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Varying thrust geometry along the Central Atlas fronts: structural criteria for 3-D reconstruction

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Multiple constraints, including poorly known parameters, determine along-strike changes of frontal thrust structures in fold-and-thrust belts. Along the 400 km long, continuous Central Moroccan Atlas belt, structural style shows significant changes, preserving similar figures of shortening. This implies the absence of large-scale vertical-axes rotations, as demonstrated by paleomagnetic studies accomplished during the development of this project. The main factors controlling thrust geometry are:

- the geometry of Triassic-Jurassic extensional basins subsequently inverted during Cenozoic compression, with especial mention to changes of cover thickness and orientation of structures

- transfer of displacement between the northern and southern thrust systems

- transfer of displacement between the basement (Paleozoic) units and the Mesozoic cover through the Upper Triassic detachment. This factor strongly determines the width of the belt in each transect, as it occurs in other basement-and-cover fold-and-thrust belts

- cover/detachment thickness ratio.

- localization and partitioning of deformation between different structures in the inner part and the borders of the massif

- amount of superposition between different cover thrust sheets, including folded thrusts

- structural style, changing from thin-skinned style to large recumbent folds along strike, probably depending on P-T conditions and cover thickness

- backthrusts related to low cover thickness/detachment thickness ratio, especially frequent in the northern Atlas thrusts

- differential shortening between sections related to layer-parallel shortening and folds associated with cleavage development in the central part of the chain

- influence of previous structures, such as individual diapirs, salt walls or igneous intrusions that modify the pre-compressional geometry of the detachment level, nucleate structures and favor buttressing. This feature can also be a source of errors in the calculation of shortening.

All these factors result in strong along-strike changes such as branching of thrust surfaces, progression of deformation towards the foreland and differential cleavage development. Influence of structures developed during the basinal/diapiric/igneous stage results in a variability of trends that varies between from less than 10° to more than 30°, what allows in some cases to distinguish between structures controlled by basinal features and newly formed thrusts.

In spite of the different techniques for cross-sections reconstruction, and in some cases, the different interpretations for the origin of structures, the shortening figures obtained along the chain are remarkably constant, on the range of 35 km, thus implying a 18 to 30% of shortening for most of the transects what attests for the reliability of the results.

Recognition and quantification of factors controlling the development of structures is the fundamental step to determine the main thrust surfaces, and the secondary backthrusts in a region where basin inversion is one of the main constraints. Structural criteria point to a dominant southward vergence and secondary northwards-directed thrusts. Minor strike-slip components were probably localized in the core of the chain. Present-day 3-D reconstruction of the Atlas is currently being done considering all these inputs as well as those obtained from merging the vast dataset obtained.