



## **Slope instability on weathered molasses at the South-Pyrenean mountain front (Murillo de Gállego, Aragón, Spain)**

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A survey has been carried on to study the geological properties of an unstable slope at the right bank of Gállego River, in the Mallos de Murillo foothill. Morphologically, this slope contrasts with the stepped pattern of glacial and fluvial terraces that characterises the External Sierras foothills and their transition to the Gállego River. The referred slope shows an irregular morphology with a thick cover of chaotic debris and no rest of preserved fluvial terraces. A main scarp is recognised in its upper contact with the Mallos de Murillo conglomerates. Minor scarps appear inside the debris slope.

The debris slope is flanked by two recent landslides. The southern one is well preserved. It involved the quaternary cover and the underlying tertiary molasses. A high-flow and permanent spring is located to the foot of this slide. Some evidences indicate that this landslide dammed the Gállego River. The northern flank of the slope creeps on to the underlying Bartonian marls of the External Sierras. It causes frequent problems to the road that cuts the slope parallel to the Gállego River.

The slope is developed obliquely to the general ESE trend of the Pyrenean structure. Its heterogeneous substratum is constituted by the proximal alluvial fan facies of the Miocene Uncastillo Formation. These deposits consists of massive conglomerates, rich in carbonate clasts, which grade rapidly to sandstones, siltstones and clays. The Uncastillo Fm draws a progressive unconformity with, at least, two units separated by

an angular unconformity. This unit is fossilising the complex structure of the Pyrenean southern front, which outcrops in the External Sierras. The local structure corresponds to a kilometric scale asymmetric syncline with a vertical to inverted limb in the tertiary molasses below the debris slope. The upper conglomerates of Mallos de Murillo are fossilising partially this structure. Very pervasive joint families cut this sector of the Uncastillo Fm. The main ones are cartographic scale high-angle N-S and E-W joints. They have morphological expression due to karstification processes. The distal alluvial fan facies of the northern syncline limb develop besides low-angle close-spaced joints to an outcropping scale.

Major rock discontinuities, as strata boundaries, unconformities, and different families of joints affecting the Uncastillo Fm have acted as a pathway to weathering. No surface of rupture has been evidenced in the base of the chaotic debris cover or in the weathered molasses. Only a complex pattern of sheared surfaces has been observed in some cores affecting the molasses at the lower part of the slope.