3-D geological model of the Central High Atlas fold-and-thrust belt

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The Atlas system, an ENE-WSW intracontinental chain in the NW of Africa, grew because of the inversion of Mesozoic extensional basins during the Cenozoic convergence between the African and European plates. The Central High Atlas (CHA) is located in the mid-western sector of the chain and is characterized by (i) the presence of an Upper Triassic décollement, (ii) thick Lower-Middle Jurassic sedimentary sequences, and (iii) the occurrence of diapirs and igneous bodies which are especially common in the central part of the chain. The northern and southern borders are characterized by fold-and-thrust-systems involving the Paleozoic basement and the Mesozoic cover and showing significant displacements, especially towards the South.

Framed on a multidisciplinary structural project aiming to reconstruct the 4-D structure of the CHA, the purpose of this work is to gather a vast constraining dataset into a present-day, regional, 3-D geological model of the CHA fold-and-thrust belt. This 3-D reconstruction gives special weight to along- and across-strike variations of the geometry of the basement and cover structures and the distribution of salt and igneous bodies. The 3-D model is founded by 23 serial cross-sections, constrained by surface geology and more than 1900 structural data and complemented by geophysical modelling. The model considers regional structures having enough lateral continuity and so we ruled out minor, local features. Stratigraphically, we considered 5 horizons: (1) the top of the Triassic located below the detachment level, and partially equivalent to the top of the basement, (2) the base of the Jurassic succession (i.e. the top of the detachment level), (3) the Lower-Middle Jurassic limit and, towards the southern and northern fronts and foreland basins, (4) the bases of the Cretaceous and (5) the Cenozoic succession.
The reconstruction of the 3-D model entailed a strong feedback between the model and the cross-sections. The incipient 3-D model helped to refine the lateral consistency between cross-sections regarding branch and tip lines, cut-offs, fault angles, etc., and so to improve and further constrain them.

Thick to thin skinned deformation dominates the eastern, central and northwestern areas of the chain while thick skinned deformation occurs in the westernmost transects. The chain is defined as an asymmetric, doubly verging fold-and-thrust belt. A north-dipping, basement regional fault represents the main rooting structure of the CHA. Its geometry varies from and almost horizontal (West), to a 10°-12° (Centre) and 15° (East) thrust ramp surface. As this fault intersects the cover, it splits into a regional thrust front with several thrust branches. To the north, antithetic basement faults change to a thrust relay system as they intersect the Mesozoic sequence. Along the core of the chain, the structural style is characterized by open salt bodies, welded diapirs and steep thrusts having relatively limited lateral continuation. The Toundoute Unit, located in the central-western sector represents a basement-and-cover thrust stack where the basement is exhumed and crops out.

This 3-D structural model provides the bases for further 4-D reconstruction of the CHA and, at the same time, served as a constraining approach for cross-section construction.