Geophysical Research Abstracts
Vol. 13, EGU2011-437, 2011
EGU General Assembly 2011

Role of mesostructural inheritances in inversion-related fracturing. Example form the Mataporquera Anticline, Western Pyrenees (Spain).

Eloi Carola, Anna Quintà, Stefano Tavani, and Josep Anton Muñoz
Barcelona University, Geodynamics and Geophysics, Barcelona, Spain (e.carola@ub.edu)

Since the pioneering work of Stearns (1968), several studies have focused on the description and interpretation of fracture patterns in reservoir-scale thrust-related anticlines (e.g. Srivastava and Engelder, 1990; Cooper, 1992; Lemiszki et al. 1994; Tavani et al., 2006; Savage et al., In press). It is widely recognised that, during thrust-related folding, fractures development results from the interplay of different factors, including the mechanical stratigraphy (e.g. Corbett et al., 1987, Woodward and Rutherford, 1989; Gross, 1995; Couzens and Wiltschko, 1996; Fischer and Jackson, 1999; Tavani et al., 2008), the environmental conditions (e.g. Chester et al., 1991; Jamison, 1992; Lemiszki et al., 1994), and the folding process (e.g. Thorbjornsen and Dunne, 1997; Tavani et al., 2006). More recently, many works have also documented how previously developed mesostructures exert a strong control on fracturing (e.g. Silliphant et al., 2002; Bergbauer and Pollard, 2004; Bellahsen et al.,2006; Lash and Engelder, 2009). Investigating the role that mesostructural inheritances exert on fracture development is particularly important in inversion-related anticlines, were the widespread presence of sin-extensional mesostructures can strongly influence the sin-inversion fracturing.

In this work we present data from the Mataporquera Anticline (Western Pyrenees, Spain). This WNW-ESE striking and ESE plunging anticline formed during the Cenozoic, when previously developed, mostly Early Cretaceous, extensional structures were reworked. Seismic cross-sections across the structure allow to constrain both Mesozoic and Cenozoic evolution of the shallower portion of the anticline. On the other hand, the same cross-sections indicate that the tectonic style was fully thick-skinned, during both Mesozoic and Cenozoic.

The mesostructural pattern observed in the Mataporquera Anticline includes extensional faults, joints and veins striking parallel and perpendicular to the Lower Cretaceous extensional master faults (ENE-WSW). These structures have been tilted together with beds during folding and are interpreted as sin-extensional (i.e. Mesozoic). Both faults and joints have been, at places, re-worked as faults. This reworking was accompanied by the development of other structures (E-W striking pressure solution cleavages and N-S striking extensional structures) allowing to infer a Cenozoic stress field consistent with the reworking of the sin-extensional structures.

Cenozoic mesostructures are mostly observed in areas poorly affected by Mesozoic extensional deformation and in the vicinity of major re-worked map-scale faults. On the other hand, in other sites, the inversion is testified only by the reworking of previously developed mesostructures. These observations allow us to conclude that, in the Mataporquera Anticline, the network of sin-extensional Mesozoic discontinuities inhibited the development of sin-inversion mesostructures.

References

Bellahsen, N., Fiore, P., Pollard, D.D., 2006. The role of fractures in the structural interpretation of Sheep Mountain Anticline, Wyoming, Journal of Structural Geology, v.28, p. 850-867. doi: 10.1016/j.jsg.2006.01.013

Bergbauer, S., Pollard, D.D. 2004. A new conceptual fold-fracture model including prefolding joints, based on the Emigrant Gap Anticline, Wyoming, Geological Society of America Bulletin, v.116, no. 3-4 p. 294-307. doi: 10.1130/B25225.1

Chester, J.S., Logan, J.M., Spang, J.H., 1991. Influence of layering and boundary conditions on fault-bend and fault-propagation folding. Geological Society of America Bulletin, v. 103, p. 1059–1072. doi: 10.1130/0016-7606(1991)103<4059:IOLABC>2.3.CO;2.

Cooper, M., 1992. The analysis of fracture systems in subsurface thrust structures from the foothills of the Canadian Rockies. In: McClay, K.R., Editor, 1992. Thrust Tectonics, Chapman and Hall, London, p. 391–405.

Corbett, K., Friedman, M., Spang, J., 1987. Fracture development and mechanical stratigraphy of Austin Chalk, Texas. American Association of Petroleum Geologists Bulletin, 71-1, p. 17-28. doi: 10.1306/94886D35-1704-11D7-8645000102C1865D

Couzens, B.A., Wiltschko, D.V., 1996. The control of mechanical stratigraphy on the formation of triangle zones. Bulletin of Canadian Petroleum Geologists, v. 44, no. 2, p. 165-179.

Fischer, M.P., Jackson, P.B., 1999. Stratigraphic controls on deformation patterns in fault-related folds: a detachment fold example from the Sierra Madre Oriental, northeast Mexico. Journal of Structural Geology, v. 21, p. 613-633. doi:10.1016/S0191-8141(99)00044-9

Gross, M.R., 1995. Fracture partitioning: failure mode as a function of lithology in the Monterey Formation of coastal California. Geological Society of America Bulletin, v. 107, no. 7. p. 779-792. doi: 10.1130/0016-7606(1995)107<0779:FPFMAA>2.3.CO;2.

Jamison, W.R., 1992. Stress controls of fold thrust style. In: McClay, K.R., Editor, , 1992. Thrust Tectonics, Chapman and Hall, London, p. 155-164.

Lash, G.G., Engelder, T., 2009. Tracking the burial and tectonic history of Devonian shale of the Appalachian Basin by analysis of joint intersection style. Geological Society of America Bulletin, v. 121, no. 1-2, p. 265-277. doi: 10.1130/B26287.1.

Lemiszki, P.J., Landes, J.D., Hatcher Jr., R.D., 1994. Controls on hinge-parallel extension fracturing in single-layer tangential-longitudinal strain folds. Journal of Geophysical Research, v. 99, no. B11, p. 22,027–22,041. doi:10.1029/94JB01853

Savage,H.M., Shackleton, J.R., Cooke, M.L., Riedel, J.J., In press. Insights into fold growth using fold-related joint patterns and mechanical stratigraphy, Journal of Structural Geology

Silliphant, L.J., Engelder, T., Gross, M.R., 2002. The state of stress in the limb of the Split Mountain anticline, Utah: constraints placed by transacted joints. Journal of Structural Geology, v. 24, p.155-172.

Srivastava, D.C., Engelder, T., 1990. Crack-propagation sequence and porefluid conditions during fault-bend folding in the Appalachian Valley and Ridge, central Pennsylvania. Geological Society of America Bulletin, v.102, no. 1, p. 116-128. doi: 10.1130/0016-7606(1990)102<0116:CPSAPF>2.3.CO;2

Stearns, D.W., 1968. Certain aspects of fracture in naturally deformed rocks. In: Rieker, R.E., Editor, , 1968. National Science Foundation advanced science seminar in rock mechanics. Special report, Air Force Cambridge Research Laboratories, Bedford, Massachusetts, AD66993751, p. 97–118.

Tavani, S., Storti, F., Fernández, O., Muñoz, J.A., Salvini, F., 2006. 3-D deformation pattern analysis and evolution of the Añisclo anticline, southern Pyrenees. Journal of Structural Geology, v. 28, p. 695-712. doi:10.1016/j.jsg.2006.01.009

Tavani S., Storti F., Salvini F., Toscano C., 2008. Stratigraphic versus structural control on the deformation pattern associated with the evolution of the Mt. Catria anticline, Italy. Journal of Structural Geology, v. 30, p. 664-681. doi:10.1016/j.jsg.2008.01.011

Thorbjornsen, K.L., Dunne, W.M., 1997. Origin of a thrust-related fold: geometric vs kinematic tests. Journal of Structural Geology, v. 19, p. 303-319. doi:10.1016/S0191-8141(96)00090-9.

Woodward, N.B., Rutherford Jr., E., 1989. Structural lithic units in external orogenic zones. Tectonophysics, v.158, p. 247-258. doi:10.1016/0040-1951(89)90327-2.