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Localized deformation and the role of precursory veins in low-temperature carbonates: case studies from the Northern Apennine, Italy.

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Micritic limestones of the Tuscan nappe in the La Spezia zone (Northen Apennine, Italy) contain shear zones, some of which exhibit well-developed calcite mylonites. As these rocks have been deformed at temperatures below 300° C, they provide the opportunity to compare operative deformation mechanisms and localization processes in fine-grained limestone during upper crust carbonate deformation. The analyzed shear zones are found in the Portoro horizon that comprises dark micrite derived from static recrystallization of aragonitic mud alternating with gold-coloured dolomitized and limonite-rich stylolites. Two types of shear zones are analyzed and discussed in this presentation as part of a study combining field, strain, microstructural (optical, cathodoluminescence, transmission electron microscopy) and EBSD fabric observations. Type A shear zones are parallel to stratification and alternate with undeformed zones for intervals of 10-20 cm, and can generate deformed packages up to 80 m thick. The undeformed portions are constituted mostly of saccaroidal dolomite with pre-tectonic veins of calcite or dolomite (associated with stylolites) at a high angle to the stratification. The undeformed matrix comprises a mixture of calcite crystals and microcrystalline dolomite, cut by veins of calcite and dolomite, none of which exhibit any evidence of intracrystalline deformation. Veins deflected within the shear zone enable correlation of the shear strain and corresponding changes in microstructures. Type B shear zones form in association with thick bands of dolomite intercalated with thin Portoro and calcite veins initially at a high angle to the stratification that are progressively deflected into mylonitic layers. The latter are the product of intracrystalline

deformation and dynamic recrystallization that is localized within the pre-tectonic veins with original equant-grained micrite and mylonite being virtually indiscernible except by crystal-fabric and defect characterization. For each of these shear zones, localization is controlled by existing heterogeneities in the units. In Type A, bedding-parallel compositional variations are the primary factor, while in Type B, localization is controlled by deformation-induced brittle precursory, seen as calcite veins. In the latter case, the calcite veins are essential for the initiation and concentration of intracrystalline (dislocation-mediated) deformation processes.