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Fluid systems and fracture development during syn-depositional fold growth: example from the Pico del Aguilla anticline, Sierras Exteriores, Southern Pyrenees, Spain.

Nicolas Beaudoin (1,2,3), Damien Huyghe (4), Nicolas Bellahsen (2,3), Olivier Lacombe (2,3), Laurent Emmanuel (2,3), Frédéric Mouthereau (2,3), Laure Ouanhon (2,3)

(1) University of Glasgow, School of Geographical and Earth Sciences, Glasgow, United Kingdom (nicolas.beaudoin@glasgow.ac.uk), (2) UPMC Univ Paris 06, UMR 7193, ISTEP, F-75005, Paris, France, (3) CNRS, UMR 7193, F-75005, Paris, France, (4) UMR CNRS TOTAL 5150 "Laboratoire des Fluides Complexes et leurs Réservoirs", Université de Pau et des Pays de l'Adour, I.P.R.A. Avenue de l'Université BP 1155, 64013 PAU Cedex, France

This study presents a reconstruction of fold-fracture-fluid evolution at the Pico del Aguila Anticline, located on the southwestern front of the Jaca piggy-back basin, Southern Pyrenees, Spain.
The kinematic evolution of the Pico del Aguila anticline is related to the successive development of N-S ramps and reactivation of E-W striking basement thrusts that occurred coevally with sedimentation in the foreland basin. Consequently, this anticline offers an ideal frame to assess the evolution of the fluid system during the syn-depositional deformation at the front of a fold-thrust belt.
Eight fracture sets (joints or faults) observed at fold-scale compose the fracture sequence defined by field and micro-scale chronological relationships. This fracture sequence reflects the Middle Eocene to Early Oligocene tectonic events and the progressive rotation of some fracture sets from NE-SW to E-W witnesses the clockwise rotation that occurred during folding.
∂18O and ∂13C values from vein cements suggest a fluid system buffered by host rocks in most cases. Fluid inclusion microthermometry measurements indicate a fluid entrapment temperature <50°C, supporting that the fluid system reflects strata burial during the main part of strata history. Small-scale vertical migrations from reservoir to reservoir are triggered by fractures related to strata-curvature, both during foreland flexure/forebulge and fold development. After folding, fractures developing in shallow sub-continental to continental strata triggered downward migration of surficial fluids, likely of meteoric origin. This phenomenon is poorly developed in early marine deposits but strongly influenced the fluid system recorded in the late continental deposits. The case study of the Pico del Aguila supports recent finding that fold-fluid systems seem to exhibit a common behavior during folding, with development of curvature-related joints triggering vertical migration of fluids from a reservoir to another. It also illustrates that this behavior may be inhibited in case of a short timespan between sediment deposition and fracture development.