History of subsidence and deformation of the Northern Apennine foredeep (Neogene to Recent)

V. PICOTTI[1], G. BERTOTTI[2], M. BELLO[3], R. FANTONI[3], M. GARIONI[3] & S. MOSCONI

[1]*Dipartimento di Scienze della Terra e Geologico-Ambientali, 67 40127 Bologna, Italy*
[2]*Faculteit der Aardwetenschappen, Vrije Universiteit, HV1081 Amsterdam, Netherlands*
[3]*ENI-AGIP S.p.A., S.Donato M.se (Mi)*

In the frame of a joint research on the tectonics and sedimentation of the Adriatic foredeeps (TAF), involving ENI-AGIP, Amsterdam and Bologna Earth Sciences Institutes, we analyzed the evolution of the Northern Apennines foredeep by constructing four cross sections, spanning from the external foreland till the relief. The cross sections are located both in the Padan (western and central Emilia) and the Adriatic (northern and southern Marche) foredeeps. They have been constructed by depth conversion of seismic lines, calibrated by means of several exploration wells. Field work on the relief belt provided essential constraints. The results allow an accurate estimate on the subsidence history, the geometry and kinematics of the thrust arrays affecting the foredeep, and the modes and timing of exhumation and relief formation.

The structural style of the belt strongly depends on the pre-thrust subsidence history. The different flexural behaviour of the foredeep produced thickness variations along-strike of the clastic foredeep infill. Because of the absence of an Apennine relief during Miocene and lower Pliocene, the provenance of the turbidites was essentially from the Alps, located to the North. The sedimentation, however, could not keep the pace with the subsidence, therefore deep palaeobathymetries were creating. The palaeobathymetry controlled the emplacement of the Ligurian nappe, an up to 6 km thick remnant of the Cretaceous–Paleogene accretionary wedge. The strict control over advancement and thickness of the Ligurian nappe operated by palaeobathymetry-subsidence patterns points out the relevant role of gravity in the Neogene motion of this thick submarine slide.

After lower Pliocene, the Ligurian nappe stopped and an embryonic relief was emerging, driven by the activity of newly created normal faults. The growth of the relief was accompanied by ending of thrust activity, increasing sedimentation rates and changing subsidence patterns, producing the final infilling of the foredeep. Along the external Apennine belt, these processes acted in a diachronous way, ranging from the Pliocene to the NW to the Middle Pleistocene in the central and southeastern sectors. Also the shape and spacing of the thrusts is strongly related to the thickness of the foredeep deposits: the thicker the clastic interval, the wider the spacing between thrust ramps. Moreover, it has been observed that erosion of the thrust top occurred on ramp anticlines located on thicker clastic foredeep successions, in contrast to thinner intervals showing top-thrust deposition.

The Plio–Pleistocene shortening increases along strike from about 5 km in the northern cross section (North verging) up to 30 km in the southern part of the belt (Northeast verging). This shortening difference can represent the amount of the Plio–Pleistocene bending of the Northern Apennines belt. The remnant arc shape of the Northern Apennines should have been acquired during Miocene, possibly due to the same differential shortening.

Late Jurassic to Early Miocene tectonic evolution of the Polish Outer Carpathians – possible influence on development of the peri-Tethyan Polish Basin

P. POPRAWA[1] & T. MALATA[2]

[1]*Polish Geological Institute, Warsaw, Poland, ppop@pgi.waw.pl*
[2]*Polish Geological Institute, Cracow, Poland*

The Outer Carpathians in Poland are divided into Magura, Dukla, Silesian, Subsilesian and Skole thrust units, derived from separate basins/subbasins. Their Tithonian to Lower Miocene basin-fill was detached from a basement, folded and thrusted over the European Platform. During Jurassic and Cretaceous further to the north, i.e., in the peri-Tethyan realm, sedimentary basins were developing (e.g. Polish Basin), of which tectonic interrelation with the northern Tethyan realm is a matter of dispute.

In the present study tectonic process governing development of the Outer Carpathians basins were examined by means of subsidence analysis. This was proceeded by backstripping of reconstructed, synthetic sections. The Outer Carpathians sedimentary basins are regarded as a deep marine ones; for this reason assumed paleobathymetry has relatively strong influence on backstripping results. Uncertainties in paleobathymetry results with widening of error bars of the analysis. Rough reconstruction of activity of source area ("cryptic ridges") of the Outer Carpathians basin's was conducted by means of deposition rate analysis. For the Polish Basin (Late Jurassic, Cretaceous and Lower Paleocene) and Polish Lowlands (Upper Paleocene-Miocene) subsidence rate maps were constructed with the accuracy of stages. This allowed for characterisation of main tectonic processes governing evolution of this part of the peri-Tethyan realm.

The results of backstripping show similarities in a general pattern of subsidence history of the Outer Carpathians sedimentary basins. For the late-most Jurassic (Tithonian) to Early Cretaceous decreasing subsidence rates and decreasing deposition rates are characteristic. This is suggestive for post-rift thermal sag stage of the basins development. The syn-rift basin-fill is not preserved due to detachment. Nevertheless, characteristic shape of depocentres of the peri-Tethyan Polish Basin indicates presence of Oxfordian rift event in the northern Tethyan realm, thus possibly also in the Outer Carpathians basins. During upper Cretaceous (Turonian-Maastrichtian) and Paleocene minor uplift (several hundreds meters at most) took place over Skole, Subsilesian, Silesian and Dukla sub-basins. This was coeval in time with increase in deposition rates, indicating that source areas were uplifted as well. During the upper part of late Cretaceous to Paleocene tectonic inversion/uplift of the peri-Tethyan basins also took place, including Polish Basin. Evolution of the Polish Basin's depocentres during late Cretaceous reveals large scale gentle folding of a foreland crust. This observations together indicate regional change in tectonic regime into compressional one, possibly resulted from Inner Carpathians collision. Therefore this phenomena are regarded here as a part of Alpine-Inner Carpathians foreland inversion.

During early Paleogene subsidence was re-established, accompanied by decrease in deposition rates. Since late Eocene rapid uplift of a big amplitude (several hundreds metres at least) begun, which prolonged until early Oligocene. This is contemporaneous with one of the main collision phases of the Alpine belt. The uplift was followed by minor subsidence event (Oligocene--Early Miocene), the last in the basins development. The Eocene–Miocene stage of the Outer Carpathians basins evolution was coeval in time with prominent increase in deposition rates. The onset of rapid deposition migrated systematically in time from the inner zone (southern part of Magura subbasin – Early Eocene) towards outer zone of the belt (northern part of Skole and Silesian subbasins – Late Oligocene), suggestive for syn-orogenic phase of the basins development. The late Eocene–early Oligocene uplift is interpreted here as a result of rapidly increasing compressional stress, predating shift of zone of shortening to the north. This event had a limited effect on development of the peri-Tethyan realm. Axis of the subtle depocentres on the Polish Lowlands changed from NW–SE (Eocene) into E–W (Oligocene). The minor late Oligocene-early Miocene subsidence is interpreted to be a result of stress relaxation after relocation of main detachment surfaces.

Comparative analysis of the northern Tethyan and peri-Tethyan realms development confirms concept of evolution from "pure shear" into " simple shear" collision style (Ziegler et al., 1995).

Ziegler P.A., Cloetingh S., van Wees J-D. (1995): Dynamics of intra-plate compressional deformations: the Alpine foreland and other examples. Tectonophysics 252, 7–59