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Fracture Pattern Variations Across a Seismically Active Fault Zone – A Case Study from the Regional scale Gubbio Fault, Central Italy

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Fault zones, developed within low porosity, low permeability carbonates can be characterized by the anisotropy of fracture density and connectivity along fault-orthogonal and fault-parallel (along strike and up/down dip) directions. Orthogonal to the fault plane different fault zone domains (fault core, damage zone, protolith) can develop. Parallel with the fault plane along strike, the displacement along the fault plane increases from the tip to the centre, and the fault shows more mature characteristics. Parallel with the fault plane along dip as the fault cuts through different types of rocks the lithological control on the damage is shown.

In order to characterize and quantify the distribution of fracture patterns along and across large displacement regional faults in carbonate rocks, we studied the seismically active Gubbio fault (GF), in the Northern Apennines of Italy. The GF has been exhumed from about 3 km depth and displaces the western limb of the east verging Gubbio anticline, where the Jurassic-Oligocene carbonate multilayer is exposed. The 3D geometry of the GF is fully exposed and accessible due to the presence of continuous outcrops along-strike and in several deep gorges, incised across the fault and the anticline.

Field observations show that the fault core contains several, 4-5 m wide domains. Each domain contains fault rocks that are characterized by heavily deformed sc-tectonites and veining. The domains are surrounded by well developed slip surfaces. In comparison, the DZ is more extended. It is over 100 m wide, and contains intense fracturing (many of them are calcite healed) that is decreasing towards the protolith. Smaller (m) scale individual fault zones that are part of the DZ are locally affecting fracture intensity.

Field observations will be integrated with field based quantitative 1D and 2D data of fracture and vein density and connectivity from micro- to large-scale. In particular, 1D data includes fault orthogonal structural transects (mesoscale), and 2D data includes image analysis of outcrop photos (meso- to large-scale), and thin sections (microscale). The results arising from integrated field observations and quantitative datasets will be used to produce a 3D model of fault zone anisotropy and fluid flow.