Geophysical Research Abstracts
Vol. 13, EGU2011-3993, 2011
EGU General Assembly 2011

Cenozoic flexure of the Iberia plate and foreland basin subsidence of the Hecho Group in the Western Pyrenees (Spain): constraints from burial and thermal evolution of pre- and syn-orogenic sequences by means of fluid inclusions, vitrinite reflectance, XRD on clay minerals and apatite fission tracks

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The burial history of foreland basins for oil exploration is generally well constrained by means of the classical approach to basin analysis based on thermal modelling of the sedimentary basin fill. Nevertheless, kinematics and burial vs. exhumation paths of the couple made up of the peripheral bulge and the foreland basin in an orogenic system are less widely investigated starting from the thermal state of pre- and syn-orogenic sedimentary sequences through time.
We investigated these kinds of sequences marking the Cenozoic flexure of the Iberia plate that are presently involved into the sedimentary portion of the Western Pyrenees fold-and-thrust belt in the Sierras Interiores (Spain) in order to define:
• the maximum depth at which the extensional deformation of the flexuring plate developed;
• the maximum burial experienced by rocks presently cropping out in the fold-and-thrust belt after their deformation during the peripheral bulge and foredeep stages;
• the exhumation paths of the sedimentary fold-and-thrust belt to the south of the western Pyrenees Axial Zone.

We integrated various paleo-thermal indicators from pre- and syn-orogenic sequences to define:
• maximum burial amounts and paleo-temperatures by means of vitrinite reflectance on terrestrial organic matter and XRD data on clay mineral assemblages;
• timing of exhumation using apatite fission tracks;
• trapping temperature of fluids by means of petrographic and micro-thermometric study of extensional vein systems coeval with flexure and with main sedimentary/tectonic burial due to foredeep subsidence and thrusting.

The comparison among such indicators mainly evidences that the upper portion of the pre-orogenic sequence (Alveolina Marls, Paleocene in age) was deformed by one conjugate system of normal faults and two related sets of extensional veins where calcite vein filling records trapping temperatures of primary fluid inclusions never exceeding 70°C. They are dramatically lower than maximum paleo-temperatures (up to about 170°C) experienced by younger syn-orogenic deposits (Hecho Group) and older pre-orogenic units (Marborè Fm, Maastrichtian in age) where field evidences of extension due to flexure are not preserved. Thus, through basin modelling, fluid inclusion constraints allowed to record the maximum depths of extensional deformation that affected the peripheral bulge; whereas vitrinite reflectance, XRD on clay minerals assemblages and apatite fission tracks allowed to define the amount of subsequent sedimentary and/or tectonic burial and exhumation. In synthesis the distribution of paleo-thermal and structural features throughout the sedimentary succession cropping out in the Sierras Interiores has provided the quantitative contribution to speculate on the geometry, kinematics and dynamics of the Iberian Plate flexure in Cenozoic times.