PARIS 1994

18-19 AVRIL / APRIL 18-19

LE TEMPS EN GEOLOGIE : DU PASSE AU FUTUR

TIME IN GEOLOGY: FROM PAST TO FUTURE

GEOPROSPECTIVE

ACTES DU COLLOQUE

ANDRA - BRGM - ECOLE DES MINES - UNESCO

Actes du Colloque GEOPROSPECTIVE - Paris, UNESCO, les 18-19 Avril 1994

PLEISTOCENE CARBONATE DEPOSITS OF CENTRAL SPAIN: PALAEOENVIRONMENTAL RELATIONSHIPS

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ABSTRACT

This paper deals with palaeoenvironmental analysis of the travertine deposits of Río Blanco (Soria) and Priego (Cuenca). Geomorphological and sedimentological studies, as well as stable isotope analysis and Uranium/Thorium and Amino Acid Racemization dating have made it possible to determine that the Río Blanco deposits are of Lower (?)-Middle Pleistocene and Upper Pleistocene age, showing predominantly lacustrine and barrier-cascade-backfilling environmental conditions respectively, this suggesting late capture by the Jalón river. The Priego deposits are of Cromer, Eem and Late-Postglacial age. Palaeobotany and amino acid racemization patterns indicate humid and temperate climate conditions during the Cromer.

INTRODUCTION

Since 1992 the Geological Engineering Department of the Madrid School of Mines has been studying carbonate sediments in central Spain, as part of a larger research project: "Paleoclimatological revision of climate evolution and environment in the Western Mediterranean Region. Evaluation of future scenarios on the Iberian Peninsula".

In spite of the fact that the original project involved the study of travertine deposits only, cave flowstone deposits were also studied. The investigated areas include a karstic zone and four cool water travertine deposit zones, as well as some caves with the remains of extinct bear species, Fig.-1.

In all areas a large variety of techniques are used in order to establish a link between palaeoenvironmental variations and chronostratigraphic scales. Field methods include, among others, sedimentological and geomorphological studies, which have proved to be useful tools for environmental analysis and relative dating of the deposits under study. Laboratory analysis ranges from classical techniques, such as petrography, diffractometry (XR), palynology etc., to more sophisticated methods, such as stable isotope analysis, palaeomagnetism analysis, U/Th dating, Electro Spin Resonance Dating or Amino-acid Racemization dating methods.

Although in the first abstract, studies on a karstic area were envisaged, because

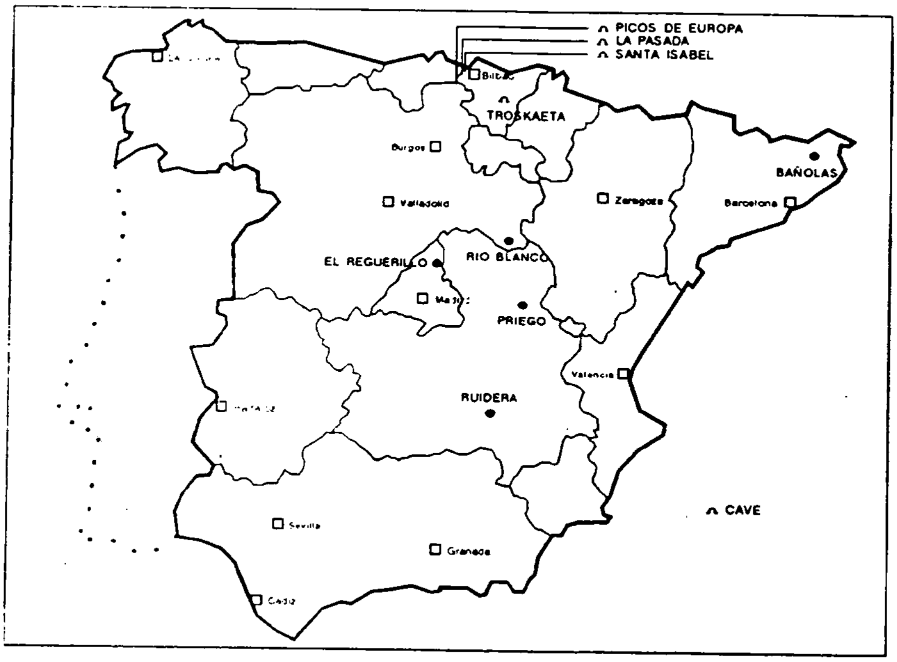

Fig. 1 - Geographical situation of the areas included in the CEC-FI2W-CT91-0075 project.

their main results were described in an other paper on GEOPROSPECTIVE, this poster communication focuses on describing the main results obtained during the study of two travertine deposits: RIO BLANCO and PRIEGO

RIO BLANCO TRAVERTINE DEPOSITS

The Río Blanco valley, Fig.-2, is roughly oriented in a S-N direction near the top of an erosive platform 1200m in average height. This erosive plain has been interpreted as being of Pliocene age, because close to its top there is a karst fIlling with numerous macro and micro-vertebrate bones remain from the upper part of the Pliocene (Lower Villafranchian) period. Palaeomagnetism analysis revealed a continuous normal polarity (Gauss zone), Hoyos pers. com. At a later date, a very intense period of karstification took place, and it is possible to observe a great number of flat-bottomed exokarstic phenomena, such as dolines and blind valleys. Today, "Río Blanco" is an affluent of the Jalón river.

The topostratigraphy of the Río Blanco, Fig.-3, reveals five levels of terraces: T1-T5. The oldest of these (T1) is predominantly made up of calcareous gravel with oncoliths. The other four consist predominantly of travertine deposits with gravel intercalations, Fig.-4. Macroscopic study revealed that the debris of upper plants (trunks or branches) and algae (stems) nucleated travertine deposition, along with algae talus (Characea) and arbuscle plants (rarely) in the living position. Microscopic analysis showed very well preserved colonies of blue-green algae, see photograpy.

In view of the fact that the Río Blanco travertine deposits appear to be connected via a kind of cascade with the Río Jalón base level, it has not been easy to estimate their age; we now have some data provided by Amino-acid Racemization Dating, which suggest that the travertine terraces are of Middle-Lower (upper part?) Pleistocene age, while the backfilled travertine barriers forming the "Las Chorroneras" cascade ("corte 4) and Velilla cliff ("corte 5") are from the Upper Pleistocene. Palynological data suggest that the oldest travertine deposits were developed within a lacustrine environment, and that the neighbouring zones were open, without important masses of forest, evolving towards the upper part to a slightly saline pond connected to a river having a very shallow water level.

Almost one hundred stable isotope analyses were carried out. Fig.-5 shows a plot of $\partial^{13} C_{PDB}$-$\partial^{18}O_{PDB}$ of the most complete sections. It may be observed that there are different point clusters which are being interpreted.

Provisional interpretation of environmental evolution in the Río Blanco valley suggests that the area remained as an isolated flat-bottomed karstic valley, more or less complex, as from the Upper Pliocene (Lower Villafranchian), being filled with lacustrine travertines, karst springs and short, water-fed course runnels. Floated tree trunks and branches were also accumulated, acting as a nucleus for carbonate deposition. Towards

Fig. 2 - Geomorphological map of Rio Blanco area.

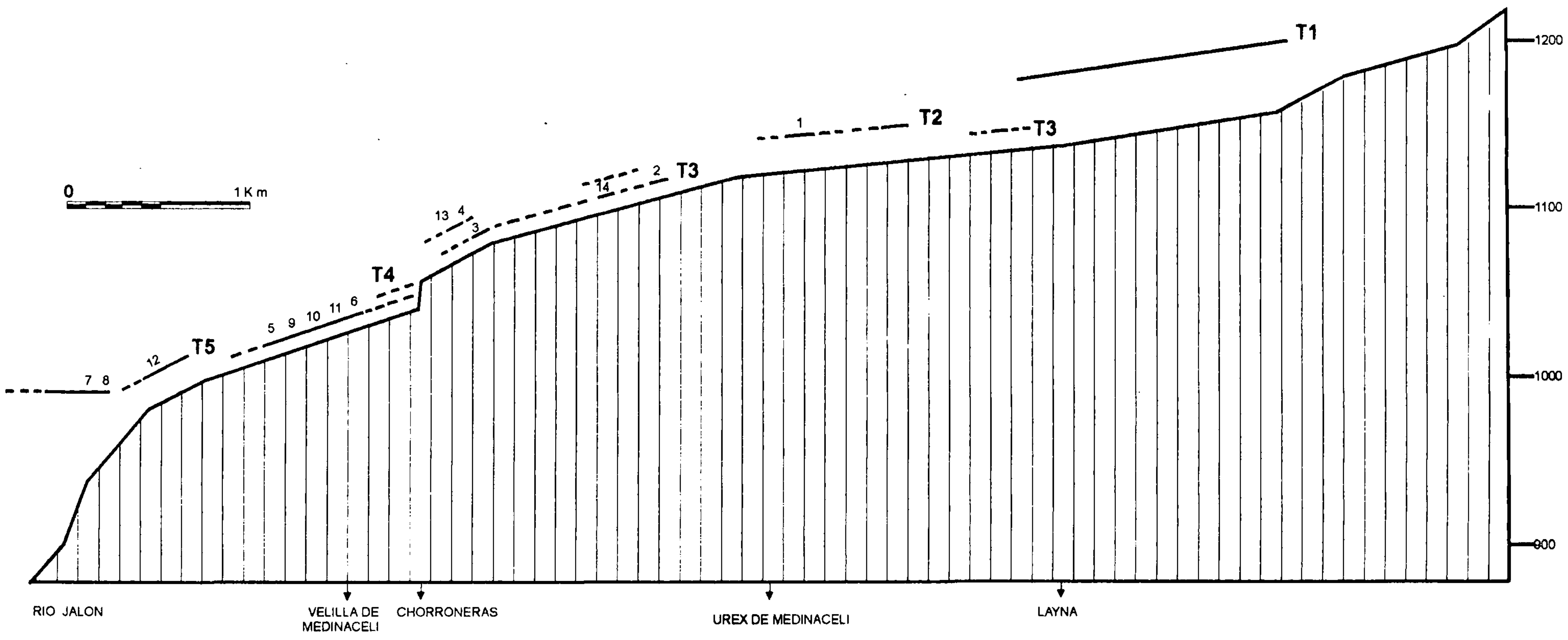

Fig. 3 - Topostratigraphy of Rio Blanco zone.

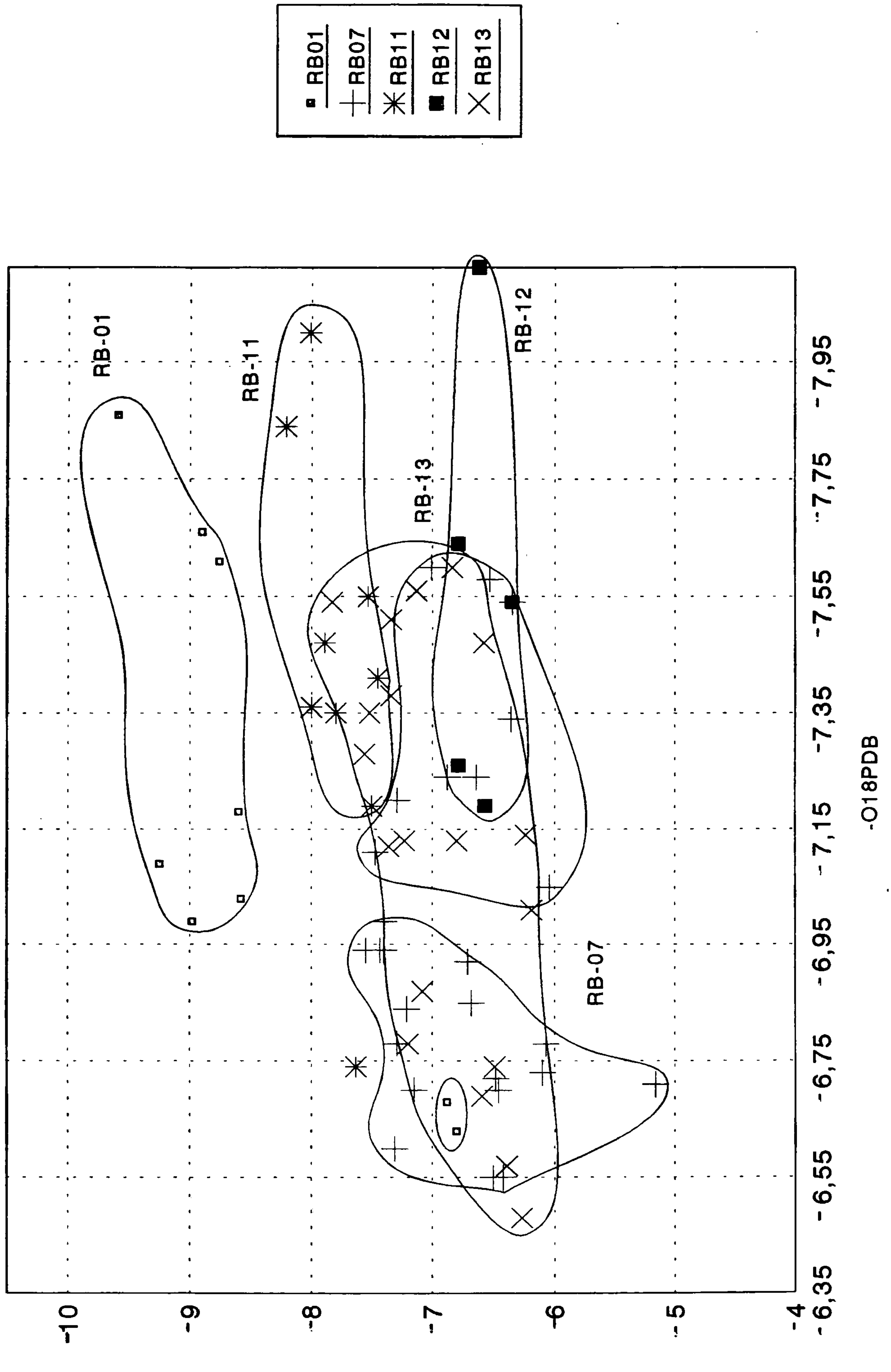

Fig. 4 - Plot of stable oxygen and carbon isotope relationships (PDB) of Rio Blanco samples. RB01 (T2), RB07 & RB11 (T3), RB12 & RB13 (T4).

the top of some sequences, a certain dryness can be deduced from saline environment pollen plants: there was a greater influence of saline waters from springs which developed in the area of Keuper (saline)-Jurassic contact. At a later date, during the Upper Pleistocene, a system of barriers, cascades and back-filled ponds developed when the Río Blanco was captured by the Jalón River.

In most cases, gravelly and blocky intercalations represent material from small alluvial fans produced by creeks which developed on both valley sides.

PRIEGO TRAVERTINE DEPOSITS.

The travertine deposits in Priego appear to be related to three river confluences, Fig.-5. After crossing the Iberian range through very narrow canyons, these rivers: the Guadiela, Escabas and Trabaque expanded onto the wide surface of the basin of the "Intermediate Depression". Subsequent loss of CO_2 allowed intense deposition of $CaCO_3$ to occur in the form of travertines. Because of a more continuous water supply, it is very common to observe thick calcareous gravel intercalations, which indicate high flow periods.

Topostratigraphic analysis, Fig.-6, revealed an seven-terrace system which might be grouped into three main units:

-- Upper terraces (T1 and T2): 100-80 m.

-- Intermediate terraces (T3 and T4): 60-50 m.

-- Lower terraces (T4-T7): 40-20 m.

The facies of the Priego travertine deposits are of more "fluviatile" character than those of the Río Blanco: there is net predominance of deposits associated with Characea thallus, at times in the living position or as phytoclasts. There are short periods of palustrine character: black lutites and casts of aquatic plant stems in the living position. Thick deposits of bioclastic gravel and sand with large-scale sedimentary structures are also frequent.

Uranium/thorium dating (R.J.), Table.-1, made it possible to determine that the intermediate levels were of Eem (Riss-Würm) age, the lower being of Late glacial-Postglacial age. The uppermost level was beyond the method range.

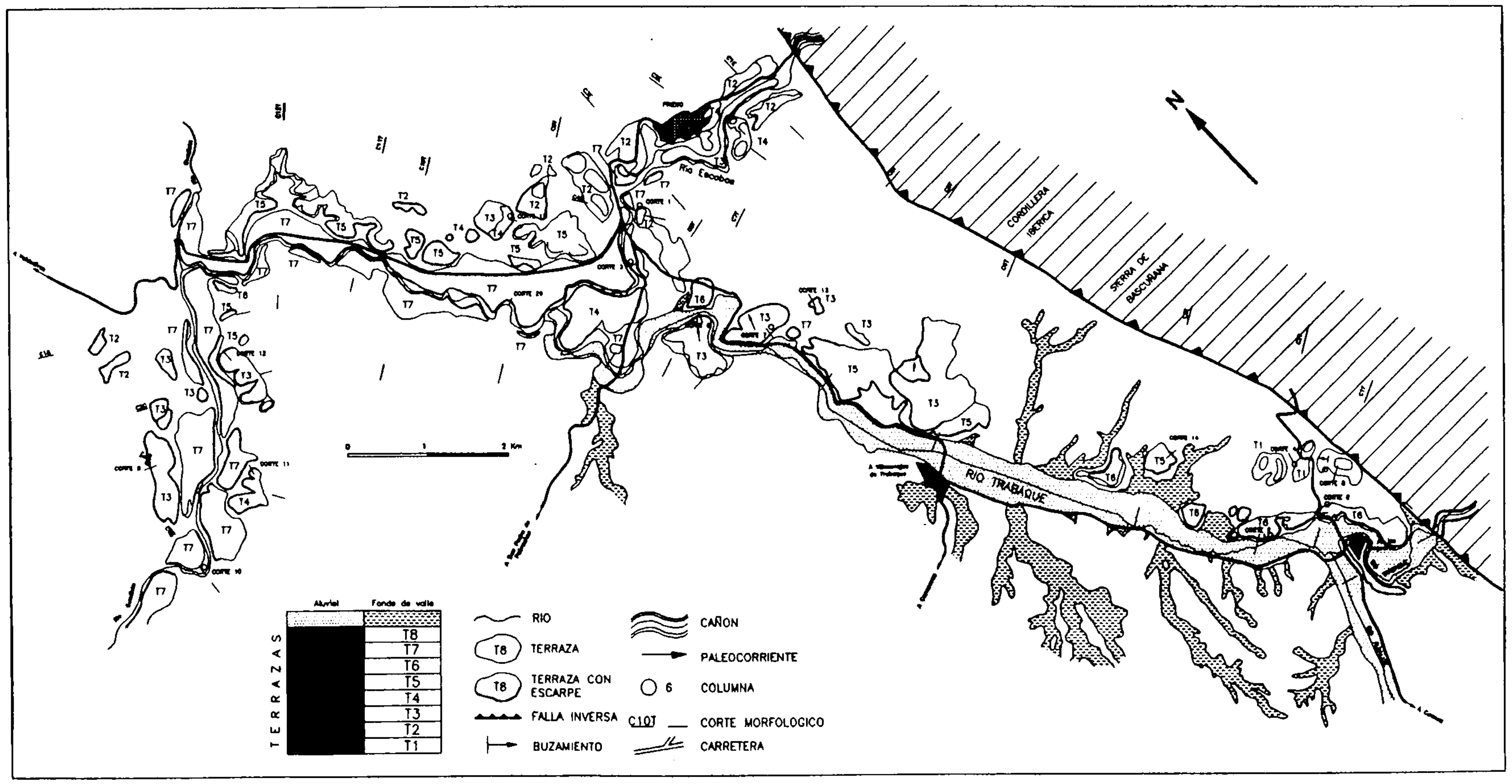

Fig. 5 - Geomorphological map of Priego area.

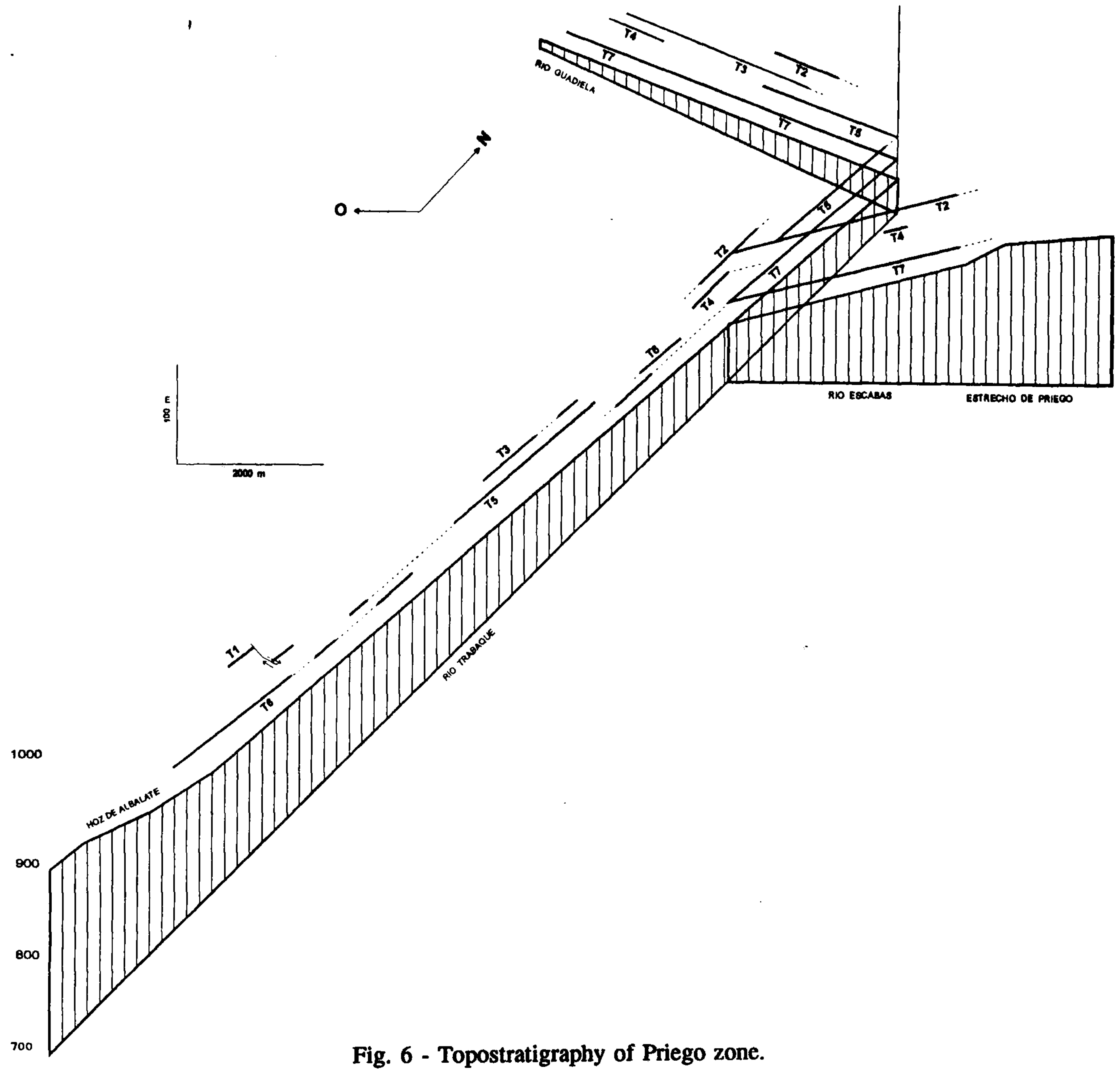

Fig. 6 - Topostratigraphy of Priego zone.

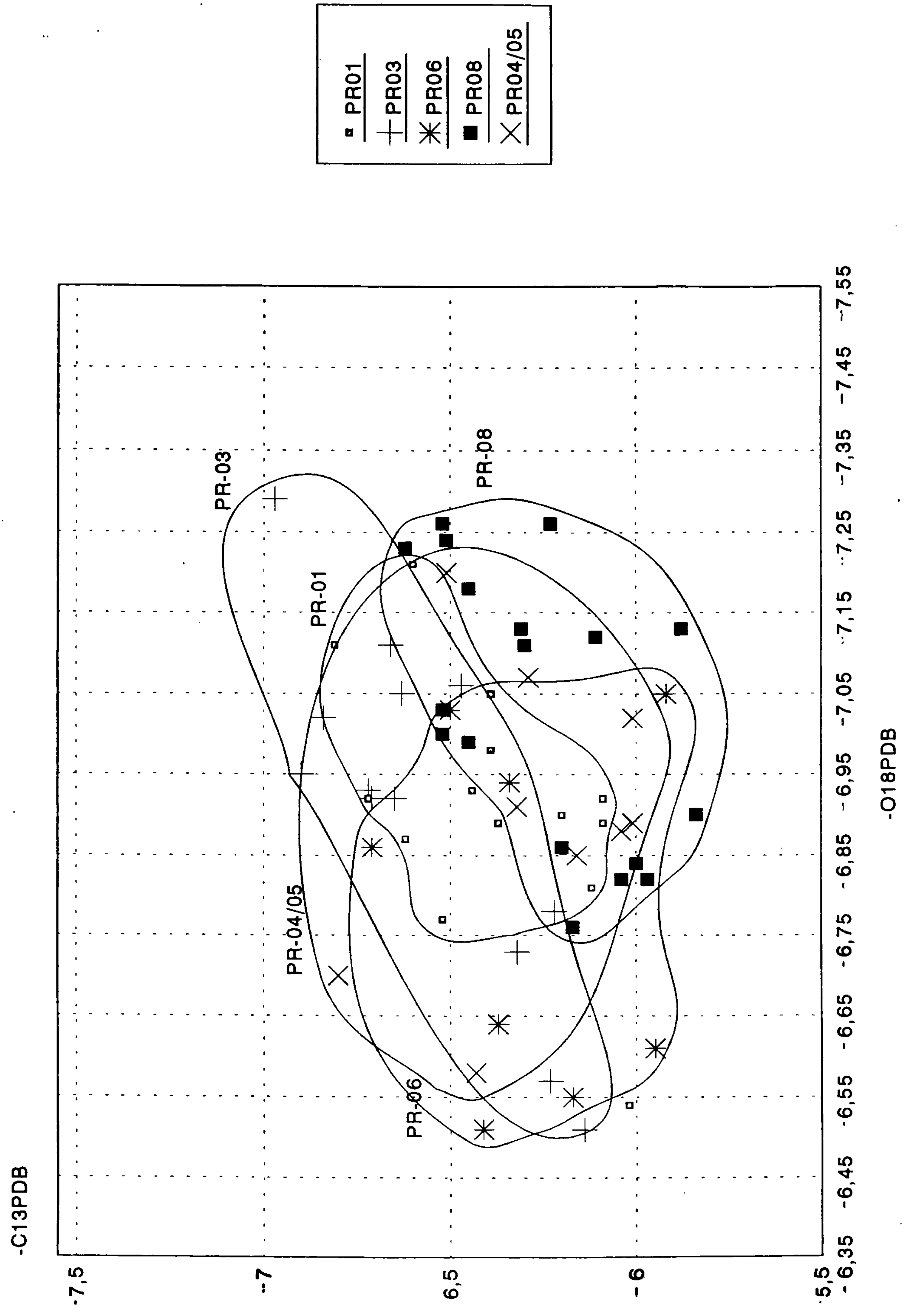

Fig. 7 - Plot of stable oxygen and carbon isotope relationships (PDB), of Priego terraces. PR04 / 05 and PR01 (T1), PR08 (T3), and PR06 (T6) and PR03 (T7).

TERRACE	SAMPLE	U ppm	^{232}Th ppm	^{234}U/^{238}U	^{230}Th/^{234}U	^{230}Th/^{232}Th	Nominal Age (BP)	Sincronic Age (BP)
T1	PR-5-5-1	0,41	0,06	1,06±0,05	1,06±0,08	23,458±2,664	>350000	—
T3	PR-6-7-1	0,37	0,02	1,47±0,02	0,68±0,01	46,812±2,53	113025±3297	—
T3	PR-6-7-2	0,33	0,02	1,58±0,04	0,65±0,02	48,323±3,96	103932±5232	32536±1147
T3	PR-6-9-1	0,45	—	1,51±0,04	0,65±0,03	—	105132±7648	—
T3	PR-6-9-2	0,48	—	1,47±0,03	0,59±0,02	—	90875±5436	—
T3	PR-7-3-1	0,17	—	1,50±0,03	0,81±0,02	—	156005±7970	—
T7	PR-3-12-1	0,38	0,06	1,53±0,02	0,08±0,00	2,333±0,110	8678±280	—
T7	PR-3-12-2	0,27	0,07	1,59±0,04	0,09±0,00	1,857±0,103	10518±472	5099±165
T7	PR-10-1-1	0,49	0,25	1,52±0,06	0,16±0,01	1,418±0.088	18196±1382	—
T7	PR-10-1-2	0,49	0,41	1,57±0,05	0,18±0,01	1,065±0,042	21735±1299	12520±41

Table.-1 U/Th dating of Priego travertine terraces.

In order to avoid uncertainties in relation to the age of the uppermost terrace levels, samples of pelecipoda (*Unio cf. margaritifera* LIN.) and gastropoda (*Cephaea cf. subaustriaca* BOURG, *Cochlicopa lubrica* (MULLER), *Planorbis* sp, *Radix aff. auricularia* (LIN), *Succinea cf. putris* (LIN), *Bithynia labiata* (NEWMAYR), *Lymnaea palustris* (MULLER) were dated by using the Amino Acid Racemization Dating Method, and an age of 733140 was obtained, Torres et al (in press). Obtained data were analysed together.

To check dating fit goodness, average racemization of isolucine, Table.-2, and age obtained were plotted, together with Wehmiller (1993), tentative curve of leucine racemization rate/age for three different theoretical "Current Mean Annual Temperatures": the representative curve for Priego appears in the "Mediterranean zone" of the plot. Temperate but not particularly warm (Fig. 8).

AGE U/Th	A/I	PRO D/L	LEU D/L	ASP D/L	PHE D/L	GLU D/L
ACTUAL	0.0520.035	0.0390.036	0.0110.024	0.0420.009	0.0340.007	0.0090.013
12500	0.1140.085	0.2680.022	0.0730.020	0.2590.030	0.0840.024	0.0680.012
105000	0.2270.037	0.4730.068	0.4310.022	0.5830.040	0.4750.042	0.2680.088

Table.-2. Average amino-acid racemization and U/Th age

An important number of stable isotope analyses have been carried out. The plot of $\partial^{13}C$ on $\partial^{18}O$ does not seem to be particularly significative (Fig. 7), and study of

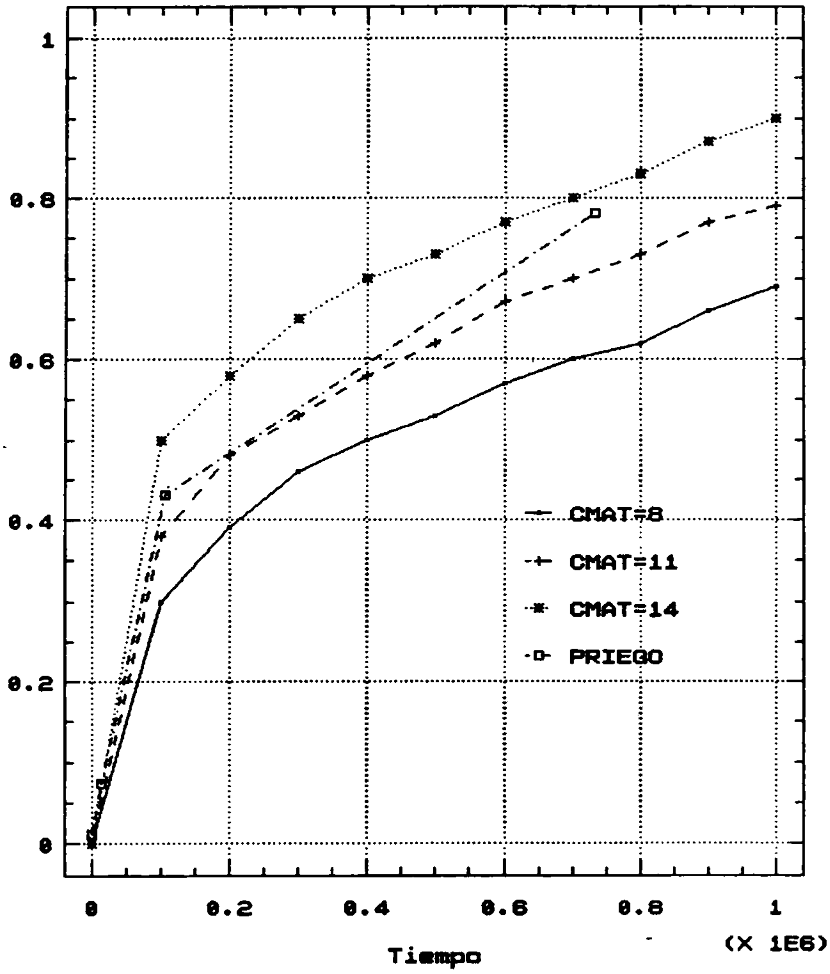

Fig. 8 - Plot of leucine razemization ratios and age, according to different Current Mean Annual Temperature

vertical isotope relationships in individual sections would appear to be more promising.

Dating of the Priego travertines confirms that their deposition took place during warm periods: Günz-Mindel Interglaciar (Cromer) for the uppermost levels, Riss-Würm interglaciar (Eem) for the intermediate terraces and Late glacial-Postglacial for the lowest. There is no palynological evidence, but palaeobotanical (leaf prints) data for the Cromer age terraces revealed, Virgili and Perez Gonzalez (1970): *Poacites* sp., *Cyperites reticulatus, Typha latissima, Quercus aff. charpentierii, Myrica cerifera., Juglans regia, Carya minor, Carya* sp., *Salyx* sp. *Populus tremula, Populus cf. laatior, Ulmus pyramidalis, Zelkova* sp. *Ficus* sp., *Prunus* sp., *Acer* sp., *Rahmnus gaunini*, this indicating a humid and temperate climate.

Geomorphological and sedimentological analysis made it possible to determine that during Cromer times the Albalate river was the most important fluvial system and the Escabas was minor or non-existent. Between Cromer and Eem times Albalate river shifted westward, probably as a result of neotectonic activity, and the river Escabas became the most active and dominant fluvial system. During the Upper Würm-Holocene, the Escabas played a distinctive role, furnishing detrital travertine to the Guadiela river, giving rise to longitudinal and point bars.

DISCUSSION

The studies carried out on the travertine deposits of Río Blanco and Priego have proved to be a useful method for palaeoenvironmental analysis. The Río Blanco would appear to be younger than previously interpreted, and must be thought of as being a karstic depression with quasi-lacustrine travertine deposits during Lower-Middle Pleistocene times. During the Upper Pleistocene, there was a barrier system with cascades and backfilling processes. Regional interpretation will allow to the hydrological history of the River Jalón River to be determined. The Priego travertine deposits correspond to warm periods between the Middle Pleistocene and the Holocene, with a complex hydrological setting, probably conditioned by neotectonic activity. There is very good agreement between U/Th and AAR dating data, and also between those provided by aminostratigraphy and palaeobotany. There are no determining results from stable isotope data interpretation.

ACKNOWLEDGEMENTS

This work is included in Project CEC-FI2W-CT91-0075 (Paleoclimatological revision of climate evolution in the Western Mediterranean Region", and contract nb. 0701041 "Datación de formaciones cuaternarias a partir de aminoácidos" (Amino-acid dating of Quaternary formations), between the Empresa Nacional de Residuos Radiactivos and the Madrid School of Mines (Polytechnic University of Madrid).

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