Quaternary International xxx (2015) 1–12

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Soil-stratigraphy in the cave entrance deposits of Middle Pleistocene age at the Trinchera del Ferrocarril sites (Sierra de Atapuerca, Spain)

Josep Vallverdú i Poch [a, b, c]

[a] IPHES, Institut Català de Paleoecologia Humana i Evolució Social, C/Marcel.lí Domingo s/n, Campus Sescelades URV (Edifici W3), 43700 Tarragona, Spain
[b] Área de Prehistoria, Universitat Rovira i Virgili, Avda. Catalunya 35, 43002 Tarragona, Spain
[c] Unidad asociada al CSIC, Departamento de Paleobiología, Museo Nacional de Ciencias Naturales, Calle José Gutierrez Abascal, 2, 28006 Madrid, Spain

ARTICLE INFO

Article history:
Available online xxx

Keywords:
Soil stratigraphy
Paleosols
Cave entrances
Colluvial fans
Middle Pleistocene
Sierra de Atapuerca

ABSTRACT

This research focuses on the description of the sedimentary infills of the Trinchera del Ferrocarril caves (Sierra de Atapuerca) in order to identify buried soils (paleosols). Sediments, soils, and sediments derived from soils form a continuity that is difficult to analyze in the field or at microscopic scales of observation. The sediments of the cave entrances of Trinchera del Ferrocarril contain weakly to strongly developed soil properties. The results presented in this paper describe three different styles of soil stratigraphy during the Middle Pleistocene. These soil-stratigraphic styles are classified based on the maturity of the soils (by development) and the degree of incision (entrenchment), similarly to pedostratigrahic models of alluvial fans. Soil stratigraphy contributes to our understanding of the different implications in the sedimentary record of environmental changes at a local and regional scale. The absolute dates of the soil stratigraphy in the Trinchera del Ferrocarril caves indicate that the environmental changes have the same temporal scale as the orbital climatic cycles (interglacial/glacial, stadial/interstadial). The different soil properties, horizon types and time intervals of soil formation indicate a specific mode of environmental change for each style of soil stratigraphy identified.

1. Introduction

Sediments and soils of Pleistocene cave entrances are difficult to correlate with current and relict landscapes. The stratigraphy of the soils is estimated and compared with the soils of the present regional landscape, and the properties of the soils are examined in order to establish a soil-development index. Some soil properties are not the product of a single isolated soil forming process. For example, calcium carbonate accumulation and depletion (decalcification) occurs during distinct phases and cycles; and some soil properties, described in the typical terra rossa soils of the Mediterranean area, are polygenic. Thus, the objective of this study consists of describing the relict properties and the ages of the soils in the deposits of the Trinchera del Ferrocarril caves.

The sedimentary successions of Gran Dolina (TD), Galeria (TG) and Sima del Elefante (TE) have been documented through a great deal of research focusing on the sedimentology, paleontology, paleoecology and geochronology of the Trinchera del Ferrocarril (railway trench) caves. Furthermore, advanced research has been conducted to study the fluvial and karst geomorphology (Fig. 1) (Parés and Pérez-González, 1999; Pérez-González et al., 2001; Rosas et al., 2001; Cuenca-Bescós et al., 2010; Rodríguez et al., 2011). Furthermore, advanced research has been conducted to study the fluvial and karst geomorphology (Benito-Calvo et al., 2008; Ortega et al., 2013, 2014). The soil-stratigraphic units described in this study can be correlated with the stratigraphic units described in these other researches (e.g. lithostratigraphy, biostratigraphy and chronostratigraphy).

The temporal scale of Pleistocene soil stratigraphy has an order of magnitude similar to the temporal scales used in archeology and geomorphology (Holliday et al., 1993). The geomorphology of soils is a discipline that deals with the evolution and change of the landscape (Birkeland, 1999). The description of the soil profile helps us to relate the landscape on a local and regional scale. The temporal framework of this study is provided by the extensive research into the geochronology of Trinchera del Ferrocarril. Numerous dating methods have been used and various dates suggested for the Galeria and Gran Dolina sites (U-Series, combined ESR-U, ESR, luminescence, paleomagnetism and biochronology) (Falguères et al., 1999; Berger et al., 2008; Moreno et al., 2012; Falguères et al., 2013; Demuro et al., 2014).

E-mail address: jvallverdu@iphes.cat.

http://dx.doi.org/10.1016/j.quaint.2015.09.031
1040-6182/

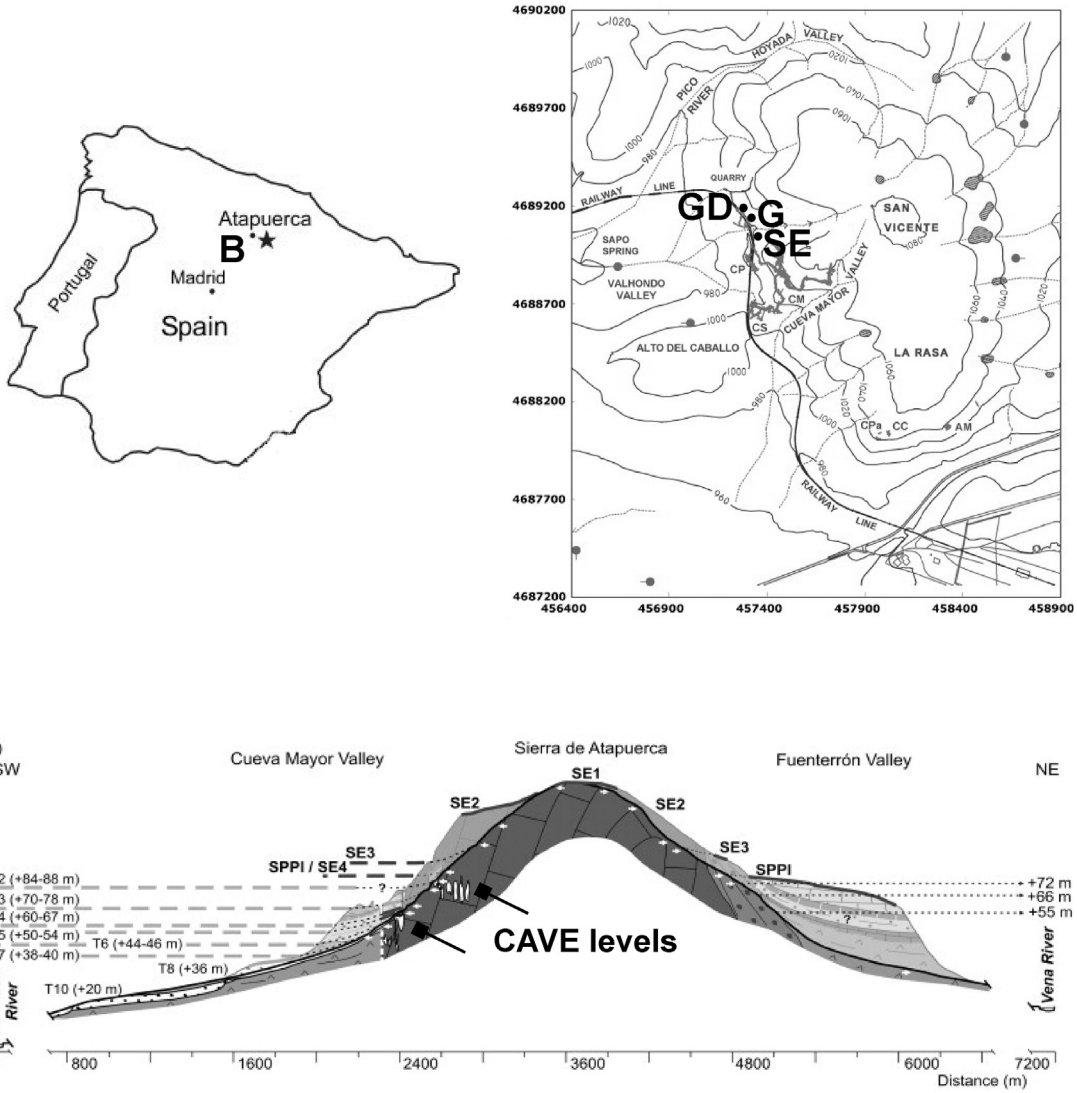

Fig. 1. The caves of the Trinchera del Ferrocarril form part of the karst system of the Sierra de Atapuerca located in the northern Iberian Peninsula near the city of Burgos (B), Spain. The cave infills mentioned in the text are SE, Sima del Elefante; GD, Gran Dolina; and G, Galeria. Below, cross-section of the Sierra de Atapuerca along with Cueva Mayor and Fuenterrón valleys (redraw from A.I. Ortega et al. 2013). Cave levels of the Sierra de Atapuerca and Pleistocene Arlazon river terraces (T) and Neogene surfaces (S) maintains relationships in their altitudinal distribution.

Some soil properties provide evidence upon which climatic and vegetal reconstructions of the past can be built (Birkeland, 1999). The soil-sediment analysis summarized in this study consists of separating relict from reworked pedofeatures by means of soil micromorphology. The description of the parent material and the soil properties can contribute to estimating a soil order and to recognizing stratigraphic bed markers (McCarthy and Guy Plint, 1998). In short, this paper describes the soil stratigraphy of the deposits of the Sima del Elefante, Galería and Gran Dolina in order to identify and classify the stratigraphic successions of buried soils (paleosols).

2. Materials

The Sierra de Atapuerca is located in the north-western Duero basin, in the Arlazon River valley. The Duero basin forms the northern Meseta, an erosion surface with an elevation of 700–800 m.a.s.l., located in the center of the Iberian Peninsula. The caves of the Sierra de Atapuerca are at an elevation of 1000 m.a.s.l. (Fig. 1). The physiography of the Sierra de Atapuerca is related to the southern Bureba corridor, a biogeographic passage which connects the Duero basin with the Ebro basin and the Cantabrian Range.

The Sierra de Atapuerca is an outcrop of Mesozoic age (Cretaceous) in the Arlanzón and Vena river valleys. There are 14 fluvial deposits of Quaternary age (terraces) in the Arlanzón River valley. The Matuyama–Brunhes boundary is located between terrace T4 (inverse polarity) and terrace T5 (normal polarity) (Benito-Calvo et al., 2008). Recently, a new chronological framework based on the chronology of the fluvial terraces and the sediments of the cave infills of the Trinchera del Ferrocarril has been proposed to explain the Pleistocene age of the karst system of the Sierra de Atapuerca (Benito-Calvo et al., 2008; Moreno et al., 2012; Ortega et al., 2013). The Middle Pleistocene biostratigraphy of the caves of the Sierra de Atapuerca consists of two faunal units (FU 5 and FU 6) (Cuenca-Bescós et al., 2010).

The Pleistocene sedimentary succession of Gran Dolina cave has 11 lithostratigraphic units: TD8, TD9, TD10 and TD11 are of Middle Pleistocene age (Fig. 2). Galeria cave contains five lithostratigraphic

Please cite this article in press as: Vallverdú i Poch, J., Soil-stratigraphy in the cave entrance deposits of Middle Pleistocene age at the Trinchera del Ferrocarril sites (Sierra de Atapuerca, Spain), Quaternary International (2015), http://dx.doi.org/10.1016/j.quaint.2015.09.031