



Examples of deep-seated slope deformation in the headwaters of the Audour and Bouhya Rivers in the Central Rif Mountains, Morocco

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Deep-seated mass movements are among the most efficient processes to erode mountainous terrains. Their evolution is controlled by variations in the post-glacial piezometric level, high-relief slopes, fault orientation and tectonic stress, seismicity and fluvial lateral erosion. These processes tend to evolve over very long time intervals (thousand to hundred of years) displacing rock volumes up to hundreds of millions of cubic meters. For this reason, deep-seated landslides constitute geomorphic marker to slope deformation passing through different periods of tectonic and climatic forcing.

The Rif Mountains extend along the northern coast of Africa forming the south western-end of the Betic-Rif-Tell orogen. This mountain system reaching over 2000m has been uplifting over the last 70 million years due to the convergence between the African and Eurasian plates. Studies on deep-seated slope deformation in the Central Rif Mountains are still poorly developed.

Our work focuses on the headwaters of the Audour and Bouhya Rivers (Central Rif Mountains) where several examples of deep-seated slope deformation were identified.

The study area is located within the contact between the Maghrebian Flyschs (J. Tisiren and Beni Ider nappes) and the External Zones (Intrarif - Tanger Unit). The Maghrebian Flyschs complex is characterized by a nappe stack consisting of turbiditic sediments topped by the Internal Zones and overlaying the External Zones. The more internal and higher units are known as the Mauritanian nappes composed by the J. Tisiren and Beni Ider nappes. From bottom to top the J. Tisiren nappe is composed by marly limestone followed by turbiditic levels consisting of graded siliciclastic sandstone with argillaceous-pelitic horizons of Berriasian – middle Albian age. The Beni Ider nappe consists of black shales (pre-flysch unit), pelites, schists and sandstone of upper Albian – Eocene - Oligocene age.

The key morphological features of the study area are four N65 trending elongated summits: the Koudiet es Sbaa (1768m), the Jebel Beni Salah (1504m), the Jemaat Ben Troun (1287m) and the Jbel Takhiyamt (1536m). Valley carving throughout upper Pliocene and most of the Quaternary was performed at the expenses of the lithological differences between the Tanger Unit and the Tisiren and Beni Ider nappes.

In this work we present the preliminary results in the form of two geomorphological maps referring to the Koudiet es Sbaa and the Takhiyamt mass movements. We perform detailed geomorphological mapping, digital photo-interpretation and DTM (pixel size=20m) analysis on two examples of deep-seated slope deformation. Morphology and morphometric properties are used to describe slope deformation and analyze the structural context on which slope deformation occurs.