Geophysical Research Abstracts, Vol. 9, 02740, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02740

Pleistocene compressive tectonics in the Central Southern Alps (Italy): Rates of folding determined from growth strata.

F. Livio (1), **G. Sileo** (1), A. M. Michetti (1), F. Giardina (1), C. Carcano (2), S. Rogledi (2), K. Mueller (3), E. Vittori (4).

(1) University of Insubria, Via Valleggio 11, 22100 Como, Italy, (2) ENI E&P, Via Emilia 1, 20097, San Donato Milanese, Italy, (3) Colorado University, 80303, Colorado Ave., Boulder, Colorado, USA, (4) APAT, Servizio Geologico d'Italia, Via Curtatone, 1, Roma, Italy (franz.livio@uninsubria.it / Fax: +39031326230 / +39031326215).

Characterizing the Quaternary deformational history of the Southern Alps in Lombardia, Italy, is a critical step for the knowledge of the Adria active tectonics. In this region, relations between seismicity and Quaternary tectonic structures are still poorly understood. We explore the high quality database, in terms of geological information, subsurface industrial geophysical data, and historical seismicity, available for this region in order to deal with this issue.

The Northern Po Plain and adjacent Southalpine margin in Lombardia have accommodated significant crustal shortening during the Neogene. The deformation reached its peak during Miocene, when the most external structural belt of the central southern Alps (the so-called "Milano belt"; i.e. Fantoni et al., 2004) began to develop. The main collisional and deformative event seems to wear out within the Tortonian ("Lombardic Tectonic Phase"; e.g., Schumacher et al., 1996), nevertheless Plio-Pleistocene compressive tectonic activity went on acting in this sector of the Adria northern margin.

Ongoing tectonic activity is in fact testified by historical and instrumental seismicity that interested this area (i.e., the 1222, Me 6.2 Brescia, the 1801, Me 5.7 Soncino, and the Ml 5.4, 2004, Salò, earthquakes; Guidoboni, 2002; Burrato et al., 2003). Active shortening is also consistent with GPS data indicating shortening rates in the range of 2.2 mm/a in the Friuli area and ca. 1.1 mm/a near Lake Iseo measured with a fixed point in the Western Alps along vectors oriented NNE-SSW (Serpelloni et al. 2005), due to the ongoing Adria counterclockwise rotation. Geological, geomorphological and geophysical evidence of Pleistocene active tectonic exist between Lake Garda and Lake Iseo, as already underlined by several Authors. South-east of Lake Garda, Desio (1965) pointed out the occurrence of some isolated hills (Castenedolo, Ciliverghe and Capriano hills) whose presence cannot be explained by glacial or fluvioglacial morphogenic processes. These hills were in fact interpreted as the culmination of growing anticlines associated to underlying thrusts (Desio, 1965; Boni & Peloso, 1982; Baroni & Cremaschi, 1986; Cremaschi, 1987; Castaldini e Panizza, 1991; Curzi et al., 1992). At Castenedolo and Capriano hills, Early Pleistocene marine deposits were uplifted more than 200 m; to the east, a Middle Pleistocene continental sequence outcropping along the Ciliverghe hill show secondary faulting and tectonic tilting (Baroni & Cremaschi, 1986, Cremaschi, 1987).

Based on this evidence, we conducted a systematic revision of the available data, new field mapping, and new study of the data obtained by ENI E&P for oil exploration. We identify evidence of Quaternary compressive tectonics. In particular, the reinterpretation of ca. 18.000 km of seismic profiles clearly show, buried below the Po Plain, a belt of segmented, 10 to 20 km long, fault propagation folds, controlled by the Plio-Quaternary growth of several out-of-sequence thrusts. We revised the mapping of four sequence stratigraphic boundary surfaces (dated at ca. 1.6 Ma, 1.2 Ma, 0.89 Ma, and 0.45 Ma.), belonging to the Quaternary infilling of the Po basin, which are characterized by a regional extent and by good stratigraphic and age constraints (Regione Lombardia, 2002).

In order to detail the Quaternary growing of the buried folds we made use of the syntectonic sedimentary record associated to each structure. If sedimentation takes place during the growth of a fold, cumulative displacement will decrease upward within the stratigraphic interval deposited during deformation. In contractional fault related folds, these syntectonic strata typically thin across folds limbs towards structural highs. The geometries of growth structures are controlled primarily by the geometry of the underlying fault and by the relative rates of sedimentation and uplift (Suppe et al., 1992). Changing in the ratio between sedimentation and uplift rates could either enhancing or masking the strata thinning and therefore has to be carefully considered.

In this paper we present an application of this approach to evaluate Pleistocene uplift rates of a fold located just South of Castenedolo Hill, and related to the growth of an underling Miocene thrust which has experienced a successive Pleistocene reactivation.

We selected this structure because (1) the stratigraphic and structural features of the growth strata are well imaged, and (2) this seismic line shows a complete section of the growth strata, from the oldest beds preserved over the pre-growth units to the youngest beds near the topographic surface.

The crestal structural relief (McClay, 1992) at a specific time T has been obtained by subtracting the thickness of all the growth beds deposited on the anticline crest prior to time T from the thickness of the same growth beds in the basin adjacent to the anticline. Uplift rates have then been calculated as the difference of structural relief relative to the top and to the bottom of a specific growth bed (Suppe et al., 1992; Masaferro et al., 2002).

The Pleistocene syndepositional growth history of this anticline can be divided into three tectono-sedimentary episodes based on the fold uplift rates, sedimentation rates and onlap/overlap geometry of the growth strata.

(1) The first episode ranges between ca. 1.6 Ma and ca. 1.2 Ma. Growth beds onlapping the fold limb and thinning as they approach the fold limb predominated during this period; the relative uplift rate is ca. 0.13 mm/a. Sedimentation rate was ca. 1.49 mm/a.

(2) The second episode initiated ca. 1.2 Ma, and lasted until ca. 0.89 Ma. The maximum sedimentation rate recorded during fold amplification (ca. 2.43 mm/a) was attained in this period. Within this time span no tectonic uplift occurred, as testified by the large number of overlapping, constant thickness, syntectonic beds.

(3) The inception of the last episode is at ca. 0.89 Ma. Sedimentation rates were very low during this event (0.3 mm/a) because of the progressive infilling of the Po basin which in this period had definitely created a continental setting in the area. Thinning of growth strata is again predominant (uplift rate ca. 0.1 mm/a).

Thus, the evolution of this anticline was a discontinuous process characterized by several tectonic uplift pulses of different duration and intensity, interrupted by periods of variable extent in which no fold growth occurred. Middle - Pleistocene to present uplift rate uplift is in good agreement with that one proposed by Scardia et al. (2006) for a nearby drilling site, based on magnetostratigraphic analyses.

The Pleistocene growth history of this anticline and the comparison with other adjacent structures is surely useful to deepen the present knowledge of recent and ongoing tectonic activity of the central Southalpine front. In fact calculated uplift rates can be used to geometrically estimate minimum slip rates and therefore to better evaluate the activity of the local tectonic structures responsible for damaging earthquakes.

A similar approach, applied to geomorphic markers, could be useful also in western Lombardy. Here clear seismological evidence for present-day tectonic activity is lacking even thought comparable Quaternary tectonic structures have been already described in the literature (e.g., Orombelli, 1976; Bini et al., 1992; Chunga, 2006; Giardina, 2006; Sileo et al., 2006). If the same relationship between fault and fold slip rates and seismic activity could be proved this would have a considerable impact on the seismic hazard assessment of Northern Italy.