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Understanding complex structures in fold-and-thrust belts. Integration of geometric and growth strata analyses, paleomagnetism, AMS and analogue models in the Western termination of the Southern Pyrenees

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Classic 2D approaches have helped the understanding of the geometry and kinematics of fold-and-thrust belts belts (FAT belts) but are insufficient to unravel many natural cases. This is because deformation is 3D from the geometric point of view and, thus, cylindrical features may be considered as a simplification. On the other hand, deformation kinematics is usually complex, diachronic and poliphasic in real cases. Therefore, FAT belts have to be always considered in 4D. In this sense, the Southern Pyrenees is a perfect location to study the evolution of FAT belts because of the exceptional outcropping conditions of growth strata, the proven diachronic kinematics and the non-coaxial interference of deformation events. Within the vast catalogue of complex structures that includes superposed folding, conical and plunging folds, oblique thrust ramps, etc here, we have selected the westernmost termination of the South Pyrenean sole thrust to illustrate how the integration of geometric and kinematic analysis can help unraveling complex structures in FAT belts.

The San Marzal pericline (4 km2 surface extension) is the lateral termination of the Sto. Domingo deca-kilometric fold. San Marzal looks like a large 70° plunging cylindrical structure. However the large magnitude ($\approx$ 60-70°) of vertical axis rotations accommodated between its flanks cannot be explained without a conical geometry. In this work we will show how the structural analysis performed on this structure has disentangled its complex geometry. This analyses comprises several hundreds of bedding data, joints and veins and more than 150 standard paleomagnetic and AMS sites. Besides, we will show how the kinematic information derived from magnetostratigraphic sections (more than 8 km of sampled profiles) has helped to constraint the folding and rotation ages and velocities. Finally, all these complex geometric and kinematic features have inspired us to build an analogue model where we can explore the 3D distribution of strain ellipsoids.