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The misorientation/weakness connection: 3D modelling and anisotropic slip-tendency analysis of the Sprechenstein Fault Zone (Eastern Alps)

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Describing the architecture of fault zones is a major goal in fault mechanics because their rheological and geometric complexity controls deformation and fluid circulation at depth. The Sprechenstein–Mules fault zone (Eastern Alps) provides an opportunity to study fault rocks and damage distribution as a function of fault geometry and host-rock lithology. For this purpose a 3D geological model of the fault network has been reconstructed from borehole data and a detailed 1:5000 geological map. The model allows fault zone architecture, including fault network geometry and topology, fault rock distribution along the main slip surfaces, and fracturing in damage zones, to be quantitatively evaluated at the km-scale. The study highlights that a first-order influence on the evolution of fault rocks and fracturing in damage zones is exerted by the composition and inherited fabric of protoliths. This results in a marked asymmetry of damage zones when different tectonic units are juxtaposed. Greenschist facies phyllonites, from a wide shear zone, which actually constitutes the ductile precursor to the Sprechenstein-Mules brittle fault, occur at the hanging wall and are characterised by a strong planar fabric, marked by phyllosilicate- and quartz-feldspar-rich layers. Hence, the hanging wall of the Sprechenstein-Mules fault zone is characterised by a strong mechanical anisotropy. We present an improvement of classical slip tendency analysis, including the effect of anisotropy. The analysis shows that, given the mechanical anisotropy and under a realistic palaeo-state of stress, the development of a misoriented and (at least relatively) weak fault zone must be considered not only pos-

sible, but even more probable than the development of Andersonian faults. This is in agreement with field and microstructural observations integrated in the 3D fault zone architecture model.