FLUVIAL AND LACUSTRINE DEPOSITS

Dating of fluvial (tufa) and lacustrine (tufa and muds) deposits: terrestrial, freshwater and brackish-water mollusc and ostracod shells.


Tufa deposits from Priego (Cuenca, Central Spain)

A common freshwater gastropod Planorbis sp.


Point bar made of tufa clasts from Priego

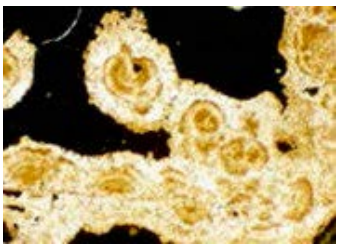

Tufa deposits from the Tagus river


Terrestrial gastropod accumulation (Helicacea) in Fuente Amarga site (Guadix- Baza Basin)


Stepped tufa terraces from the Henares river


Digging for clean samples in the tufa sands of Rio Blanco (Soria, Spain)


Chara sp gyrogonite


Microphotograph of a thin section showing a blue-green algae built tufa from Priego

With a length of more than 1,000 km and stretching from its headwaters in the Iberian Range to its mouth in the Atlantic Ocean, the Tagus river is the longest watercourse in the Iberian Peninsula. In its headwater area and flowing southwest from this Range there are many tributaries with catchments in the same Range. These tributaries flow over mainly carbonate Mesozoic rocks, and have produced considerable tufa accumulations, e.g., the Henares and Dulce rivers, near Sigüenza, the Trabaque, Escabas and Guadiela rivers near Priego, and the Cifuentes and Ruguilla rivers, near Trillo (Fig.1). Likewise, tufa accumulations linked to a small pond in the vicinity of Gárgoles de Arriba have been reported.

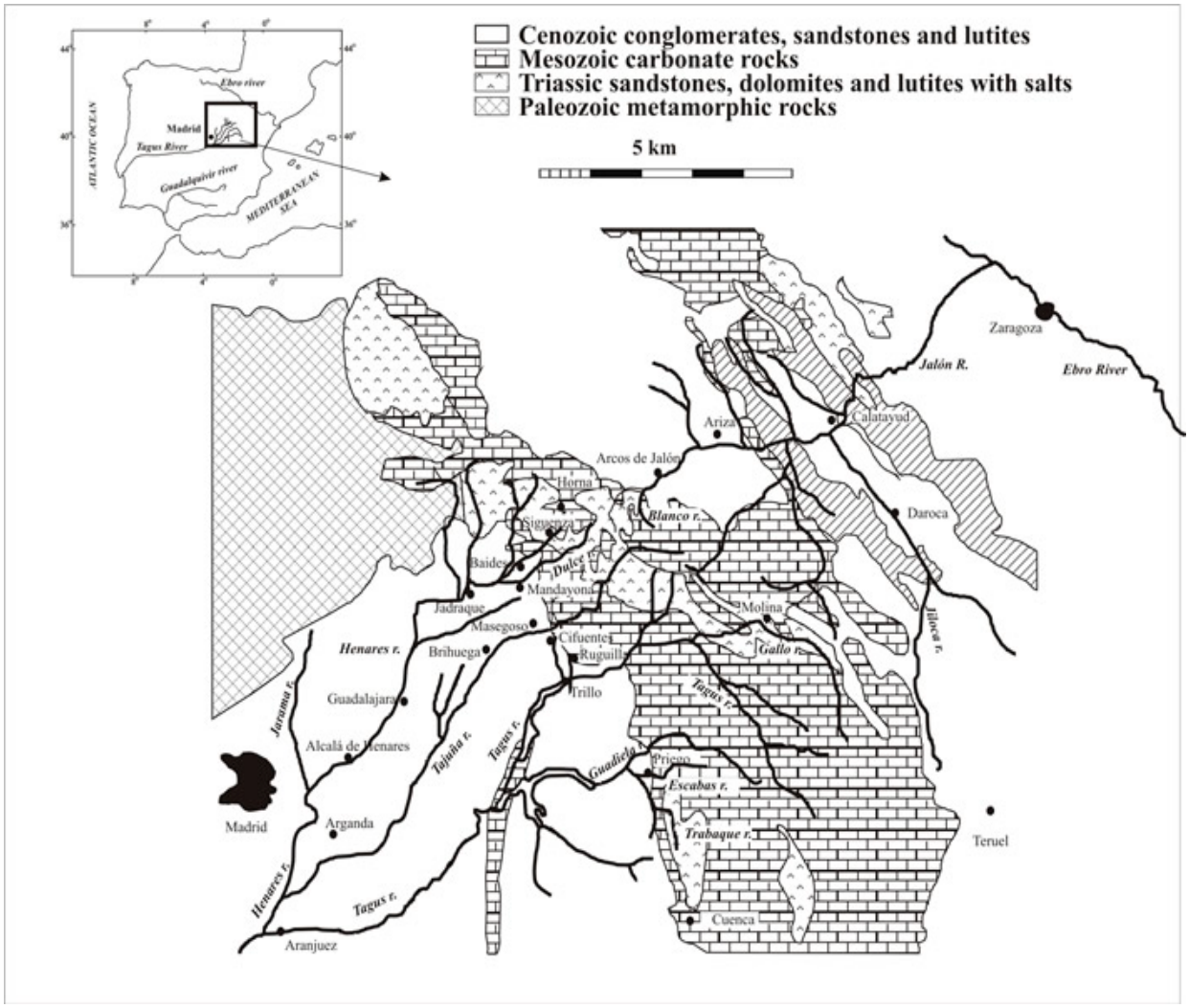


Figure 1. Geographical location of the study area. The Henares, Dulce, Cifuentes and Ruguilla tributaries of the Tagus river, with their catchment basins in the Iberian Range, which produced tufa accumulations, are shown. The Gárgoles de Arriba lake, which produced tufa accumulations, is also presented.

Traditionally, relative dating has been performed through geomorphological studies. However, the presence of barrages or distinct local-base levels can produce synchronic tufa deposits at a range of relative elevations. Likewise, perched springline tufas and palustrine deposits can develop on top of previous deposits.

Ages can be determined by several dating methods, the most commonly used being 14 C and U/Th (Henning et al ., 1983; Durán et al., 1988; López Vera and Martínez Goytre, 1988, 1989; Ordóñez et al ., 1990; Arenas et al ., 2000; Horvatincic et al. , 2000; Garnett et al ., 2004, among others). However, the range of the radiocarbon method (ca . 30-40 ka) is a serious limitation. U/Th dating sometimes presents constraints linked to U-geochemistry (input/output) as well as to detrital thorium (232 Th) presence and the method range.

In the present study we report on the amino acid racemization dating of their ostracod valves (Torres et al ., 2005; Ortiz et al ., 2009). Likewise, we performed a sedimentological study (Fig.2,3) and a palaeoenvironmental reconstruction of these deposits on the basis of their oxygen and carbon stable isotopes signals in order to give a general framework of the evolution of the southern part of the Iberian Range during the Middle and Upper Pleistocene and the Holocene.

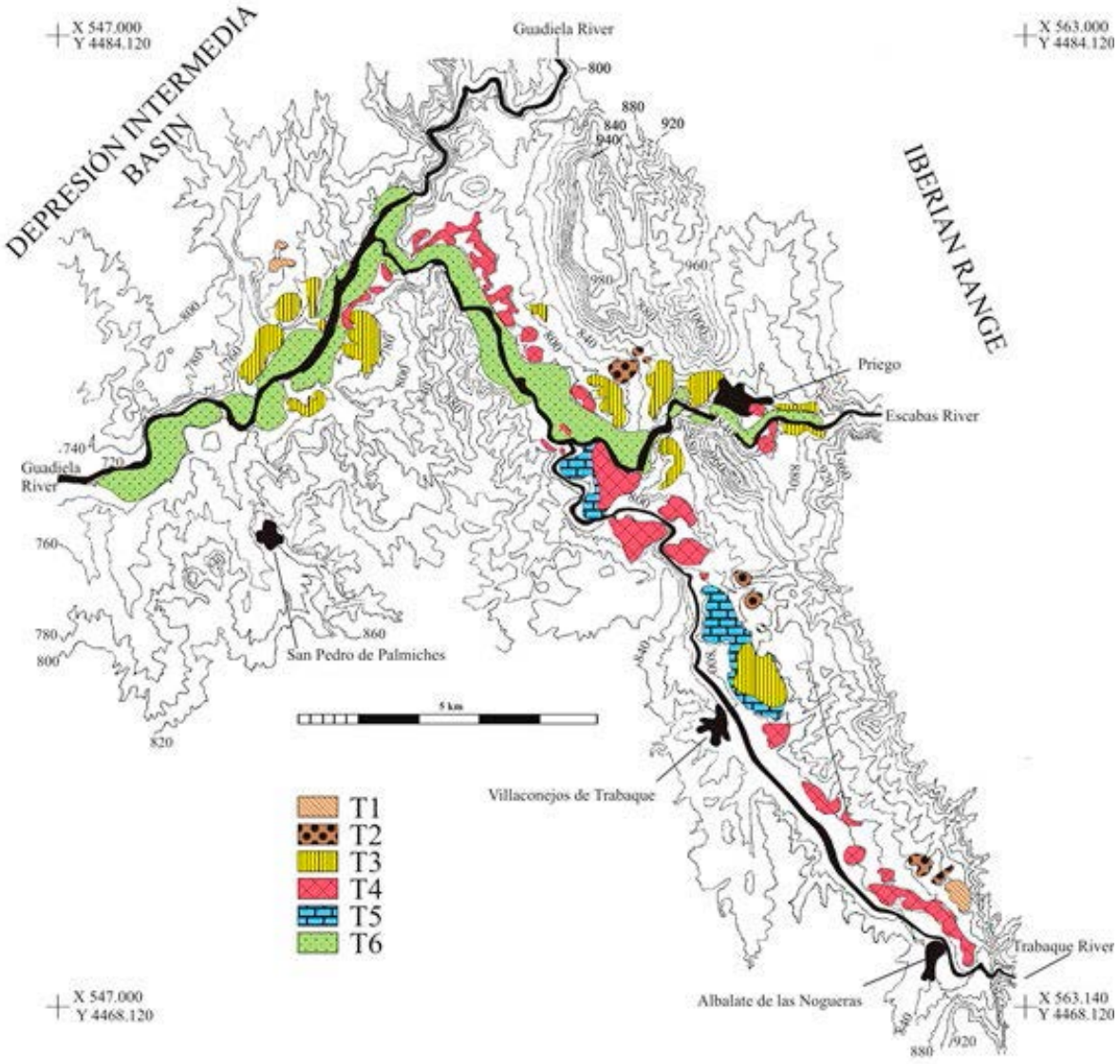


Figure 2. Map showing the distribution of the tufa fluvial terraces in the Priego area according to their relative elevation above the current thalweg (T1-T6) and geographical location of the stratigraphic sections studied. Each section was designated according to its corresponding river (Trabaque river-TR; Escabas river-ES; Guadiela river-GU), the relative elevation above the current thalweg (T1-T6) and the downstream order along the river longitudinal profile.

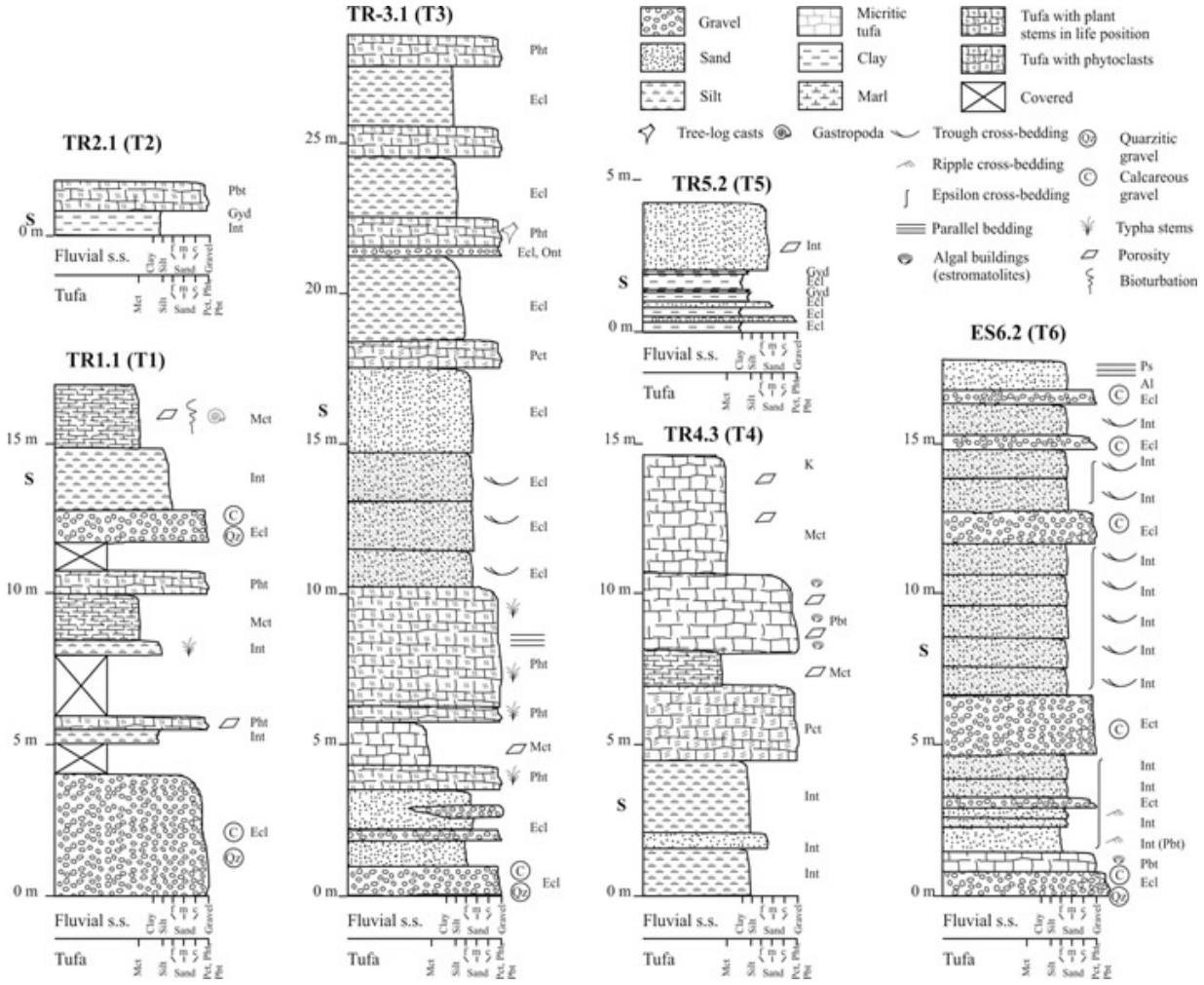


Figure 3. Some representative stratigraphic sections of the Priego area with the identified facies. The samples location (S) is shown in each stratigraphic section. Tufa facies (Pedley, 1990) are also represented; Autochtonous deposits: Phytoherm framestone tufa (Pht), Phytoherm boundstone tufa (Pbt); Clastic deposits: Phytoclastic tufa (Pct), Oncolithic tufa (Ont), Intraclastic tufa (Int), Micritic tufa (Mct); Other deposits: Karst deposits (K), Extraclastic deposits (Ecl), Gyttja and sapropel deposits (Gyd).

Results

We determined the aminostratigraphy and aminochronology of tufa deposits located in central Spain associated with the Tagus river and some of its tributaries (the Henares, Dulce, Cifuentes, Ruguilla, Trabaque, Escabas and Guadiela rivers). We used aspartic acid and glutamic acid racemization ratios obtained from the ostracod Herpetocypris reptans . Tufa accumulations were found to be of different origins; those in the Henares, Cifuentes and Ruguilla rivers are of paludal origin, while those in the Dulce and Tagus rivers are of fluvial origin. A generally good correspondence was found between the age of the deposits and the position of the terraces above the current thalweg. However, the geomorphological evolution of the Henares, Cifuentes and Ruguilla rivers (infilling of pre-existing valleys) has produced deposits of distinct ages at the same elevation above the current river thalweg, and sometimes, older tufas are located below younger ones.

We distinguished eight main tufa deposition episodes. These occurred predominantly during even Marine Isotopic Stages (MIS) (Torres et al ., 1994, 1995, 2005; Ortiz et al ., 2009) (Fig.4), at 406 ± 90 (MIS 11), 264 ± 68 (MIS 7e), 189 ± 40 (MIS 7a), 130 ± 27 (MIS 6-5e), 101 ± 25 (MIS 5c), 32 ± 10 (MIS 3), 14 ± 4 (MIS 1), and 6 ± 2 (MIS 1) ka. These results are in agreement with the dating of similar deposits from nearby areas and other zones of Spain and Europe. The tufa stable isotope compositions were similar to other examples in central and southern Spain and their plot falls in the same field as other lowland European stream tufas. O xygen stable isotopes were influenced mainly by temperature and rainfall. The d 13 C values indicated a major effect of soil-derived carbon rather than carbon from the catchment area, but moderated in each tributary by evaporation, flow regime and biological effects (photosynthesis).