Unraveling the origin of the loess of the lower Ebro river basin

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INTRODUCTION AND OBJECTIVES

The largest loess area in the Iberian peninsula is located in the lower Ebro depression and Móra d'Ebre basin (**Fig. 1**), occupying around 2000 km^2. Most of the outcrops date from the Last Glacial Maximum (LGM), with ages between 17 and 34 ky (*Boixadera et al.; 2015*). The principal source area of the loess, taking into account (1) the N-NW wind direction, (2) the topographic situation of loess, (3) their coarse texture and (4) mineralogy is the Ebro floodplain, in particular its T2 terrace. The objective of this study is to locate more precisely the source areas by aerodynamic modelling and grain size distribution analyses of the T2 and the loess.

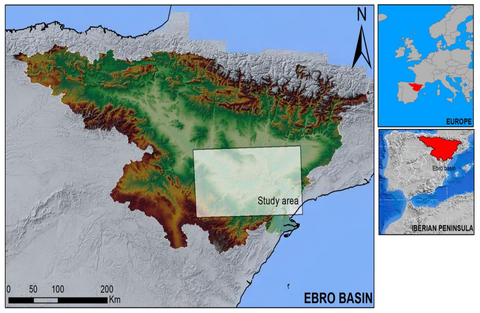

Figure 1. Location of the studied loess area in the lower Ebro Valley. Spain.

GRAIN SIZE DISTIBUTION - T2 TERRACES (Source area)

Forty samples were taken from the T2 terrace of the Ebro, Cinca and Segre rivers with a subsequent granulometric analysis by laser diffraction (**Fig. 2**) to be able to have a complete distribution of the possible main source area (**Fig. 3**). The Ebro river has a predominance of coarse and medium sands at the top that evolves to medium and fine sands down to the union with Segre river. The lower section is dominated by fine and very fine sand. The Segre river has a predominance of medium, fine sand and silts down to the mouth of the Cinca where the percentage of silt decreases. The Cinca river has a predominance of silt, medium and fine sand in the upper section with a progressive decrease in silt in the reaches located downwater.

Figure 2. Particle size distribution (USDA) of the T2 terraces in the Ebro, Cinca and Segre rivers from Zaragoza, Monzón and Balaguer respectively down to the lowest point of Móra basin

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RELATIONSHIPS LOESS - T2 TERRACES

The results of applying a wind erosion-deposition model (*Lindsay and Rothwell, 2008)* by winds from the NW match very precisely most of the known loess outcrops, therefore it validates the hypothesis of the source area (**Fig. 4**); where terrace T2 occupies 80,000 ha (**Fig. 3**). The textures of the terraces are sandier (coarser) than the loess textures (**Fig. 5**). Together with some identified deflaction areas, they are considered to be the main source areas for loess (*Plata et al., 2019).* Similarly as in *Wolf et al. (2019)* we found a clear relationship between the topographic height and the fine sand content of loess *(***Fig. 6***)* and a less clear tendency to decrease fine sand content with respect to the distance to the Ebro river according to a NW direction (**Fig. 7**).

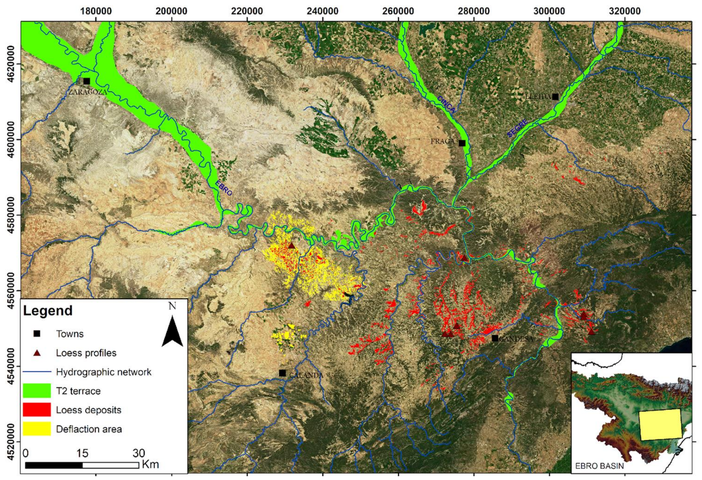

Figure 3. Distribution of loess deposits and source areas (T2 terraces and deflaction basins) in the study area in the lower Ebro Valley

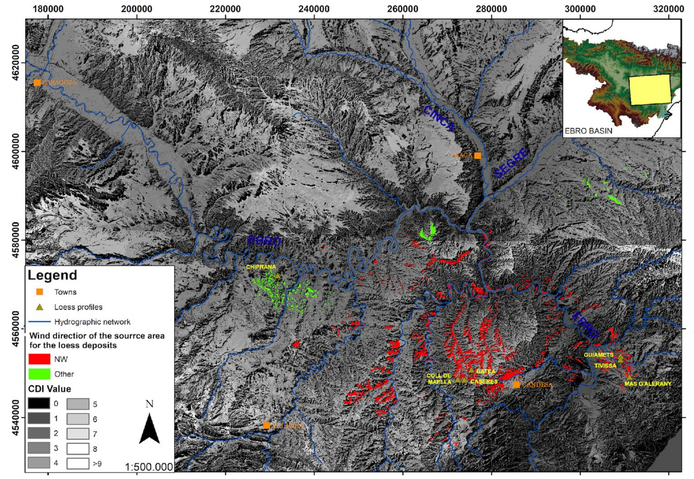

Figure 4. CDI (Channelling/Deflaction Index) map derived for the model of Lindsay and Rothwell (2008) setting a NW wind direction. Loess oucrops have been classified according to the wind direction of the source area.

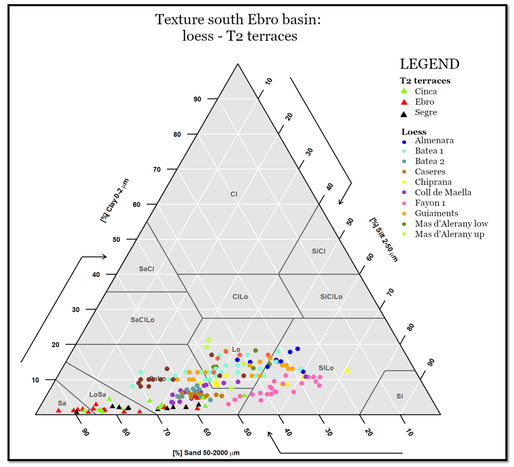

Figure 5. Textural classes of the materials of T2 Terraces (triangles) and loess deposits (circles) (USDA) as in Figure 3.

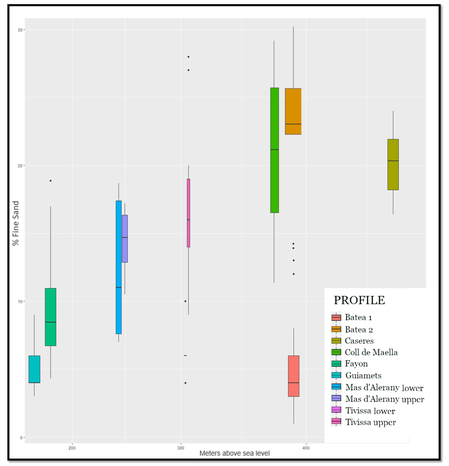

Figure 6. Relationship between % fine sand in loess and the absolute loess profile height.

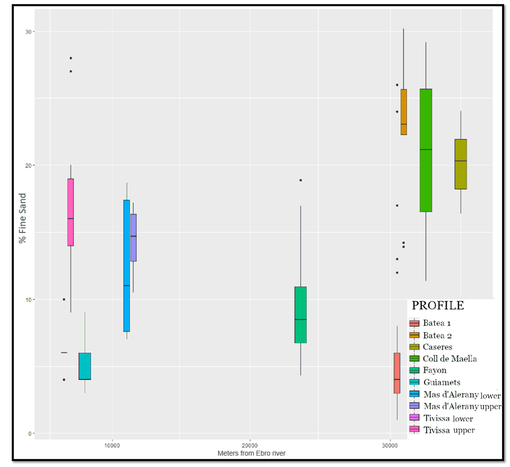

Figure 7. Relationship between % fine sand in loess and the distance to Ebro river according to a NW wind provenance.

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CONCLUSIONS

- The terraces are the main source area of the loess, although further sampling and analyses (as e.g. mineralogy) are still required to confirm this.
- Distance to the Ebro river doesn't seem to be as determinant as absolute height, pointing to more local sources of loess and shorter travel distances.