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Interaction between deformation and sediment routing systems in active fold and thrust belts: an investigation in the Marche Apennines

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One of the most interesting and unexplained features seen in several active fold-thrust belts and well recognized in the northern Apennines (especially in the Marche region) is the presence of a transverse drainage network (discordant to the structures) in which some rivers cut the anticlines at the axial culminations, causing incision of very deep gorges. We are currently investigating how such features arise. Previous studies in the Umbria-Marche region have pointed to the difficulty in explaining the drainage network by antecedence because the folds were thought to have grown below sea level, which was thought to have regressed from the region only in the late Pleistocene (Mazzanti & Trevisan, 1978; Alvarez, 1999). Moreover, there is no evidence to suggest that the transverse drainage network could have developed by superposition onto pre-existing structures. In addition, a simple model of antecedence or superposition (Oberlander, 1985) cannot explain why the rivers cut through the structural culmination.

The Marche region of the northern Apennines is characterized by deformed, pretectonic carbonate-dominated, Jurassic-Palaeogene stratigraphy, which crops out in the main mountain ridges. In the surrounding areas these carbonates are covered by syn-tectonic siliciclastic and evaporitic wedges filling foredeep and satellite basins,

the ages of which range from late Miocene (late Tortonian-early Messinian), in the innermost part, from Pliocene to Pleistocene-Quaternary in the outermost part and the present day foredeep is in the Adriatic Sea.

Our preliminary studies have shown the potential importance of the pre-tectonic palaeogeography, which has influenced the actual drainage network geometry, and its relationship with the deforming area. The area has been divided in inner and outer side and the Fossombrone-Cesana-Frasassi (FCF) thrust front represents the divide. In the inner side of the chain it was possible to recognize two large erosional unconformities, one between the Serravallian/Tortonian pelagic sediments (Schlier Formation) and the Upper Messinian prodeltaic sandstones (Colombacci Formation) cutting the Lower Messinian evaporites (Gessoso Solfifera Formation) and a second in the Upper Messinian and Lower Pliocene related to a major transgression. The importance of this observation is that the two unconformities indicate a period of emersion and subsequent transgression. The drainage network probably formed largely during this time. In the outer side, in the Esino river basin and the associated Frasassi gorge, in sequence Upper Messinian (Colombacci Formation) and Lower Pliocene sandstones were recognized. The deposits represent a prograding delta system produced by a palaeoriver (the PalaeoEsino). The importance of this observation is that the prograding system has typical delta geometry and it coincides with the modern Esino River that hasn't changed position during the orogenic evolution. One explanation could be that the river incision was already active during the Upper Messinian/Lower Pliocene contemporaneous with the deformation, at least within and Eastward of the FCF. One possible period for emersion and erosion could be the Messinian crisis. In this case the Esino palaeochannel would have been covered in the Upper Messinian/Lower Pliocene marine transgression. Eventually the river valley was completely filled with marine sediments. During the latest emersion corresponding to the present day sea level, subaerial erosion has taken place again and the new river has reincised the old river valley taking advantage of the easily erodable marly-clay sediments. Evidences for this evolutionary scheme can be observed from seismic lines and boreholes. Three main structures are recognized and analyzed in the seismic lines. They are deformed in three time steps and their evolution indicates a clear and in both cases different relation between the deformation-uplift and the transgressive-regressive system.

We hypothesize that during the subaerial period the early drainage network may have carved channels and gorges into the actively growing folds determining the observed relationships between transverse rivers and axial culminations that may be the result of the local amplification of fold structures caused by river erosion (Simpson, 2004).

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