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Seismicity spatial organization and damage pattern at the Alps-Dinarides transition

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The paper affords the study of the spatial organization of seismicity in the region site of the Alps-Dinarides transition (Friuli, in NE Italy and W Slovenia), through two non-conventional methods of spatial analysis are used: fractal analysis and principal component analysis (PCA). The fractal analysis helps to evaluate the tendency of hypocentres to define a plane, or to propagate along linear structures or directions. The PCA analysis is used to infer the orientation in the space of planes fitting through earthquake foci, or the direction of propagation of the hypocentres, enabling a correlation with the tectonic structures. Furthermore, we study the spatial seismicity pattern at the shallow depths in the context of a general damage model, through the crack density distribution. The results of the three methods concur to a complex and composite model of fracturing in the region. The hypocentre pattern fills only partially a plane, i.e. has a fractal dimension close to 2. The three exceptions regard planes with Dinaric trend, without interference with Alpine lineaments. The shallowest depth range (0-10 km depth) is characterized by the activation of planes with variable orientations, reflecting the interference between the Dinaric and the Alpine tectonic structures, and closely bound to the variation of the mechanical properties of the crust. The seismicity occurs mostly in areas characterized by a variation from low to moderate crack density, indicating the sharp transition from zones of low damage to zones of moderate damage. Low crack density indicates the presence of more competent rocks capable of sustaining high strain energy while high crack density areas pertain to highly fractured rocks that cannot store high strain energy. Brittle failure, i.e. seismic activity, is favoured within the sharp transitions from low to moderate crack density zones. In the deepest depth range (10–20-km depth), on the contrary, the study evidences the dominance of the tectonic Dinaric system to the NW of the External Dinarides, in depth. This depth interval is characterized by a more organized pattern of seismicity. Seismic events mainly locate on the Dinaric lineaments in the northern and eastern parts of the region considered, while on Alpine thrusts in the western and southern parts.