those faults are in the range 0.07 to 1.46 m.

References

V. Matoš, B., Tomljenović, B., Herak, M., Herak, D. & Takač, D. (2009): New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement for those faults are in the range 0.07–1.46 m (Fig. 1).

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