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The large landslide of Carlantino, in the Daunian sub-Apennine (Southern Italy)

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In the Municipality of Carlantino (Foggia, Apulia) a large landslide extends for nearly 2 km from the hilltop down to the valley. The relevance of the landslide, due to the presence at the top of the town built-up area and, at the toe, of a large reservoir dammed by an earth dam on the Fortore River, motivated several investigations, lasted almost 20 years, aimed both at gathering data for the consolidation design and monitoring the landslide activity.

The Daunian sub-Apennine area is endemically affected by many landslides of different kinds. The present morphology results as a consequence of a strong distensive tectonics, whose effects are the nearness of stacks of Plio-Pleistocene sedimentary sequences with old flysch fragments. Large areas are covered by varicoloured clays, which constitute a high plasticity clay formation, where the incidence of shallow landslides may overcome the 50% of the total area.

One of the most outstanding landslides, for both size and risk, is the so-called landslide of the Toppo district. It is bordered in the upper part (560 m a.s.l.) by the last houses of the built-up area, and at the base (190 m a.s.l.) by the valley bottom, occupied today by the Occhito dam. It is classified as a complex landslide with the upper feeding zones, both in axis and on the sides of the landslide canal, involving calcarenites of the Daunia formation; the formation is characterized by stratification joints perpendicular to the bedding planes, above blue clays and varicoloured clays in a scenario of high tectonic complexity and severe climatic regime.

One dating of some early movements was made on peat sampled near the toe of the landslide, giving an age of 4000 years before present.

The Carlantino landslide is of tectonic controlled type, with the upper feeding area aligned along the direction of a big fault, which joins stiff calcarenites with clayey soils. The first probably prehistoric slide occurred on the right side of the top area; afterwards, other 4 slides come out in 1984, 1992, 1997 and 2005. Many other minor slides reached the channel at several lower elevations. A big part of the earth body, detached in 1984, never reached the accumulation zone as it stopped at about half the length of the channel.

There are several points of interest in the study of the behaviour of these large slides. The most important are the large extent of the landslide body and the coexistence in the upper, lower and lateral parts of strain and stress fields somewhat independent. As an example, 30 years after the last catastrophic movement of the upper part of the landslide body, the accumulation zone reveals still today the effects of small deformations.

In a similar manner, the stress field along various zones around the main upper fault can be different, leading to different stability conditions of the top area.

The high permeability of the calcarenites overlying clayey soils determine the conditions of perennial feeding of the landslide body by groundwater. Temperature and conductivity logs carried out in numerous boreholes drilled along the slide body allowed tracing the preferential groundwater pathways and recognizing the groundwater feeding zones.

The monitoring of the slide has been and is performed with several techniques, including the most recent ones, with different levels of performance, as single beam laser pointers, TDR (Time Domain Reflectometry), and Acoustic Emission measurement.

The last topic under investigation is the response of the slide to the seasonal changes of the reservoir level, in terms of kinematics and in terms of chemical interactions of freshwater with interstitial clay water.