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Structural style and deformation patterns in folded carbonate platform units: the case study of Pag anticline, External Dinarides, Croatia

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Field-based structural analysis coupled with microstructural and petrographic observations could provide a spatial and temporal information for understanding both the geometric and cross-cutting relationships and kinematic evolution in folded carbonate unit. Here, we describe the preliminary results of a structural study carried out in the Island of Pag, External Dinarides (Croatia).

The External Dinarides are a NW-SE striking fold and thrust belt developed during the Paleogene to Miocene and consist of a series of imbricate thrust sheets of folded carbonate rocks, with general SW vergence, that controlled the syntectonic sedimentation in wedge-top basin. The deformation style of the belt is characterized by thrust-propagation folds, associated with both in-sequence and out-of-sequence thrusting (Tari, 2002). The Pag anticline involves about one km of Cenomanian to Senonian, well layered rudist-bearing platform carbonates, overlayed by 250 m of early Lutetian to Priabonian Nummulitic limestones. This anticline represents a good field analogue for Upper Cretaceous folded and faulted tight-carbonate reservoirs.

The Pag anticline extends for about 30 km along-axis. In cross section, it shows an asymmetrical “box-type” geometry, with high angle to overturned limbs and a wide, flat hinge zone. The fold is crosscut by minor thrusts and backthrusts, and by two main sets of sub-vertical strike-slip faults oriented N-S and E-W.

The forelimb is very continuous along strike, and is characterized by beds dipping 60-70° SW in the northern sector of the island, passing gradually to vertical and overturned beds towards the southern sector. In contrast, the backlimb shows a higher structural complexity. In the northern sector, the gently NE-dipping hinge zone is thrusted over the NE limb through a low angle backthrust dipping to the N associated with a kilometre-scale footwall syncline. The deformation in the footwall of the backthrust is accommodated by minor footwall splays. In the central part of the fold, where the lowermost structural level crops out, the deformation is expressed by the development of a hectometric triangle zone, and the transition from the backlimb to the hinge zone consists of a wide deformation zone characterize by indentation and thrust passive-roofing with associated limb rotation.

At meso- to micro-scale, the fold- and fault-related deformation patterns consist of a complex array of veins and stylolites, that occur both prior and during fold and fault development. Petrographic and microstructural observations helped to unravel the timing and cross-cutting relationships between such deformational elements formed during different tectonics events.

The structural style and deformational pattern documented in this study can be explained with a progressive tightening of the fold; therefore, we suggest that in well-layered carbonates, in absence of weak mechanical interlayers, bedding-parallel shear is mainly accommodated by development of minor thrusts and backthrusts, diffuse veining and pressure-solution cleavage development. This structural complexity, which might be overseen in seismics, might be very common in buried hydrocarbon reservoirs in folded platform carbonates.

Cited references

Tari, V. 2002. Evolution of the northern and western Dinarides: a tectonostratigraphic approach. EGU Stephan Mueller Special Publication Series, 1, 223–236, 2002