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Active tectonics and seismic hazard in the Central Western Southern Alps: a review

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The active tectonics of Northern Italy is characterized by the growth of the two thrust belts surrounding the Po Plain, i.e., the Southern Alps and the Apennines.

Along the Apennines foredeep, regional geological, geophysical and geodetic data (e.g., Bigi et al., 1990; Serva, 1990; Doglioni, 1993; Bello & Fantoni, 2002; Fantoni et al., 2004; Boccaletti & Martelli, 2004) clearly show that Quaternary deformation rates decrease westward from the Ferrara, to the Emilia and the Monferrato Arcs. Most important for our study, this trend is in good agreement with the westward-decreasing level of seismicity shown by the historical catalogue (e.g., Boschi et al., 2000; CPTI, 2004). Typical damaging shallow crustal (focal depth 10 to 15 km; Selvaggi et al., 2001) earthquakes are more frequent in the east (Ferrara) than in the west (Monferrato). Geomorphic and stratigraphic observations (Amorosi et al., 1996; Benedetti et al., 2003; Boccaletti & Martelli, 2004) demonstrate that both the external and pedeapenninic thrust fronts produced significant late Pleistocene to Holocene displacement. Seismotectonic analyses (e.g., Serva, 1990; Selvaggi et al., 2001) clearly show that these compressional tectonic structures are capable of producing earthquakes with magnitude in the order of M6.

This is also true for the Southern Alps-Po Plain margin between Friuli and western Lombardia, despite the obvious difference in the structural evolution of the two thrust belts, which implies also a different seismic style in terms of maximum earthquake magnitude and recurrence behaviour (e.g., Serva, 1990; Doglioni, 1993; Castellarin and Cantelli, 2000). The rates of seismicity show a marked reduction moving from the Italy-Slovenia border toward the Veneto and Lombardia regions. In particular, based

on the available observations during the historical time window, earthquakes in the Southern Alps show higher maximum magnitudes (in the order of M 6.5) then in the Northern Apennines, as clearly illustrated by the strong events occurred in the Friuli (such as the Jan. 25, 1348, and the May 6, 1976, earthquakes; e.g., Slejko et al., 1987; Barbano, 1993) and Lake Garda areas (such as the Jan. 3, 1117, and the Dec. 25, 1222, earthquakes; e.g., Magri and Molin, 1986; Serva, 1990; Curzi et al., 1992; Sauro and Zampieri, 2001; Galadini et al., 2001; Burrato et al., 2003). These strong historical seismic events have longer return periods in the west (Garda) then in east (Friuli). Focal mechanisms of recent low magnitude earthquakes (such as the November 13, 2002, M4.2, Lake Iseo, earthquake, and the November 24, 2004, M5.2, Salò earthquake on the west coast of Lake Garda) are consistent with the active compressional tectonics illustrated by the geological evidence and seismic profiles along the Central Southern Alps foothills.

The understanding of Quaternary tectonics and seismic potential around the Po Plain should therefore be framed in a common regional geodynamic setting.

If this approach is correct, then a problem arises in the assessment of the seismic hazards in the Central Western Southern Alps. In the Monferrato Arc (NW Apennines) significant Quaternary tectonics deformation (illustrated for instance by seismic reflection profiles performed for the oil industry; Bello & Fantoni, 2002) is associated to a seismicity level which, even if lower than in the Ferrara Arc, is far from being negligible in terms of seismic hazards. The sector of the Southern Alps facing the Monferrato Arc, however, despite the clear evidence of Pleistocene tectonics (e.g., Orombelli, 1976; Bini et al., 1992; Zanchi et al., 1997), shows no record of local earthquakes with epicentral Intensity greater than VI (MCS scale). Based on this lack of available historical data, the seismic hazard of the region between western Lombardia and Ticino, at the Italy - Switzerland border (also known with the “Insubria Region”) is commonly regarded as insignificant (e.g., Stucchi, 2004). We argue that the geological evidence should be taken much more carefully into account before making suitable conclusions on the seismic potential of Insubria, an area that is one of the most economically developed and industrialized, and therefore exposed to seismic risks, of the whole Europe.

In this paper we address this topic using the review of available literature, and new results from geomorphic, stratigraphic and paleoseismological investigations at selected sites along the Central Western Southern Alps piedmont belt such as:

- the Albese con Cassano site, few km east of Como, where Mid-Pleistocene deposits show evidence for paleoliquefaction, reverse faulting and tectonic uplift;
- the Val Faloppia site, few km east of Como, where a back-thrust in the Oligo-

Miocene Gonfolite Fm. clearly controls the geomorphic evolution of the Monte Olimpino range front and possibly the uplift of a sequence of late glacial to Holocene fluvial terraces;

- the Salò site, along the Lake Garda shore, where a M5.2 earthquake occurred on Nov. 24, 2004, and generated significant ground effects.

The preliminary results and methodological approach of these active tectonics and paleoseismological studies in the Central Western Southern Alps might be relevant for several other alpine areas, showing similar seismotectonic features and poor seismic hazard characterization from the geological point of view.

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