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Paleo-fluid flow in folded, poorly lithified Quaternary sediments revealed by diagenetic concretions developed during the growth of Quattro Castella Anticline (Northern Apennines, Italy)

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Diagenetic concretions and mineral masses may provide a useful tool to better understand paleo-fluid flows in transforming porous media. Moreover, the selective cementation responsible of diagenetic alterations formation, plays a key role in diminishing sediments porosity and permeability and hence reservoir quality. In compressive settings of a fold-and-thrust-belt, the presence of deep or blind thrusts could lead to the generation of folds which may influence syn-kinematic sedimentation, deep fluids migration and shallow fluid flow pattern. In this contribution we present a multidisciplinary field and laboratory study on carbonate concretions developed in Quaternary poorly lithified, shallow marine syn-kinematic sediments of the Quattro Castella Anticline in Northern Apennines (Italy). The study site is located along the Enza River, where shallow marine to continental sediments are exposed along the forelimb of the fold nucleated during Late Miocene and still active today. Field mapping was aimed to link bedding attitude of syn-kinematic sediments with the geometry, arrangement, shape and size of concretionary bodies. The studied concretions are both tabular (i.e. parallel to sediment bedding) and elongate single or coalescent concretionary bodies (i.e. plunging at different angle to bedding dip throughout the stratigraphic section). Concretions dimensions range from a few centimeters in single elongate concretions, up to a few meters in tabular and coalescent ones. In situ permeability measurements and laboratory grain size analyses were performed along the studied section to constrain the petrophysical properties of sediments hosting carbonate concretions. Carbon and oxygen stable isotopes analyses on carbonate concretions (performed both on hand specimens and also on thin sections), together with petrographic and cathodoluminescence observations, were used to better constrain the diagenetic environment in which calcite precipitation occurred. Our results indicate that the growing anticline promoted the development of a local topographic and hydraulic gradient which induced cement precipitation in the form of carbonate concretions in syn-kinematic sediments. Such diagenetic alterations can be a good marker to reconstruct the paleo-fluid flow history in structurally complex siliciclastic reservoirs.