Structural evolution of the onshore/offshore Atlas system of Morocco

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A review of most industry reflection seismic surveys across the flanks and plunges of the High and Middle Atlas system provides new constraints for models of this foreland mountain range. The Atlas system is discordantly superimposed on the Paleozoic structural grain. Thus, the Mesozoic/Tertiary re-activation of earlier Paleozoic structures is limited to a few late Paleozoic Triassic strike-slip faults.

An overall north-northeast striking Triassic rift system is segmented by transfer faults, and overlain by a Late Triassic/Earliest Jurassic much less faulted sag basin that is associated with widespread plateau basalts. Middle and Upper Jurassic rifting is a distinctly separate event that only rarely coincides with Earlier Triassic rifts. The role of Paleozoic/Early Mesozoic strike-slip faulting and its reactivation amphasized by so many authors appears to be more limited and complex .

Onshore, salt tectonics are active from the Jurassic to the Quaternary. The compressional deformation and/or inversion of the Atlas Mountains begins during the Upper Cretaceous and is active until today. A low-relief folded belt forms in its earlier evolution, and is followed in late Miocene-Pleistocene time by the high relief forming event responsible for the uplifts of both, the Atlaș and the Anti-Atlas systems.

Striking features of the Atlas system are the near-absence of a flexural foredeep-like depression; its intersection with the Atlantic passive margin, its extension into the oceanic domain, intermittent mantle-derived volcanism from the Triassic into the Quaternary, a complex interplay of basement-involved deformation, inversion and décollement tectonics and finally widespread salt tectonics which often overprint and camouflage deeper tectonic patterns.

Melt segregation and migration during deformation of anisotropic partially molten rocks

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Understanding dynamics of orogen roots implies a better knowledge of the role of partial melting in the mechanical behaviour of deep crustal rocks. In migmatitic terrains, melt occupies sites created by the heterogeneous deformation at a metric scale, such as hinge of folds, foliation-parallel veins or shear zones. The flow of the melt is driven by the pressure gradients so that the sites of low pressure are the sinks of melt. In order to understand the mechanisms of melt accumulation in metric structure such as a fold, analogue modelling has been performed with partially molten paraffin wax. The solidus of the wax is at 50°C and its liquidus at 75 °C. During the experiments, the wax layer is at 60±2°C and contains 15 to 20 % of liquid. The liquid is homogeneously distributed within the whole layer. The viscosity contrast between the liquid and the solid matrix is about of ten orders of magnitude.

The pervasive foliation of high-grade metamorphic rocks has also been taken into account. Before deformation, the layer is molded by pouring liquid wax in a rectangular mold. During the solidification of the wax, a weight is then applied at the surface of the mold. This process generates a horizontal planar intrinsic anisotropy.

The wax layer is embedded between two 68/70 paraffin layers. An upper layer of sand overlies these layers and is used as a load to increase the vertical stress. Initially, the layers are 250 mm long, 150 mm wide and 35 mm thick. The finite horizontal shortening is of 36 %. The average deformation rate is 3×10^{-6} s^{-1}. The 68/70 paraffin layers are softer than the wax layer and act as a solid medium for the development of the fold. During the experiment, a part of the liquid moves