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Abstract

The Basento Valley: a natural laboratory to understand the mechanic of earthflows

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In Southern Italy structurally complex flysch formations, subjected to intense tectonic events, are present in a large part of the internal territory along the Apennine mountain chain. They consist of layers or isolated elements of fractured rocks incorporated into a mass of clay of marine origin. The fresh formation is usually found at few meters from the ground surface. The outcropping soils, though have the same geological origin of the substratum, are characterized by very different mechanical properties, being weathered by physical and chemical actions and dislocated by displacements. The earthflow body is composed of clay blocks of the parent formation that have been subjected to a rapid deterioration, and by lapideous blocks and fragments of limestone, sandstone, siltstone or marl (depending on the nature of the parent formation) in turn plunged into a softened, fine-grained matrix. This consists of a mixture of clay and centimetre to millimetre-sized hard lumps (lithorelicts). The nature of the liquid supplied during soil movement may have a direct influence on its behaviour. In fact, being volumetric strains much larger when the soil is exposed to distilled water than to salt solutions (Di Maio, 1996), landslide body exhibits softening because of adsorption of fresh water (such as rainwater) following stress relaxation phenomena due to slope failure.

The superficial weathered cover is often involved in earthflows lasting hundreds of years, with cyclic reactivations due to particular sequences of rainfall. During their life, the mechanism of earthflows change progressively depending on the quantity of material furnished by the alimentation zone and on the consistency of the soils of the landslide body that can vary over time. At different mechanisms, different geomorphological shape of the landslide body and of style of motion correspond.

All these aspects are illustrated through the description of some earthflows taken under observation in the Basento Valley, occurred in the formation of the Varicoloured Clays, a flysch constituted of limestone and clay.

The High Basento Valley and all the earthflows occurred in that area have been studied by Guida and Iaccarino (1991). They recognized that the evolution of these earthflows can be schematized through four stages, starting from the first-time mobilisation.

In the first stage (A) there is a quick mobilisation of the soil mass that flows downward. The landslide surface is highly softened and very irregular, with steps and cracks. The displacement rate ranges between very rapid and moderate (Cruden and Varnes 1996). In the stage B, the landslide flows within well-defined and easily recognisable lateral shears and the displacement rate is continuously decreasing, eventually becoming slow. In the stage C, the ground surface is more and more rounded and regular, and the soil body stiffer and stiffer. The geomorphological elements that characterise the earthflow (main and secondary scarps, lateral shears) tend to disappear. The displacement rate is still decreasing, ranging from slow to extremely slow, and the style of movement changes, taking the features of a slide. In the stage D, the landslide body is not easily recognisable on the slope, even through accurate surveys. Movements are extremely slow until a complete stop, which can occur even tens or hundreds of years after mudslide mobilisation.

Monitoring of some earthflows in the Basento Valley, recognized as representative of the Basin, has been performed through the integrated use of rain gauges, topographic benchmarks, Casagrande and vibrating wire piezometers and inclinometer tubes. The results have shown that earthflows can be active for decades, but their evolution displays strong changes of both geomorphological and kinematic features, according to the classification of Guida and Iaccarino (1991). In particular, sudden changes of the displacement rate are induced by changes of boundary conditions caused by varying alimentation conditions, that typically occur after bad weather conditions, or by earthquakes. The low permeability of the soil combined with the non uniform state of strain and stress induced by movement, make the development of excess pore pressures very likely during the stages of high velocity. In particular, the establishment of undrained conditions are responsible for generation of high shear strains that affect the soil body throughout its thickness, giving it a flow-like aspect. The following dissipation of excess pore pressures is associated with the decrease of the displacement rate and the changing pattern of slope movement. When the entire unstable mass reaches a gentle mature morphological configuration, the landslide can still move due to pore pressure fluctuations and/or to toe erosion.

References

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