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3D decompaction and sequential restoration: a tool to quantify sedimentary and tectonic control on elusive Quaternary structures

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Basin-wide detailed 3D model, deeply constrained by the interpretation of an impressive dense seismic dataset (12.000 km, provided confidentially by ENI S.p.A.) and 136 well stratigraphies, is the core of a workflow of decompaction and sequential restoration in 3D aimed to quantify the sedimentation and uplift rate in the central part of the Po Plain (northern Italy), during Quaternary.
The Po basin is the common foredeep of two opposite verging chains, the Southern Alps, to the north, and the Northern Apennines, to the south, that influenced the evolution of the foreland basin from Paleogene onward. In this particular setting there are many examples of interaction of sedimentary processes and tectonics, both at regional and local scale.
During the Quaternary the complex interaction of tectonic processes, sea-level fluctuations, climate changes, and sediment supply produced the filling of the basin with the progradation of the fluvio-deltaic system, from west toward east.
The most important tectonic phases can be easily recognized along the basin margin marked by the deformation and tilting of river terraces and of exposed syntectonic sediments; conversely their detection is particularly difficult in the central-distal part of the basin.
In such structurally complex area analysis of syntectonic deposits and growth strata are strategic to describe the basin evolution and tectonic control; in their analysis 3D decompaction and regional tilting must be taken into account to assess the residual vertical separation that can be attributed to tectonic processes only.
The Pleistocene portion of a detailed 3D model, build in the framework of the EU-funded GeoMol Project, is the starting point of a sequential restoration workflow in 3D that included the unfolding and decompaction of 6, chronologically constrained, sedimentary units ranging from 1.5 to 0.45 Myr.
This previously unavailable detail in the definition of the geometry of Quaternary bodies in the central part of the Po Basin provided a set of detailed pictures that show the topography and the evolution of the infilling at different point during time.
As a matter of fact the resulting 3D surfaces describe the basin configuration and the changes and migration of regional depocentres controlled by thrust activity up to the Pleistocene but also allow to highlight the interference of active tectonic and sedimentation in the central portion of the Po basin, an area considered less affected by the main structures (e.g. the Emilia and Ferrara-Romagna arcs).
In the analysis of this structure also the foreland tilting has been subtracted from the topography resulting after unfolding and decompaction, for the 6 time intervals; we obtained a residual signal related to the growing anticline, and the uplift rate of the structure during its Pleistocene evolution.

The project GeoMol is co-funded by the Alpine Space Program as part of the European Territorial Cooperation 2007-2013. The project integrates partners from Austria, France, Germany, Italy, Slovenia and Switzerland and runs from September 2012 to June 2015. Further information on www.geomol.eu