

Earthquake hazard estimation in intraplate areas based on fractured clasts: Case study from the Outer Carpathians (Poland)

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Outer Carpathians are thrust-and-fold belt formed due to the Eocene through Miocene subduction of oceanic or suboceanic crust intervening between continental crust of European and ALCAPA plates and subsequent Miocene collision. As a result of these processes the Outer Carpathians became an intraplate area welded to the European and ALCAPA plates. Like numerous intraplate areas, the Polish segment of the Outer Carpathians is considered as largely aseismic during recent times. Therefore, the earthquake hazard in the region is considered to be either negligible or not-existing. However, the period of instrumental and historical record in the region is rather short. It appears, therefore, that extending the period of observations by including the geological record of earthquakes may facilitate the evaluation of seismic risk. In the Outer Carpathians such record can be provided by the tectonic fractures cutting clasts in the Neogene strata covering Outer Carpathian thrust-and-fold belt. Fractured clasts occur commonly in Miocene through Holocene fluvial gravels and paraconglomerates. In the studied localities, architecture of fractures is well-organized and independent of textural properties of the clasts bearing strata. It appears, therefore, that the fractures are tectonic features.

Fractured clasts have been observed in numerous areas of recent, and historical seismicity. Consequently, the origin of fracturing is believed to be related to earthquakes. Fractured clasts occur commonly in Miocene conglomerates within the Vietnamese segment of the Red River Fault Zone. However, in the latter area Holocene gravels are devoid of fractured clasts. The area has been recently seismically active, with historical earthquakes attaining magnitudes up to 5.5. We believe, therefore, that clast fracturing takes place only if the magnitude of the related earthquake exceeds 5.5. It appears that the geological record of numerous strong (>5.5) earthquakes in the Outer Carpathians should compel us to reconsider the earthquake hazard in this area. Within the Polish segment of the Outer Carpathians the Neogene strata, bearing clasts cut by tectonic fractures, were observed mainly: (1) close to the map-scale thrusts and strike-slip faults, (2) within intramontane depressions filled by poorly indurated strata, and (3) close to map-scale normal faults bordering the intramontane depressions. It follows, that these regions (1-3) are the areas of increased earthquake hazard.