Visualization and modeling techniques in complex tectonic settings for petroleum potential assessment, a geometrical example from a collisional mountain belt

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In the last decade, a number of innovative geophysical and geological techniques were developed to investigate and model complex geologic settings (e.g., Caumon et al., 2009). This, in combination with an almost unlimited computational power that allows handling large datasets, is the key to generate elaborate 3D geological models (e.g., Zanchi et al., 2009). One of the main goals of a 3D model, for example in the oil industry, is to reproduce the exact features of a structure to reduce the explorative risk. Robust and accurate structural models are therefore of utmost importance in the exploration workflow. Understanding the processes that generated potential traps (e.g., Cristallini and Allmendinger, 2001; Galera et al., 2003; Moretti, 2008) allows discriminating between a discovery and a dry well.

This approach is extremely useful in areas with low or no seismic coverage such as onshore collisional belts. Here we present an example of such a situation aimed at investigating the geometrical relationships between folding and thrusting in a collisional mountain belt even although not relevant for oil exploration. A small area of the Helvetic nappes from the Swiss Alps is reconstructed from several existing cross-sections, partly redrawn and line-length balanced. The cross-sections were interpolated in 3D to obtain eight main surfaces corresponding to formational tops and a number of fault surfaces.

This 3D model represents a very intuitive tool for examining a portion of a complex nappe structure. The model highlights the shape of the main anticline-syncline pairs and how these fold trains vary in amplitude and wavelength, and variations in fold style along strike and in map view. The changes correlate with regional shortening as determined from line-length balancing. The model also puts in evidence the lateral extension, the strike, and the variation in displacement of the principal faults. The 3D model allows understanding how the internal nappe structures, namely folds and thrust faults, change along strike.

Caumon G.,·Collon-Drouaillet P., Le Carlier de Veslud C., Viseur S., Sausse J. 2009. Surface-Based 3D Modeling of Geological Structures. Math Geosci 41, 927–945.

Cristallini E.O. & Allmendinger R.W. 2001. Pseudo 3-D Modeling of Trishear Fault-Propagation Folding. Journal of Structural Geology, 23, 1883-1899.

Moretti I. 2008. Working in complex areas: New restoration workflow based on quality control, 2D and 3D restorations. Marine and Petroleum Geology, 25, 205–218.

Zanchi A., Salvi F., Sterlacchini S., Zanchetta S., Guerra G. 2009. 3D reconstruction of complex geological bodies: Examples from the Alps. Computers & Geosciences, 35, 49–69.

Galera C., Bennis C., Moretti I., Mallet J.L. 2003. Construction of coherent 3D geological blocks. Computers & Geosciences, 29, 971–984.