Fold analysis: a key to understanding the progressive deformation of the Mexican Fold Thrust Belt (MFTB)

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The MFTB is the southern termination of the Rocky Mountain Fold-Thrust Belt. The details of deformation in this part of the fold-thrust belt and how the Sevier and Laramide structures extend into the MFTB in central Mexico are not well understood. Through systematic and comparative geometric-kinematic analysis of mesoscopic folds, within the framework of the major structures, we evaluate how deformation was accommodated and accumulated at different positions within the fold belt. Two generations (D1 and D2) of thin-skinned shortening structures have been documented, with a similar direction of transport towards the NE. This study focuses on D1, the most important phase. The dominant lithology in the area is carbonate, which presents lateral lithological variations associated with four Cretaceous paleogeographical elements. These are, from west to east: El Doctor Platform (EDP), Zimapan Basin (ZB), Valles-SLP Platform (VSLP), and Tampico-Misantla Basin (TMB). The two Cretaceous carbonate platforms were relatively rigid and accommodated far less shortening than the adjacent basins during deformation. The D1 structures are open, km-scale fault-bend folds in the platforms and usually tight folds at a mesoscopic to cm-scale in the fine-grain rocks of the basins. The style and history of folding varies notably from one basin to the other. A pervasive axial plane cleavage is displayed in rocks of the ZB, but further east in the TMB, such a fabric is only present along the boundary with the VSLP Platform and around local detachment zones. Minimum shortening calculations in this study, using buckle folds and detailed cross sections, suggest that this is a severe underestimate. Our estimates are that the EDP was shortened by ~50%; the ZB by 60-70%; and the VSLP by 40%. In the Tampico-Misantla Basin, there is a gradient from 70% shortening close to the western boundary with the VSLP to 19% shortening at the tectonic front of the MFTB on the east.

In the first part of the study, special attention is paid to the effect of the paleogeographical elements on the heterogeneous progressive deformation of the MFTB. Some questions addressed are: 1) What was the role of the two carbonate platforms in the deformation of the rocks in the adjacent basins? 2) How can veins be used as markers in the analysis of progressive deformation of folds? 3) What can mesoscopic folds tell us about the evolution of the MFTB as a whole?

In the second part of the study, stable isotope and fluid inclusion analysis of fold-related veins in the basins and platforms is being undertaken. In addition, systematic analysis is being made of fault-related rocks and veins from major thrusts on the boundaries between basins and platforms in order to address the question: Do platforms behave as fluid flow barriers during shortening?

Finally, fission track and U-Th-He analyses are being carried out on apatite separated from volcaniclastic units underlying the carbonates in both basins and in the hinterland. The results should allow calculation of burial ages and/or exhumation rates at different positions along the fold belt. Together with the structural information, these data should help to answer the question: How do platforms control deformation of the fold-thrust belt and the burial history of the basins and their subsequent exhumation?