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The role of tectonic settings and inherited structures on the localization of low-permeability deformation bands in porous sandstone (Provence, FRANCE)

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Faults and cataclastic deformation bands can strongly affect the petrophysical properties of porous sandstones. These structures can control fluid flow in reservoir settings and can therefore influence the location and the formation of ore bodies. Deformation band organization and distribution, their control on fluid flow, and the mechanical reasons for their formation remain misunderstood, especially at the basin scale. The distribution, the microstructure, and the permeability of band networks have been analyzed with respect to contractional and extensional tectonic settings in the porous Cretaceous sandstones of Provence (South-East Basin, France).

Different types of conjugate networks of deformation bands are identified in the entire area:
(1) distributed networks of Shear-Enhanced Compaction Bands (SECB), showing crush microbreccia and permeability reduction less than 1 order of magnitude;
(2) distributed or localized networks of Compactional Shear Bands (CSB), showing protocataclastic microstructures and permeability reduction ranging from 1 to 3 orders of magnitude;
(3) localized networks of Shear Bands showing protocataclastic to ultracataclastic microstructures and permeability reduction ranging from 1 to 5 orders of magnitude.

Reverse-sense shear-band networks, showing low-permeability, are only observed around the Roquemaure thrust and are kinematically consistent with this inherited basement fault. This severely contrasts with the pervasive distribution of SECBs and CSBs, showing greater permeability, which are observed as distributed band networks within the sedimentary-cover fold limbs of the foreland, North to the Roquemaure thrust.
Normal-sense shear bands are organized in conjugate networks, isolated or localized as dense band clusters, sometimes adjacent to normal fault zones. Small cataclastic fault zones are observed as restricted to sandstone unit, suggesting that shear strain localization can be initiated within the sandstone layers in extensional setting, without any influence of inherited structures as observed in contractional setting.

This analysis underlines the major role of tectonic settings and inherited structures on the localization of low-permeability deformation bands in porous sandstone reservoirs. This is especially the case in contractional setting where no faults initiated in sandstone unit are observed, and low-permeability deformation bands are only observed around large scale thrust.