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The Role of Inherited Structures on Temporal Development, Fault Propagation and Seismicity Distribution – an Example of an Active Strike-Slip Fault

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A field study of the NW-SE trending Ravne fault in the Julian Alps (eastern Southern Alps, Slovenia) together with work on seismological parameters has revealed segmented geometry along the trace of a fault and provides a good insight into growth and linkage processes of active faults. Altogether four segments of different length and with slightly different orientation can be distinguished. In the current regional stress field the fault system is dextral, as evidenced by earthquake focal mechanisms, but fault architecture, kinematic indicators, and the degree of rock damage within the fault zone strongly suggest the existence of several earlier kinematic phases. The first stage of activity, connected to Eocene thrusting, produced hangingwall uplift on a NW-SE trending, towards NE dipping fault system. Subsequently, the fault zone was disintegrated and displaced by E-W trending thrusts and reverse faults, connected to N-S compression during the Miocene, which resulted in N-S offsets of a few hundreds of meters between the neighbouring fault traces. During the Miocene-Pliocene transition, at the onset of counter-clockwise rotation of Adria microplate, the orientation of the fault system was favourable for dextral strike-slip reactivation. Previously dismembered fault trace started acting as a segmented, right-stepping fault array in the overall transpressional tectonic setting, associated with formation of small-scale transtensional basins in the overstep zones.

The mutual relationship among the length of individual fault segments, separation and

overlap distances play a deciding role in propagation and growth patterns of a re-establishing fault trace. The 1998 earthquake cluster activated a part of the fault plane where, at the surface, the fault makes a right-step between two segments with 425 m of overlap and 80 m of separation, and stopped on SE margin of a transpressional basin, where a 370 m long overlap and 300 m wide separation between fault segments was not breached. The 2004 earthquake sequence with minor magnitude activated the part of the fault further to the NW where surface fault exposure is poorer. This indicates that the fault is actively growing in its NW end by linkage of previously displaced fault trace. The spatial distribution of both aftershock clusters exhibits the distribution pattern across the entire fault trace and with some events occurring outside the cluster which is typical of earthquakes on faults which are reactivating older pre-existing structures. The depth distribution of epicentres reveals a confinement of all events to the upper first 10 km of the crust in the area where mechanical discontinuities and heterogeneities of pre-existing structures play a role on active fault processes. Considering the length of co-seismic rupture with the computed seismic moments suggests that the M_0 scales with the length of individual segments. Based on average observations and values of seismic moments for earthquakes on strike-slip faults it can be seen, that both seismic moments of the 1998 and 2004 are bellow average. This also proves the reactivation behaviour and small time difference in the occurrence of both main shocks. The pre-deformed and mechanically shattered fault zone in the first few upper kilometres of the crust can not sustain stronger earthquakes as the hosting rocks do not have the needed strength to carry the energy release of a stronger earthquake shock. Two medium sized earthquakes with their epicentre locations only a kilometre apart exhibit an example of an active fault growth processes on an older reactivated architecture and also give a good insight on local and regional structural conditions.