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The role of pressure solution in the evolving fracture stratigraphy properties of Mesozoic platform carbonates

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The study carbonates are exposed in the axial zone of the southern Apennines ftb, Italy. These rocks form a natural laboratory to investigate the time-dependent variation of primary heterogeneities and both dimensional properties and distribution of high-angle joints, veins, and shear fractures. We integrate field-based stratigraphic and structural analyses of the platform carbonates with both petrographic and microstructural investigations of selected specimens to unravel their depositional setting and diagenetic evolution. Furthermore, we focused on the modalities of pressure solution-assisted deformation of bed interfaces and single beds to investigate their possible control on the geometry, distribution, and relative timing of the high-angle fractures. The platform carbonate succession includes a Pliensbachian in age, well-layered, lagoonal carbonate unit including both mud-and grain-supported limestone beds, and a Toarcian in age oolithic carbonate unit. Our results showed that pressure solution mainly localized within bed-parallel interfaces and within the grain-supported limestone beds. During early-to-burial diagenesis, precipitation of calcite rims and blocky calcite cements predominantly occurred in the latter beds, in which ghosts of meniscus cements associated to the earliest diagenetic stages are documented. The fracture intensity (P10) computed for the earliest high-angle fracture set shows the highest values in correspondence of the grain-supported beds. During the Oligo-Miocene Apennine orogeny, the mechanical layering of the carbonates evolved due to flexural slip of the layered carbonates, and formation of intra-carbonates thrust faults with flat-ramp-flat geometries were documented. Specifically, there formed s-c-c' tectonites along the primary interfaces juxtaposing the single bed packages, and oblique-to-bedding reverse faults offsetting the single beds developed due to pressure-solution assisted deformation.The Plio-Quaternary transtension dissected the platform carbonates, and caused both their uplift and exhumation from shallow crustal depths. By computing the fracture density (P20) and intensity (P21) associated to transtension, the highest values were calculated within the coarser grained carbonate beds. Independently from their thickness, these carbonate beds are the most fractured ones in the study succession. These results hence showed that the platform carbonates acquired the mechanical properties during early-to-burial diagenesis, that later permitted strain clustering within the stiffer, grains-supported beds. We invoke that chemical/physical compaction and diffuse cementation of these carbonate beds were responsible for the Plio-Quaternary fracture distribution throughout the platform carbonates. Moreover, we also documented similar P20 and P21 variations, which are consistent with the profound control exerted by primary mechanical interfaces on vertical growth of transtensional fractures. Indeed, we interpreted the similar P20 and P21 variations as a result of shear stress localization along per-existing, stratabound fractures, which ruptured these interfaces forming small-scale process zones (high P20 values) at their extensional quadrants (high P21 values). Ongoing petrophysical analysis will shed lights on the dimension, distribution, and overall connectivity of the pore system aiming at assessing the overall control exerted by bed-parallel stylolites and pressure solution seams on the efficiency of the mechanical interfaces abutting the stratabound transional fractures.

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