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TOWARDS A MAP OF THE UPPER PLEISTOCENE LOESS OF THE PO PLAIN LOESS BASIN (NORTHERN ITALY)

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ABSTRACT: Upper Pleistocene (MIS 4–2) loess sequences occur in most of continental Europe and in Northern Italy along the Po Plain Loess Basin. Loess is distributed along the flanks of the Po Plain and was deposited on glacial deposits, fluvial terraces, uplifted isolated hills, karst plateaus, slopes and basins of secondary valleys. Loess bodies are generally tiny and affected by pedogenesis, being locally slightly reworked by slope processes and bioturbation. Notwithstanding, loess in the Po Plain is an important archive of paleoenvironmental record and its mapping provides new insights in paleoenvironmental and palaeoseismic reconstructions of Northern Italy.

KEYWORDS: Loess, Po Plain loess basin, upper Pleistocene, mapping

1. INTRODUCTION

In the framework of European terrestrial palaeorecords, loess is one of the best archives for Quaternary palaeoenvironmental reconstruction (e.g. Smalley & Leach, 1978; Coudé-Gaussen, 1990; Pye, 1995; Cremaschi, 2004). Maps published in the last decade that present the distribution of loess in Europe eliminate loess outcrops in Northern Italy or, alternatively, define them as loess derivates (Haase et al., 2007; Bertran et al., 2016; Lindner et al., 2017). As a consequence, despite systematic studies carried out on the Upper Pleistocene loess sequences at the margin of the Po Plain (see Cremaschi, 1987, 2004 and references therein), loess in Northern Italy is overlooked in comparison to the classical sequences described in continental Europe (Amit & Zerboni, 2013), and crucial data are excluded from the interpretation of loess formation at a continental scale.

For this reason, in the last few years we revised the sedimentological, paleoenvironmental, and geochronological data regarding the loess from the Po Plain Loess Basin (PPLB), including new data derived from studying some classical loess outcrops (e.g., Ferraro, 2009; Wacha et al., 2011; Cremaschi et al., 2015; Cremaschi & Zerboni, 2016), as well as freshly identified sequences (e.g., Rellini et al., 2009; Zerboni et al., 2015; Frigerio et al., 2017). Moreover, in a region - the Po Plain foredeep - of moderate seismicity loess is a stratigraphic marker of increasing interest for earthquake hazard characterization (e.g., Livio et al., 2014). To provide the necessary spatial context for these tasks, a systematic mapping of loess outcrops along the Po Plain is on-going and preliminary results are here discussed.

2. THE PO PLAIN LOESS BASIN

Loess is a wind-blown, mainly silty-sized sediment. It is widespread in Northern Italy, where it is typical of glacial periods, when sediment grinding (weathering), transportation, and sedimentation are enhanced by dry environmental conditions with poor vegetation cover and characterized by strong winds (Cremaschi, 1990; Orombelli, 1990; Pye, 1995).

Except for a few thick sequences of unweathered loess deposits (as the Val Sorda sequence) and/or complex pedosequences (as at Monte Netto), most of the outcrops in Northern Italy consist of thin loess sheets located on dissected fluvial terraces, glacial deposits, uplifted isolated hills, and karst plateaus (Fig. 1). These are for the most part set along the southern margin of the Alps and the northern margin of the Apennines. Loess sequences can also be found on top of polygenetic paleosols, inside sinkholes, and intercalated in rock-shelter deposits. Furthermore, loess deposits in Northern Italy are often associated with Middle Palaeolithic archaeo-

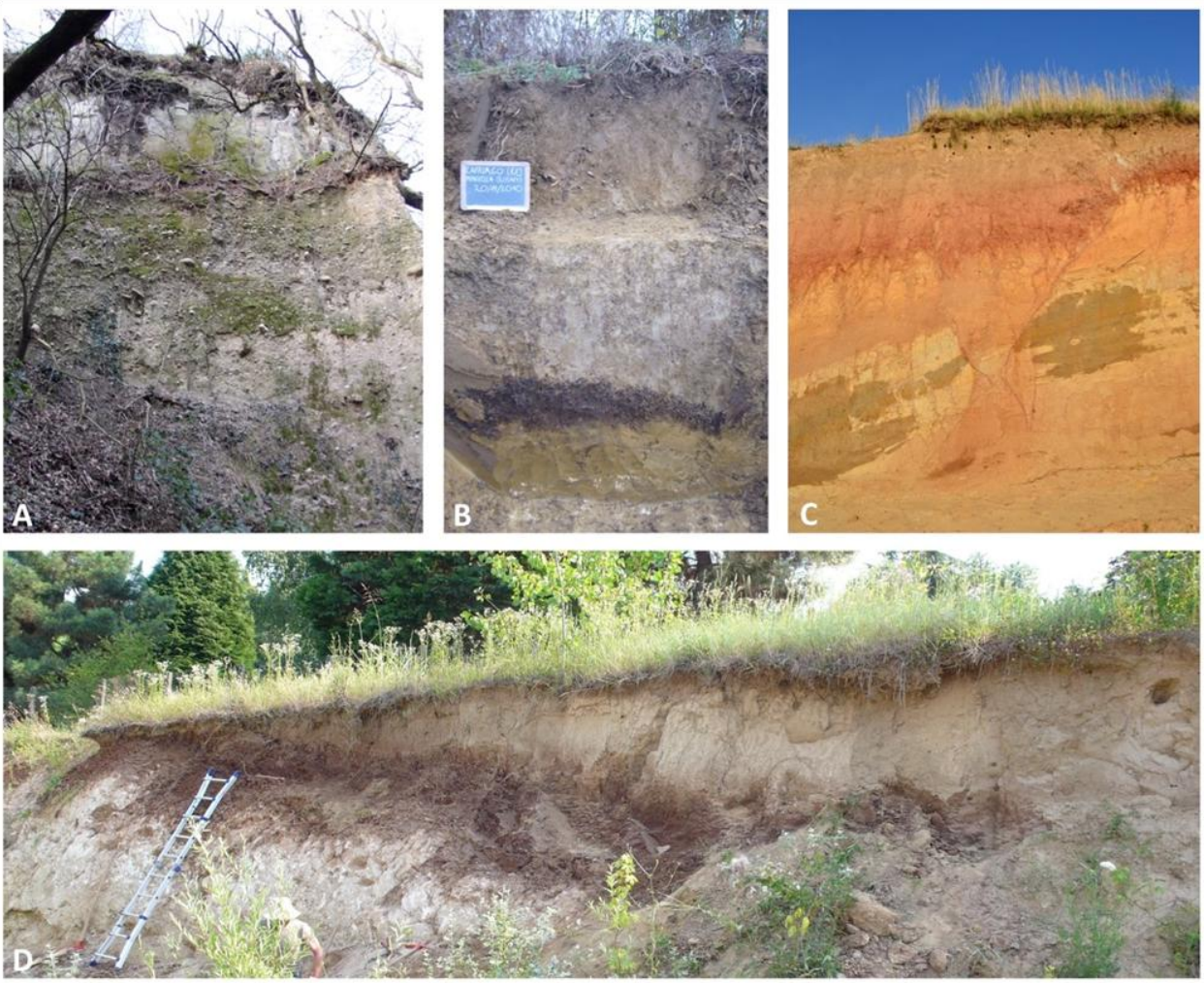

Fig. 1 - Some loess outcrops investigated in the last few years. A) The Val Sorda sequence (Cavaion Veronese, VR): loess lies on a glacial deposit. B) Loess at the margin of the Apennine (Cavriago, RE) (Cremaschi et al., 2015). C) The Monte Netto (Capriano del Colle, BS) sequence (Zerboni et al., 2015), displaced by an array of normal faults (i.e., gravity graben). D) Loess sequence at Pecetto di Valenza (AL) (Frigerio et al., 2017).

logical sites, showing that the Po Plain Loess Basin (PPLB) was a suitable environment for Mousterian hunter-gatherers.

Available chronology, based on a number of radiocarbon, TL, and OSL dating suggests that the formation of loess occurred during the Upper Pleistocene, between at least 75 and 16 ka BP (MIS 4-2) (Cremaschi, 2004; Zerboni et al., 2015). Thicker sequences (as at Ghiardo and Monte Netto sites) also record weak to moderate soil-forming processes dating to the Upper Pleistocene interstadials and the Holocene. At many sites, the uppermost part of loess sequences likely underwent moderate to strong reworking due to post-Last Glacial Maximum (post-LGM) reactivation of slope processes, enhanced Holocene bioturbation, and, more recently, human-induced processes (tillage). As a result, colluvial and bioturbated units/soil horizons were formed, whose ^{14}C and OSL dating provided mid-Holocene ages that are interpreted as due respectively to the mixing of soil humic acids over a long time and rejuvenation of dose signal. This has been demonstrated at Monte Netto and Ghiardo sequences (Cremaschi et al., 2015; Zerboni et al., 2015).

3. DRAWING THE LOESS MAP

The available geological maps present loess deposits only fragmentarily, as layers inside or at the top of Quaternary formations, without providing any information on the sedimentary and post-sedimentary (pedogenetic) processes affecting loess covers. On the other hand, the available pedological maps suggest the occurrence of silt-bearing soil horizons, but interpretations of sedimentary processes ruling the accretion of silt are lacking. A few attempts to reconstruct the spatial distribution of loess in the PPLB have been preliminary published by Cremaschi (2004), Cremaschi et al. (2015), Zerboni et al. (2015); moreover, the Climex Map

of the LGM (Vai & Cantelli, 2004) offers a good representation of many loess outcrops. For these reasons, the publication of a new map presenting the spatial distribution of loess is necessary and relies on field surveys in key regions, integrated by observations on (i) geological contexts and (ii) active and inactive surface processes.

At the first stage, we will identify and study landforms acting as sedimentary traps for loess aggradation (Cremaschi, 2004), such as: (i) glacial sediments (moraines) and fluvioglacial deposits at the southern fringe of the Pre-Alps; (ii) karst plateaus (and sinkholes) between Lombardia and the Dalmatian coast, and in the Conero promontory (Marche region); (iii) isolated hills in the middle of the Po Plain, actively growing through repeated coseismic uplift during the Late Quaternary; (iv) fluvial terraces of different ages on the Apennine foothills between southern Piemonte, Emilia Romagna and Marche regions; (v) glacis and erosional surfaces in the Apennine range of Marche, Emilia Romagna, and Liguria regions, where sedimentation can be influenced by the pre-existing topography. In the map, loess outcrops will be represented distinguishing between: (i) unweathered loess; (ii) weathered loess and loessial soils displaying different degrees of weathering and characterized by distinctive soil-forming processes; and (iii) colluvial/reworked loessic sediments (loess derivates). At a second stage, a more detailed classification of loess units will be under evaluation. This will offer a better comprehensive palaeoenvironmental context in the light of the maximum expansion of Alpine and Apennine glaciers and the shoreline of the Adriatic Sea during the LGM, which will be included in our map as reconstructed in the Climex Map (Vai & Cantelli, 2004).

4. PRELIMINARY CONCLUSIONS

Because loess deposits in Northern Italy are generally thin and can be easily affected by soil-forming processes, sometimes their characteristics do not fully meet the standard requirements generally accepted for classical loess (Haase et al., 2007). Although loess deposits and loessial soils in the Po Plain are slightly different, the main sedimentological and pedological characteristics are similar in their field appearance, particle size distribution, and mineralogy, thus suggesting a similar source. The source area was identified as the Po flood plain, which was exposed during glacial periods and was subject to intense winds at that time. The investigation of several key sequences and the systematic mapping of outcrops are demonstrating the importance of North Italian loess for the reconstruction of Upper Pleistocene palaeoclimates of the northern Mediterranean region and the paleoseismic record of the Po Plain foredeep.

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