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SCREE SLOPE DEPOSITS DURING A COLD-DAMP CLIMATIC PHASE IN THE EARLY MIDDLE AGES IN THE GULF OF LA SPEZIA (LIGURIA, ITALY)

ABSTRACT: CHELLI A. & TELLINI C., *Scree slope deposits during cold-damp climatic phase in the early Middle Ages in the Gulf of La Spezia (Liguria, Italy).* (IT ISSN 0391-9838, 2001).

In the coast of the eastern promontory of the Gulf of La Spezia (Liguria, Italy), it was identified a scree slope which is partially buried and partially reworked by a following translational landslide. An examination of the morphological and fabric characteristics of the scree slope revealed that it is made up of three stacked layers (a, b, c) of which the lowest (a) corresponds to a talus slope, the middle layer (b) to the accumulation of materials from debris flows and the highest (c) to the combined action of debris flows and localized falls from the overlying walls. The age ^{14}C attributed to a wood sample (*Fagus* sp.) found inside the scree slope enabled us to associate its formation, and indirectly the formation of the landslide which partially reworks it, to the cold and damp climatic phase that characterised the early Middle Ages (V cent.-VIII cent. A.D.).

KEY WORDS: Scree slopes, Cold-damp climatic phase of the early Middle Age, Gulf of La Spezia, Liguria, Italy.

RIASSUNTO: CHELLI A. & TELLINI C., *Depositi di versante riferibili a una fase climatica freddo-umida altomedioevale nel Golfo della Spezia (Liguria, Italia).* (IT ISSN 0391-9838, 2001).

Nella costa del promontorio orientale del Golfo della Spezia (Liguria, Italia), è stato individuato un deposito di versante di tipo gravitativo, in parte sepolto e in parte rielaborato da un corpo di frana di scivolamento successivo. L'esame dei caratteri morfologici e tessiturali del deposito hanno evidenziato come esso sia composto da tre livelli detritici sovrapposti (a, b, c) dei quali quello inferiore (a) è riferibile ad un deposito per gravità tipo falda di detrito, quello centrale (b) all'accumulo di materiale da parte di processi di trasporto di massa tipo *debris flows* e quello più alto (c) all'azione congiunta di *debris flows* e crolli localizzati dalle pareti soprastanti. L'età ^{14}C restituita da un campione di legno (*Fagus* sp.) ritrovato all'interno del deposito ha permesso di riferire la sua formazione, e indirettamente anche quella del movimento franoso che in parte lo rielabora, alla fase climatica freddo-umida che ha caratterizzato l'Alto Medioevo (V-VIII sec. A.D.).

TERMINI CHIAVE: Depositi di versante, Fase climatica freddo-umida altomedioevale, Golfo della Spezia, Liguria.

INTRODUCTION

In these notes we wish to indicate the localization of a scree slope in correspondence with the coast of the eastern promontory of the Gulf of La Spezia (Liguria, Northern Apennines), whose formation, on the basis of its fabric features, of the age provided by a wood sample enclosed within it and of the geometrical relations with a landslide body, provides interesting informations as palaeogeografic and palaeoclimatic as on the slope evolution within this part of the Eastern Liguria.

THE SCREE SLOPE

During a study of some landslides along the coast of the eastern promontory of the Gulf of La Spezia, we identified a scree slope which was partially buried and reworked by a translational landslide involving a portion of sea cliff with a surface of 75 x 10^3 m^2 (Chelli, 2000).

The scree slope, outcropping at sea level, covers the seaward slope in the tract behind the beach of Marosa at

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the outlet of the valley with same name (fig. 1). It has a maximum thickness of 15 metres and covers an area of 0,05 km^2 . It mainly consists of calcareous, dolomitic and marly lithotypes of the «Calcare massiccio» and «Calcare a *Rhaetavicula contorta*» formations belonging to the Tuscan facies Unit of Lerici-Tellaro (Federici & Raggi, 1975), outcropping along most of the coastal strip of the promontory (fig. 1). The scree slope surface presents gullies, while in correspondence with the coast line wide sections have been exposed by sea erosion and the mass wasting of the slope.

In the scree slope we have identified three layers which are distinguishable on the basis of fabric and texture (fig. 2A).

Starting at the bottom, layer a), with a thickness of approx. 4 metres, is made up of clasts with variable size and of matrix ranging from gravels to coarse sand. The clasts (ranging from a few centimetres to 1-1.5 metres) are chaotically piles, with their longer axis only rarely alligned in the direction of the dip slope. The matrix forms lens of limited extension occupying a portion between 20% and 25% of the exposed layer surface. The lower limit of this layer is not visible as it disappears beneath the beach, while the upper limit which marks the border with the layer above (layer b) is clearly distiguishable and ondulated.

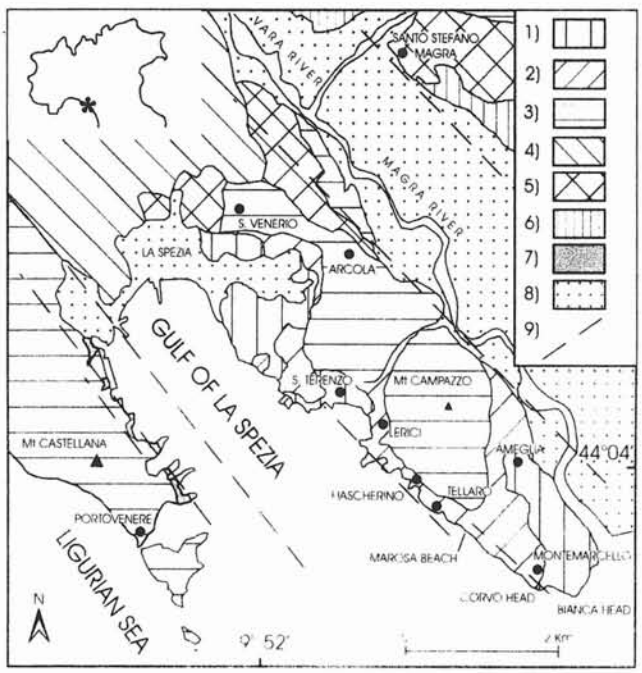

FIG. 1 - Geographical and geological setting of the area of the Gulf of La Spezia and the lower Magra Valley. Legend: 1 - Massa Unit; 2 - Lerici-Tellaro Unit; 3 - Tuscan Nappe; 4 - Gottero Unit; 5 - Canetolo Unit; 6 - Ligurid Helmintoid Flysch Unit; 7 - Panigaglia Unit; 8 - recent deposits; 9 - main faults (modified from Federici & Raggi, 1975).

The next layer b) (fig. 2A) has a maximum thickness of approx. 2 metres, of which a residual strip exists in correspondence with the southern tip of the section (fig. 2B), where strong cementation caused by the circulating waters has conserved the original stratification, visible for approx. 1.5 metres perpendicular to the coast line. It presents an inclination of approx. 30° and sinks below the beach deposit WSW. Layer b) has two distinct units: b1) and b2). Starting from the bottom, the first 150 cm approx. (unit b1 in fig. 2B) are made up of a massive matrix-supported diamict which is clearly greater in volume than the clastic fraction. The irregular, elongated clasts with sharp corners present longest axis sizes ranging between 4-5 cm and 9-10 cm and the matrix is made up of minute sandy gravel. Inside unit b1) there are intercalated lens of material with an openwork structure with a maximum thickness of 50-60 cm, limited lateral extension and a lenticular shape. They are made up almost exclusively of irregular clasts of sizes varying from 2-4 cm to 20-22 cm with a very scarce gravelly matrix. Above unit b1) lies unit b2) with a thickness of approx. 50 cm. It differs from unit b1) for the clear prevalance of fine fraction, varying from fine gravels to silt, occupying approx. 70% of the exposed surface. Inside the matrix there are clasts of sizes ranging from 5 cm to 15 cm. Some clasts are arranged in an imbricate structure or are nevertheless alligned with the dip of the stratification, forming thin beds of stones.

The stratigraphy of the whole slope end with layer c) (fig. 2A), characterised by a thickness of 3.5-4 m and made up of a gravelly-sandy-weakly silty matrix-supported diamict. The clasts, which are completely immersed in the matrix, are of various sizes ranging from elements which are measurable in centimetres to blocks with an average diameter of 1.5-2 metres.

The fabric and texture of the scree slope have led us to hypothesise a genetic interpretation of the layers composing it.

Layer a) with a massive structure characterized by a scarce matrix which is coarse grained and only present in the spaces between clasts is intrepreted as a talus slope which accumulated at the base of the cliff.

Layer b) presents a more complex structure in comparison with layer a). Of particular significance in this layer are its organisation in units determined by different matrix contents, with the matrix clearly superior to the clastic fraction in unit b2), and the presence of lens of mainly coarse material in unit b1).

An examination of specialist literature on stratified slope deposits (Bertran & *alii*, 1995; Van Steijn & *alii*, 1984; Van Steijn & *alii*, 1995) revealed some similarities between the fabric of the layer b) and the fabric of deposits associated with debris flows. The characteristics of the lens with an openwork structure of unit b1) correspond with those of deposits associated with lateral levees or the bottom of the tracks characterizing the starting area of the debris flows, while unit b2), which is rich in matrix with clasts that are alligned in the direction of the flow and ar-

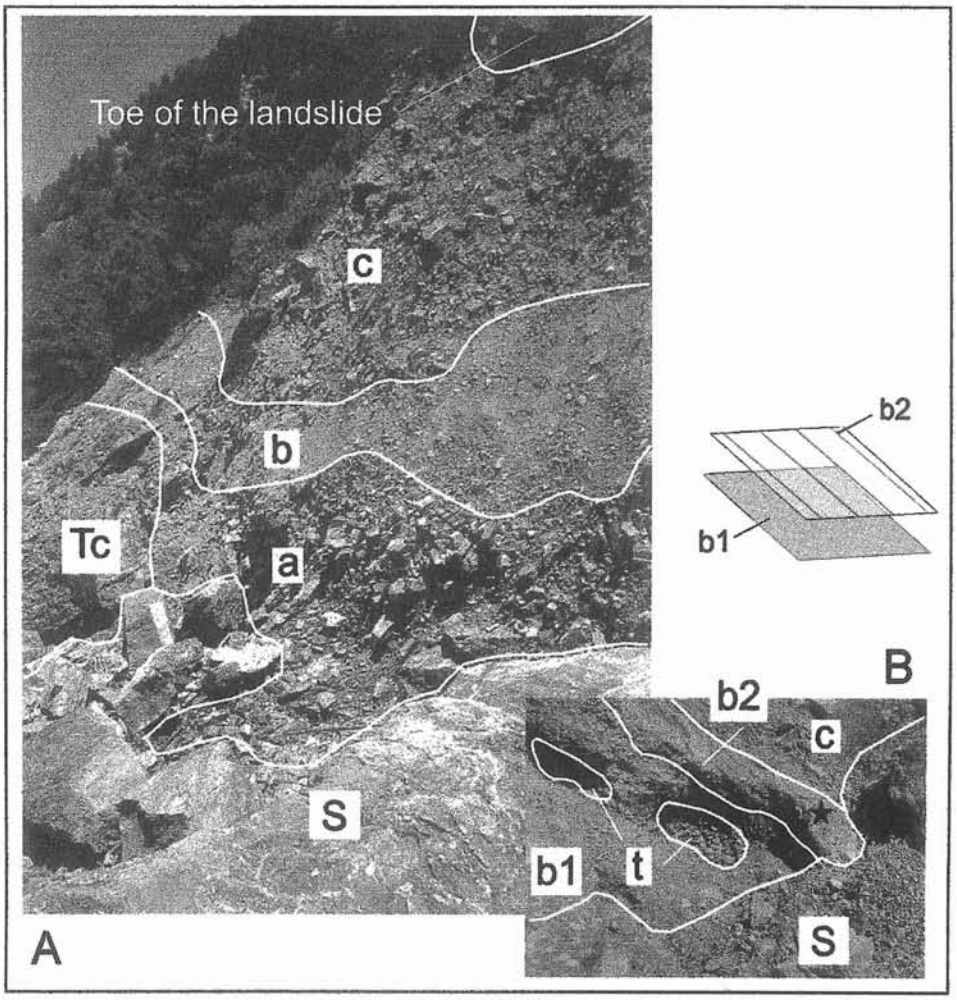

FIG. 2 - In (A) highlights the scree slope partially overlain by the toe of the Marosa Valley landslide and (B) shows a detail of the portion of layer b where the stratification is preserved (the overlap between units b1 and b2 is illustrated in the sketch apart) and where the wood that underwent radiometric dating was found (★). Legend: Tc - *Rhaetavicula contorta* limestone; a, b, c layers with different structures constituting the scre slope; S - beach deposits on which there are some blocks that fell from the overlying slope; b1, b2 units constituting layer b; t - lens mainly made up of clastic material.

ranged in an imbricate structure, could relate to tracks and levees corresponding with the distal end of the debris flow deposits. Overall, layer b) could therefore be the expression of the overlapping of subsequent debris flow deposits originating from the remobilization of material from a talus slope.

Layer c) presents structural characteristics which bear some resemblance to those of layer b) and it is, therefore, plausible to suggest that a substantial contribution to its construction came from debris flows, although the absence of sections parallel to the flow direction prevented us from making accurate observations as with layer b). In layer c), moreover, there is an increase in the average size of the clasts compared to the underlying layers and the presence of substantial blocks with diameters of over 3 metres, which can be explained by the direct, occasional contribution of falls from overlying walls to the construction of this part of the scree slope.

Inside unit b2, approx. 15 cm below its upper limit (fig. 2B), a piece of wood was found of a length of approx. 10 cm, that was analyzed at SEM [1] and identified as a portion of the roots complex of *Fagus* sp. The sample underwent a standard radiometric analysis and resulted as having a ^{14}C conventional age of 1410±60 years B.P. (Beta-148234). The age that was obtained, calibrated according to Stuiver & *alii* (1998), gave a calendar age of 610/670 cal A.D. (1σ).

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FINAL REMARKS

The dating of the wood sample found inside the scree slope made it possible to associate it with the cold-damp climatic phase of the early Middle Ages (V-VIII cent. AD), with which we consider likely the powerful action of mass wasting and debris flows on the slope, as shown by the geomorphological survey (Chelli, 2000) and by the analysis of the fabric of the deposit. The geometric relationships between the scree slope and the landslide body covering it, together with considerations on the morphological evolution of the slopes of the promontory of the Gulf of La Spezia in relation to the oscillations of the average sea level during the Holocene, make it possible to put forward the hypothesis that the landslide may also reasonably have occurred in the same period (Chelli, 2000).

Geomorphological evidence of the early Middle Ages cold-damp climatic phase were found out by different Authors in some places of the Northern Apennines and Po Plain. Landslide events, in some cases with the formation of lakes by lanslide dam, as in the upper valley of the Montone River, in Romagna and in the Apennines chain in the area of Modena near Boccassuolo, as reported by Veggiani (1981) can be associated to this climatic phase, as well as in the Apennines chain of Reggio Emilia near Casoletta (Bertolini G., pers. com.). These landslides occurred at the same time of the deposition of the thick alluvial deposits wich cover, in different sites, towns and remains of the Roman Age, such as the necropolis at south-west of the centre of Cesena, the ruins of a bridge near S. Carlo (Cesena) and the Emilia Way near Forlimpopoli (Forlì) (Veggiani, 1983; 1986). The effects of this period of increased rainfall include the alluvial deposits, with a thickness up to 5 metres, which buried the Roman town of *Mutina* (Modena), as reported by Cremaschi & Gasperi (1989) and the great floodings described in the chronacles of Paolo Diacono, Sigonio C. and Sabellico (Banzola, 1974).

These events were accompained by change in the flow paths of many rivers of the Romagna Plain, such as the Ronco River, Lamone River, Santerno River and the Po River itself. These phenomena were determined by the frequent floodings that caused the uplift of the river-beds promoting the breaking off of the banks (Veggiani, 1974; 1985; 1986).

Evidences of such climatic phase result from the studies on the change of the vegetational cover during the storic time in the north-eastern Italia area. The cooling promoted the migration of the beech (*Fagus silvatica*) and the bitter oak (*Quercus cerris*) from the watershed of the Apennines chain to the inner part of the Po Plain (Veggiani, 1986) and the syncronous diffusion of the pine (*Pinus* sp.), such as highlighted from a pollen analysis of a core sampled in the Lagoon of Venice by Bertolani Marchetti (1968).

The previous description outlines that the formation of the scree slope found in the Gulf of La Spezia is included within a phase of climatic deterioration interesting the Northern Apennines and surrounding area at regional scale. In this perspective the scree slope has a noteworthy palaeoclimatic meaning for the reconstruction of the holocenic evolution of the dynamic of the slopes in the area of the Gulf of La Spezia.

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