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Report on the INQUA-AEOMED field-trip workshop 'Reconsidering Loess in Northern Italy' (Po Plain, 1-3 July 2013)

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ABSTRACT: This report presents the results of the field-trip workshop entitled 'Reconsidering Loess in Northern Italy' (Po Plain, 1-3 July 2013), organized in the framework of the AEOMED Project of the INQUA TERPRO Commission. The workshop focuses on presenting and discussing the sources and formation processes of the loess in the Po Plain area. The sedimentological, palaeopedological, palaeoclimatic and palaeoseismic aspects of five main loess sequences in the Po Plain (Val Sorda, Gajum, Monte Netto, Ghiardo, Boschi di Carrega) were presented and discussed in the field. The discussions carried out during three field days aim to map knowledge gaps and to define the next scientific goals in the field of loess research in the Po Plain in particular and in Italy in general
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Keywords: AEOMED; Loess; Po Plain Loess Basin; Upper Pleistocene palaeoclimate.

Introducing the AEOMED Project

The second workshop of the AEOMED Project, 1-3 July 2013, (Loess and aeolian additions to current surface soils and paleosols in Mediterranean climate) was aimed to visit and discuss some of the most representative loess sequences along the northern and southern fringe of the Po Plain Loess Basin (PPLB), northern Italy. The main long-term aims of the AEOMED Project (https://ppsg2011.uni-hohenheim.de/94176), which is part of the TERPRO Commission of INQUA, are: (i) to assess the spatial pattern of loess deposits across the Mediterranean: (ii) to analyze loess successions in similar geomorphic units of various Mediterranean environments; (iii) to estimate the potential of dust emission and deposition in the various Mediterranean environments, based on the under-

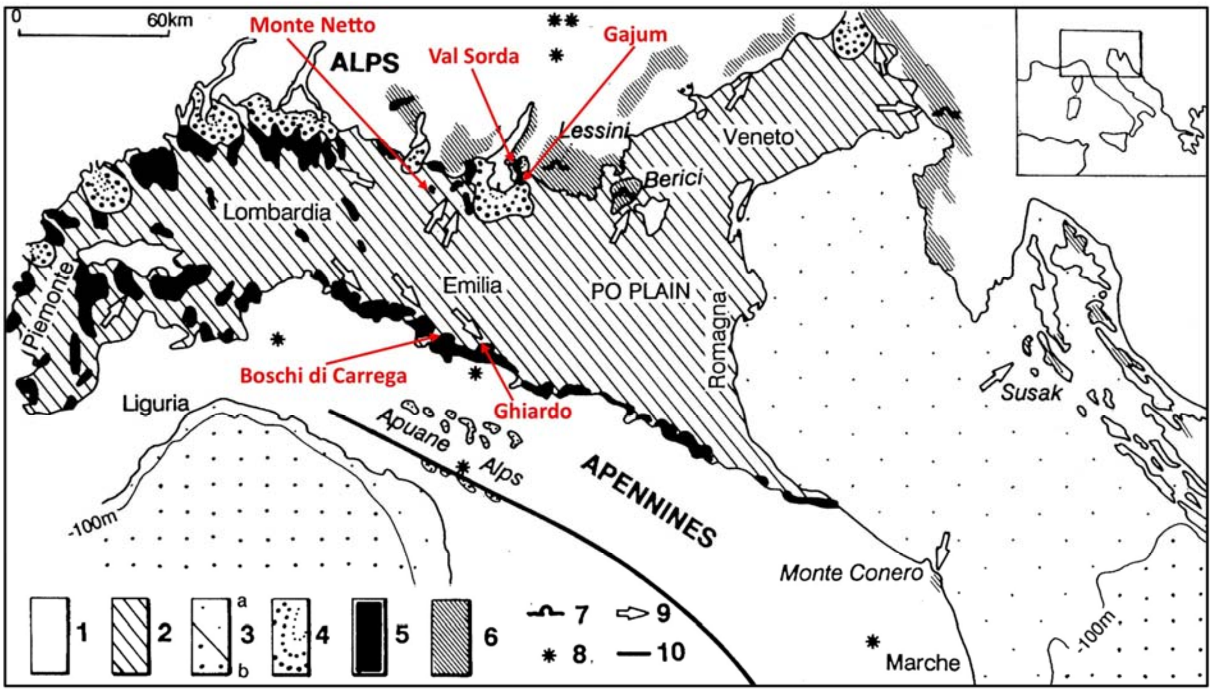

Fig. 1 - Map illustrating the distribution of loess in the Po Plain (modified from Cremaschi, 1990); the sites visited during the workshop are also indicated. 1) pre-Quaternary bedrock; 2) alluvial plain; 3) present-day sea extent; 4) moraine systems; 5) loess on fluvial terraces and moraine ridges; 6) loess on karst plateaus; 7) loess in rock shelters; 8) loess on erosional surfaces; 9) direction of dominant winds during loess sedimentation; 10) possible SW boundary of the loess basin.


Fig. 2 - The participants to the workshop visiting the Val Sorda sequence.

standing of the mechanisms of dust and loess generation, transportation and deposition. Short term aims of AEOMED Project for the following two years (2013-2015) are: (i) to reconsider the loess in northern Italy, mainly the Po Plain loess; (ii) to study loess sites with non glacial aeolian loess deposits, specifically loess and dust derived from the Sahara desert in sites at the central and southern Italy; (iii) to map the loess in Italy along a north-south climatic transect. This project will contribute to identify sources of recent and palaeo-dust/loess around the Mediterranean Sea and to evaluate rates of loess/dust deposition in the context of palaeoclimate reconstructions, and soil formation processes.

The workshop held in Italy on July 2013 entitled 'Reconsidering Loess in Northern Italy' was aimed to bring together loess experts from Italy and elsewhere to discuss the loess topic in Italy in the context of the loess issue in Europe and around the Mediterranean basin in several key sites at the PPLB. Basic questions were discussed such as variety of loess types, sources of the different loess types, climatic deriving forces for loess transportation and deposition, loess accumulation processes, the formation of loessial soils in glacial and non-glacial environments and its paleoclimatic implications.

The workshop was organized by R. Amit, A. Zerboni, E. Costantini, S. Carnicelli, M. Cremaschi, F. Livio, and A.M. Michetti as part of INQUA TERPRO activities. Wide board of expertise attended at the meeting (30 scientists) including geomorphologists, palaeopedologists, sedimentologists, Quaternary geologists, geoarchaeologists and palaeoseismologists. In addition 9 grants were available for young researchers from Italy, Israel and Mexico. Additional support, derived from the Università degli Studi di Milano, Università degli Studi dell'Insubria, Università degli Studi di


Fig. 3 - A detail of the loess/paleosols sequences deformed by a gravity graben at Monte Netto; note the thick red paleosol buried by loess.

Fig. 4 - Loess sequences at the southern fringe of the PPLB: (A) the participants discussing the significance of loess and paleosols at the Ghiardo site; (B) the loess sequence at the Boschi di Carrega site. Note in (B) a deep and dark horizon with high concentration of Mn concretions.

Firenze and CRA-ABP, allowed opening new trenches and soil pits at each study site.

Reconsidering Loess in Northern Italy: An example of the extensive Po Plain loess

In the framework of European terrestrial palaeo-records, the loess in Italy in general, and the loess in the Po Plain in particular, represents an extraordinary sedimentary record for palaeoenvironmental reconstructions (Fig. 1). Despite of many systematic studies carried out in the last decades on loess sequences located at northern, eastern and southern margin of the Po Plain, loess in Italy is somewhat overlooked in comparison to the classical sequences described in central and north Europe. As a result, crucial data are excluded from the analyses and interpretations of the loess in Europe.

The term loess refers herein to silty sediments, which have been transported and accumulated by aeolian activity (Cremaschi, 1987a). However, because the loess deposit in northern Italy are generally thin and can be affected by syn- and post-depositional weathering, soil formation and colluviation, sometimes their characteristics do not fully meet the standard requirements generally accepted for classical loess. Thus the identification of loess in all studied sites was based on geomorphological criteria, textural and mineralogical characteristics and geoarchaeological evidence (Cremaschi, 1987a; 1990).

Two of the visited sites are located in the eastern part of the Garda lake area (Fig 2). The Val Sorda sequence is a 5 m-thick, very well preserved Upper Pleistocene stratigraphic section consisting of the succession of a till, capped with a rubified Eemian paleosol, which is overlain by a colluvial layer and a thick loess unit, which includes three chernozem paleosols (Cremaschi, 1987b; Ferraro, 2009). The loess sequence is capped, compacted and preserved by glacial deposits dated to MIS 2. The texture of the loess is sandy silty with no much clay. The well sorted silt and fine sand composed mainly by muscovite and quartz with subangular quartz grains. The age of the upper chernozem -like soil derived from humic acids is c. 28 ka BP (Cremaschi, 1987b); OSL and IRSL dating yield an age for the aeolian deposition between c. 63 and 19 ka BP (Cremaschi, 1987b; Ferraro, 2009). The importance of Val Sorda loess sequence is its high degree of preservation. The fact that the original features of the loess and loessial soils are well preserved is the result of the burial by the uppermost thick moraine deposits that isolate the loess sequence from later and recent pedogenic processes. The loess sequence at Gajum site (Cremaschi, 1987b) is similar to the loess sequence at Val Sorda, with local colluvial material present at the bottom and aeolian loess at the top. Differently from the loess section in Val Sorda, the loess in Gajum site was accumulated in a depression at the top of a karst plateau and was not buried by any glacial or fluvial deposit. Thus it was subject to continuous weathering and pedogenic processes, resulting in more weathered loess deposit; radiocarbon ages indicate that loess deposition occurred up to c. 42 ka BP (Cremaschi, 1987).

Monte Netto site (Capriano del Colle, BS) is an isolated hill in the middle of the northern Po Plain (Fig. 3), whose growing is due to the amplification of a buried thrust-related anticline since the Middle Pleistocene (Livio et al., 2009). A highly rubified, polycyclic paleosol covered by few tens of centimeters of loess characterize the top of the anticline. At the distal part of the exposure the thickest loess sequence of the whole PPLB is found. The continuous growing of the anticline during the late Quaternary allowed such an exceptional thick accumulation of loess. The upper part of the section corresponds to at least three events of aeolian sedimentation, two of which are OSL dated to the Upper Pleistocene, while a later aeolian activity has been radiocarbon dated to the end of the LGM. Loess sedimentation at Monte Netto started after an intensive phase of pedogenesis of fluvial sediments, likely occurred under interglacial conditions. This produced a highly rubified paleosol rich in illuvial clay. Subsequent weathering phases gave rise to the formation of paleosols progressively less rubified and rich in clay toward the top of the sequence, which may correspond to several upper Pleistocene interstadials. Palaeopedological indeces also confirm a progressive reduction of the intensity of pedogenesis rate during the Upper Pleistocene. Textural changes between fresh and weathered loess is underlined by the occurrence of horizons showing a high concentration of manganese concretions. The sequence also preserves evidence of strong palaeoearthquakes, which contributed to the displacement of the loess strata and the pedological horizons (Livio et al., 2009).

The last two sequences are located at the foot of the Apennines (Fig. 4), and are represented by thick loess strata covering deeply weathered Pleistocene fluvial sediments. The aeolian loess went through intense to moderate pedogenesis, which result in different loessial soil profiles in each site. In the soils we generally identify processes of accumulation of illuvial clay, decalcification, and acidification, which were followed by release, translocation, reduction/oxidation and precipitation of Mn and Fe through hydromorphism (Cremaschi, 1987b). Ghiardo site (Cavriago, RE) is a complex loess sequence, deposited on Pleistocene alluvial terraces (Cremaschi, 1987b). This sequence records an Upper Pleistocene aeolian sedimentary phases of loess accumulation (c. 63 to 36 ka BP), which underwent intense weathering processes. Moreover, the surface buried by loess and its initial phase of deposition are contemporaneous with the dwelling of Mousterian hunters, while the top part of the soil bears traces of Chalcolithic land management, which appears to have influenced the soil forming processes. The high terrace of Boschi di Carrega (Collecchio, PR), is covered by loess accumulated during the Late Pleistocene. This loess sequence correlates with the loess sequence of the Ghiardo terrace. Soil data collected since the 60s (Ferrari and Magaldi, 1968), show deep horizons developed in loess, forming complex soils with most of them acidified at the top.

To sumarize, although the loess deposits and loessial soils in each site were slightly different, the main sedimentological and pedological characteristics are similar mainly in their stratigraphic appearance, particle size distribution, and mineralogy. In places where the loess was not buried by fluvial or fluvio-glacial sediments and was subject to continuous pedogenic processes the loess is more weathered and more clayey. This arise the possibility that the loess in the Po Plain is derived from the same local sources, which might be the Po flood plains and the Po influents, which were exposed during glacial time for long periods and were subject to intense winds at that time. Possibly, the combination of increased wind strength with availability of sediments allowed the formation and/or transportation and deposition of loess over a large area, from

Fig. 5 - Group photo of part of the participants to the AEOMED workshop.

the Adriatic coast to the inner part of the Po Plain, at the foot of western Alps (Cremaschi, 1990). The fact that most of these loess areas were not covered by ice during glacial times, arise the possibility that the source for the loess can be primary silt size fractions or local proximal sands, which were subject to aeolian abrasion to form silt size grains. These preliminary assumptions should be supported by more data and more studies, which will be conducted in the near future.

Concluding remarks and future work

The results of this workshop will be the basis for planning the next steps of the AEOMED Project working group, which will aim to study the non-glacial loess of Italy (e.g., Costantini et al., 2009). The data from the non-glacial loess will be later compared to the glacial loess type in the PPLB and around the Mediterranean to better understand the process of loess formation, transportation, accumulation, distribution and its association with soil formation and climate. In a wider perspective, as Italy represents a natural bridge between the north Africa/Sahara and Europe, it would be important to understand any contribution of Saharan dust to Italian loess, to compare it to the extant dust flux and to infer any possible modifications triggered by recent global changes. During the conclusive discussion, we decided to integrate all information regarding the loess in the PPLB to draw a map showing the distribution and properties of the loess sediment and soils. The map of PPLB will be published in a collaborative paper, which will present and interpret all published and new data regarding the loess in northern Italy. The newly opened loess-soil pits will be dated by OSL, and results integrated with published and unpublished ages for loess formation to get a better time constrain on the loessial periods in the Po Plain.

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