3D Structural analysis of a growing anticline: the Piadena case (Central Po Plain, Northern Italy)

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GEOMOL PILOT AREA AND SEISMIC DATASET

The reconstruction of the subsurface geology of the central part of the Po Plain is one of the goal of the GeoMol Project (Alpine Space Programme). The dataset available for the Italian pilot area is constituted by 12,000 Km of seismic lines kindly provided by ENI S.p.A.; 17 seismic horizons have been defined and mapped; their depth has been checked with the constraints deriving from a dataset of 126 well-logs for hydrocarbon exploration.

PIADENA ANTICLINE

The Piadena anticline is controlled by a blind thrust (the most external front of the Emilia arc) with strike from WNW-SEE to NW-SE in its eastern tip. It was already recognized in literature (Pieri and Groppi, 1983; Cassano et al., 1986) and in the Structural Model of Italy (1992) on the base of the offset and deformation of the base of Pliocene. The 3D model of the GeoMol Italian pilot area allowed to acquire new data and analysis tools to better define the geometry, the structure evolution and to tentatively evaluate its recent (upper Pleistocene) activity.

The Piadena structure is located along the western border of the pilot area; the buried anticline is placed between the Oglio river to the North and the Po river to the South. The Oglio river currently erodes the continental deposits of the Last Glacial Maximum.

The ongoing activity of the Piadena blind thrust during, at least, the lower Pleistocene is marked by the deformation of the base of Calabrian (1.5 Myr, PLS150).

PIADENA THRUST GEOMETRY AND AGE

The thrust ramp offsets the Pliocene horizons and is detached in the Eocene-Miocene Gallare Marls. The transition from flat to ramp of the thrust geometry is well resolved by seismic data and 3D model and is located in correspondence of the main underlying Messozoic normal faults with mainly NW-SE strike. These faults represent the paleostructural margin between the Trento platform to the North and the Lombardian basin to the South and to West.

The seismic lines interpretation, calibrated with well logs stratigraphy, allowed to constrain the inception age of the thrust.

The first grown strata are in the upper Pliocene interval, while the maximum of the activity of the structure is during the Gelasian.

BASE INFILLING

The lateral continuity of the anticline, also during the lower Pleistocene, and the geometry of the structure is well described by the 3D model.

The Pleistocene activity of the Northern Apennines thrust fronts interacts with the inflow of the basin and the transition from marine to continental environment.

The thickness analysis of the Pleistocene deposits shows the migration of the depocenters. During the distal marine sedimentation (from Pliocene to 1,25 Myr horizons, PLS125) the tectonic signal of the growing Piadena anticline is evident (A, B).

The transition from marine to continental environment in the area is marked by the arrival of the deltaic system (PLS114, 1.14 Myr), with the shelf break located close to the Piadena area (C), and the further migration of the deltaic system eastward (PLS087, 0.87 Myr) with the complete infliting of the accommodation space (D). In these time intervals the signature of the anticline growing is poorly recognizable because of the great sedimentation rate of the deltaic shelf. The sedimentation rate of the continental environment (from PLS087 to the present) is lower and the thickness analysis shows reduced values along the Piadena area and higher values along the Po and Mirno rivers (E).

RESTORATION WORKFLOW

The workflow used to backstrip the deformation of slighted folded horizons in area like the Po Plain or the Adriatic foredeep (Maesano et al., 2013) follows these steps: decompaction and removal of sedimentary load, restoration using trishear or dislocation modeling.

DECOMPACtion RESULTS

The decompaction of shallow horizons is performed using the Dickinson equation (1953). The decompacted horizons show less amplitude of the fold, if compared with the pre-decompaction ones, that in most cases can be related to the tectonic activity of the underlying fault.

In the case of continental horizons with a very low amplitude of residual folding, as the Piadena anticline for the 450 kyr horizon (1b), the residual deformation can be tentatively related to very slow motion on the fault, but the role of the river and environmental contest must be also taken into account.

Instead the decompaction results for the shelf marine horizon (870 kyr), performed using the Scater and Christie equation (1982), show a residual folding (2b) with enough amplitude to be considered related to the ongoing activity of the Piadena thrust at least during the middle Pleistocene.

REFERENCES


