Stress And Strain Patterns Related To The Inversion Of The High Atlas Aborted Rift

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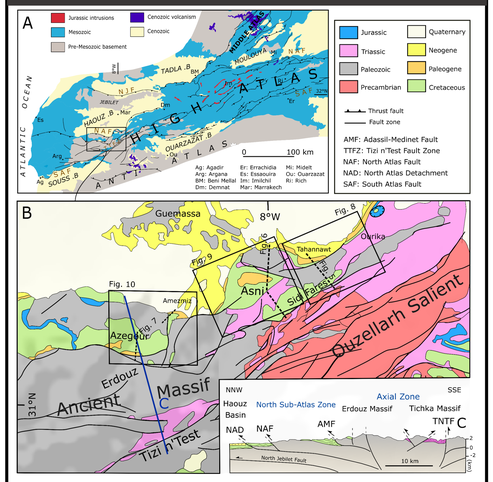
Introduction

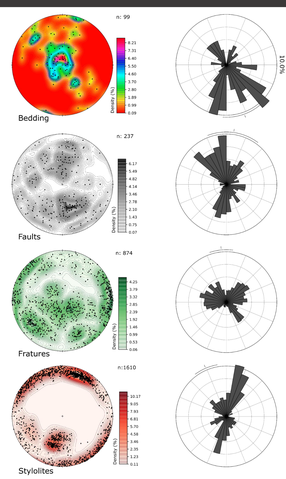
Located in a foreland position with respect to the Rif-Tell collision belt, the intracontinental Atlas system is a FTB built up at the expense of Africa-Eurasia convergence during the Cenozoic (e.g. Skikra et al., 2021). The range's development is linked to the reactivation of Triassic-Jurassic rift system as a compressional orogenic belt in the framework of Alpine orogeny. Despite the substantial studies made to try to understand the range's structural evolution during the last two decades, there is still a considerable controversies essentially surrounding the paleostresses evolution involved in the High Atlas basin inversion. The intent of the present work is to reconstruct the paleostresses associated with the High Atlas formation and to discuss how the resulting strain is accommodated in the study area. To do so, several brittle deformation meso-structures were measured in the northern front of the Marrakech High Atlas, between Ourika and Azegour regions.

Geological Setting



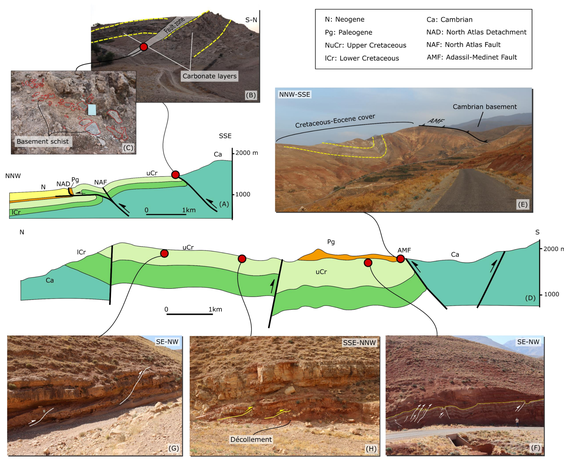
Geological and structural setting of the study area. (A) Simplified geological map of the Moroccan High Atlas simplified and adapted from Teixell et al. (2003); (B) Closer view of the Marrakech High Atlas with the location of the three investigated sectors (adapted from the geological map of Morocco, Hollard et al., 1985). These are located in the northern sub-Atlas zone that is marked by restricted Mesozoic-Cenozoic cover succession unconformably lying over the Precambrian-Paleozoic basement; (C) NNW-SSE structural cross-section along the Marrakech High Atlas showing the orographic evolution from the external basins to the axial zone (adapted from Fekkak et al., 2018).

Data and Methodology

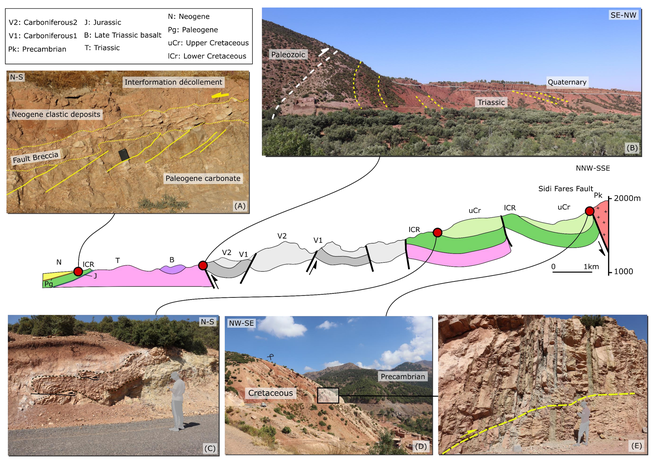


Identifying the regional stress field is achievable through quantitative assessment of fractures and striated micro-faults sets. Paleo-stress reconstruction could thus be performed by analyzing a spectrum of meso to microscale brittle deformation structures that possess the ability to record the stress pattern history

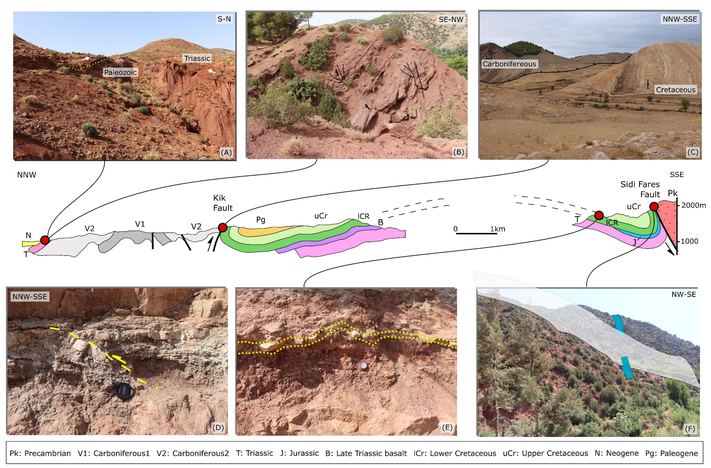
Field Observations



Cross sections in Amezmiz (A) and Azegour (D) sectors. (B) Field view of the Cretaceous series showing northwest verging fault with evidence of basement materials within the fault breccia (C); (E) Panoramic view showing the Cretaceous layers folding near Adassil-Medinet Fault; (F, G and H) Field pictures of meso-scale reverse faulting affecting the cover series.

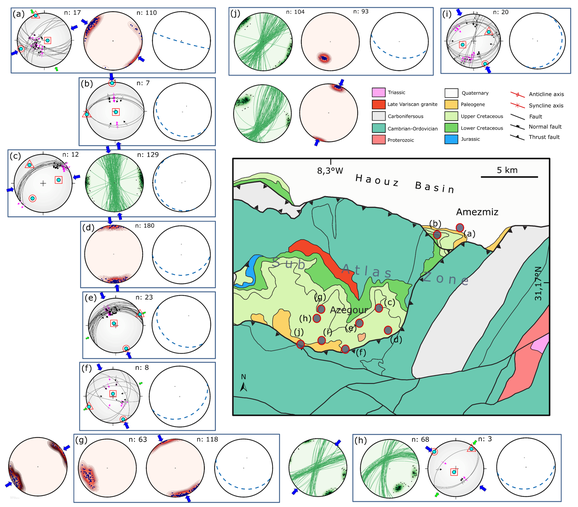


NNW-SSE geological section crossing Kik plateau. (A) basement-cored Triassic anticline; (B) Faulted and titled Triassic series; (C) Vertical zed Cretaceous layers near Kik Fault; (D and E) field views of small-scale reverse fault and folds affecting the competent layers of the Lower Cretaceous deposits; (F) NW-SE thrusting of Sidi Fares Fault zone over the Mesozoic-Cenzoic series in Asni region.

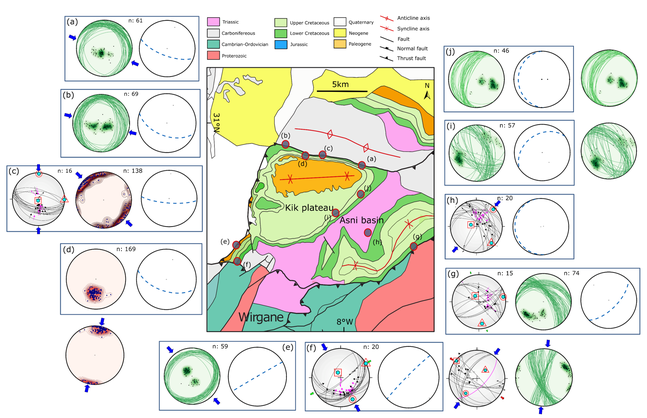


NNW-SSE cross section along Tahannawt-Sidi Fares region. (A) Normal fault between the Eocene carbonate series and the Mio-Pliocene molasses in Tahannawt region; (B): Overturning Triassic layers in contact with the basement north-verging thrust fault; (C) Meso-scale fault-related folding within the Triassic series; (D and E) View of the vertical to overturned Cretaceous series near Sidi-Fares Fault zone.

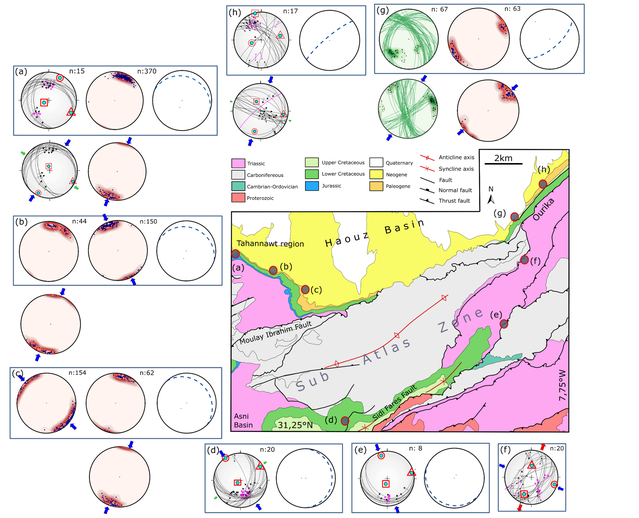
Paleostress Analyses



Paleostress reconstruction in Azegour-Amezmiz region (grey: fault plans data; green: fractures data; red: stylolites). The dashed lines indicate the mean bedding. Data outside the rectangles indicate the pre-tilting attitude.

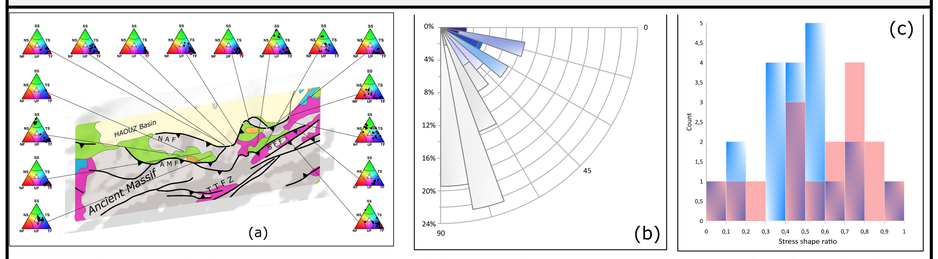


Paleostress reconstruction in Kik-Asni region (grey: fault plans data; green: fractures data; red: stylolites). The dashed blue lines indicate the mean bedding orientation. Data outside the rectangles indicate the pre-tilting attitude.



Paleostress reconstruction in Tahannawt-Ourika region (grey: fault plans data; green: fractures data; red: stylolites). The dashed lines indicate the mean bedding orientation. Data outside the rectangles indicate the pre-tilting attitude.

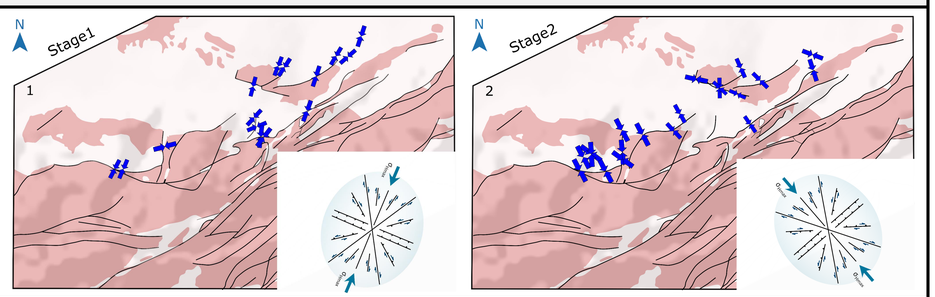
Stress regime



(a): the stress regimes from the various sites of faults planes measurements; (b): statistical data of the slip vectors angles of the fault planes data showing dominance of high slip angles; (c) Comparison of data distribution of the stress shape ratio values revealed from the present study (blue columns) and from Ellero et al. (2020) study (red).

Discussion

Conceptual stress model of the Marrakech High Atlas orogenic evolution based fractures and micro-faults stress inversion data.



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