Alpine fold and thrust structures: a 3-D model of the Säntis area (Switzerland)

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The Säntis area offers one of the most spectacular insights into the fold-and-thrust belt of the Helvetic nappes. The nearly perfect outcrop conditions, combined with the exemplary intersection of formation boundaries with topography, make it a natural laboratory for structural geology. Since the pioneering work of Heim (1905) at the beginning of 20th century, the area was mapped in detail (Eugster et al., 1982) and investigated in terms of deformation mechanisms (e.g., Groshong et al., 1984), structural evolution and fold-thrust interaction (Funk et al., 2000; Pfiffner, 1982, 1993, 2011). The proposed restorations are mostly two-dimensional palinspastic reconstructions, either in map or in cross sectional view.

The main goal of this research is to better understand the geometrical relationships between folding and thrust faulting, investigating for example fault-propagation folds and analyzing the lateral changes of folds and thrust structures along strike. A three-dimensional model of the area is built using 3D MOVE, combining cross-sections from Schlatter (1941), Kempf (1966), Pfiffner (in Funk et al., 2000, 2011), the geological map 1:25.000 by Eugster et al. (1982) and a digital elevation model (DEM) with a regular grid of 20X20m.

Six main horizons are reconstructed, corresponding to the base of the Öhrli and Betlis Limestones, the Helvetic Kieselkalk, Schrattenkalk and Garschella Formations and the Seewen Limestone. The main structural elements in the Säntis area, such as the Säntis Thrust or the Sax-Schwende Fault, are also implemented in the model. The 3D model obtained highlights the shape of the main anticline-syncline pairs (e.g., Altmann-Wildseeli, Schafberg-Moor, Roslenfirst-Mutschen, Gulmen, etc...); such fold trains vary in amplitude and wavelength along strike. The model also shows clearly the lateral extension, the trends and the variations in displacements of the principal faults. The reconstruction of 3D horizons allows the geologists to investigate cross sections along any given directions. The 3D model is useful to understand how the changes of the internal nappe structures, namely folds and thrust faults, change along strike. Such changes occur either across transverse faults or in a more gradual manner.

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