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Scaling properties within S-C deformation bands. The case of the Monti Sibillini thrust (Central Apennines)

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Along the Monti Sibillini Thrust, in the Umbria-Marche sector of the Northern Apennines (Italy), the pelagic, Late Eocene-Oligocene, carbonates of the Scaglia Cinerea Formation are underthrusted to the late Cretaceous-Middle Eocene Scaglia Rossa Formation. With a detailed meso-structural study of the footwall we were able to determine how the mechanism of deformation is fundamentally cyclical both in the nature of shear processes, and in the evolution of the structural regime. Particular attention has been dedicated to the fluids: to their role during thrusting and to their relationship with pressure-solution and shear veins formation. The meso-structural study has been carried out through 20 structural stations covering more than 90% of the whole stratigraphic thickness of the Scaglia Cinerea Formation. The features characterizing the underthrust unit of the Monti Sibillini Thrust are S-C deformation bands, similar to those described by Lister & Snoke (1984), but here S-surfaces are alternatively shear veins and pressure solution surfaces, and C-surfaces are always shear veins. The spacing of S and C surfaces is directly connected with the distance of the main thrust surface, with the more closely spaced being closer to the thrust than the larger. The intersection between S and C typically isolates rock blocks (lithons) with sigmoidal shape in section. Although the dimension of these sigmoidal lithons is connected with the distance of the thrust, the ratio between the two principal axes remains constant. In cross section, the ratio between length and thickness is constant for lithons of dimensions from one-meter to few centimeters, whilst for smaller dimensions the aspect ratio is not maintained any longer. The scale-invariance or self-similarity within a specific scale range is typical of several non deterministic phenomena commonly referred to as fractals. The constant aspect ratio during deformation is a self-similar process that has been observed in several fault rocks ruled by fractal lows. Thus, through the study of the lithons dimensions and the characteristic spacing of the S and C surfaces, we

have been hypothesized the presence of a fractal law for the deformation. The collected data allowed the interpretation of the temporal and spatial relationship among the observed deformation structures (S-C deformation bands, shear veins and stylolites) that brought to develop a dynamic model for the deformation. The proposed model explains the observed features through cycles of alternating fluid pressure build up, bringing to hydrofracturing, and consecutive collapse, producing pressure-solution and stylolithization, similar to a fault valve behavior (Sibson, 1990).

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