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# PADUL PEAT BOG

## 107 m deep borehole drilled in the Padul Peat Bog (Granada, SE Spain)

Padul peat bog is located 20 km south of Granada city (Andalusia, southern Spain) ( Fig. Padul1 ).It was formed in a highly subsident fault-bounded tectonic basin at the foot of the Sierra Nevada, and consists of an endorheic basin, surrounded by mountains. It is placed 720 metres above sea level and some parts are permanently covered by water. Its longitudinal axis is NW-SE oriented. It has a surface area of 4 km 2 and a maximum depth of 100 m. The bedrock consists mainly of faulted Mesozoic dolostones that caused the basin to sink gradually.

Drilling campaing in the Padul Peat Bog (Granada)

Padul drill hole core sampling

Top of the Padul peat bog record

The uppermost part of the Padul peat bog record was studied digging a 8m deep trench

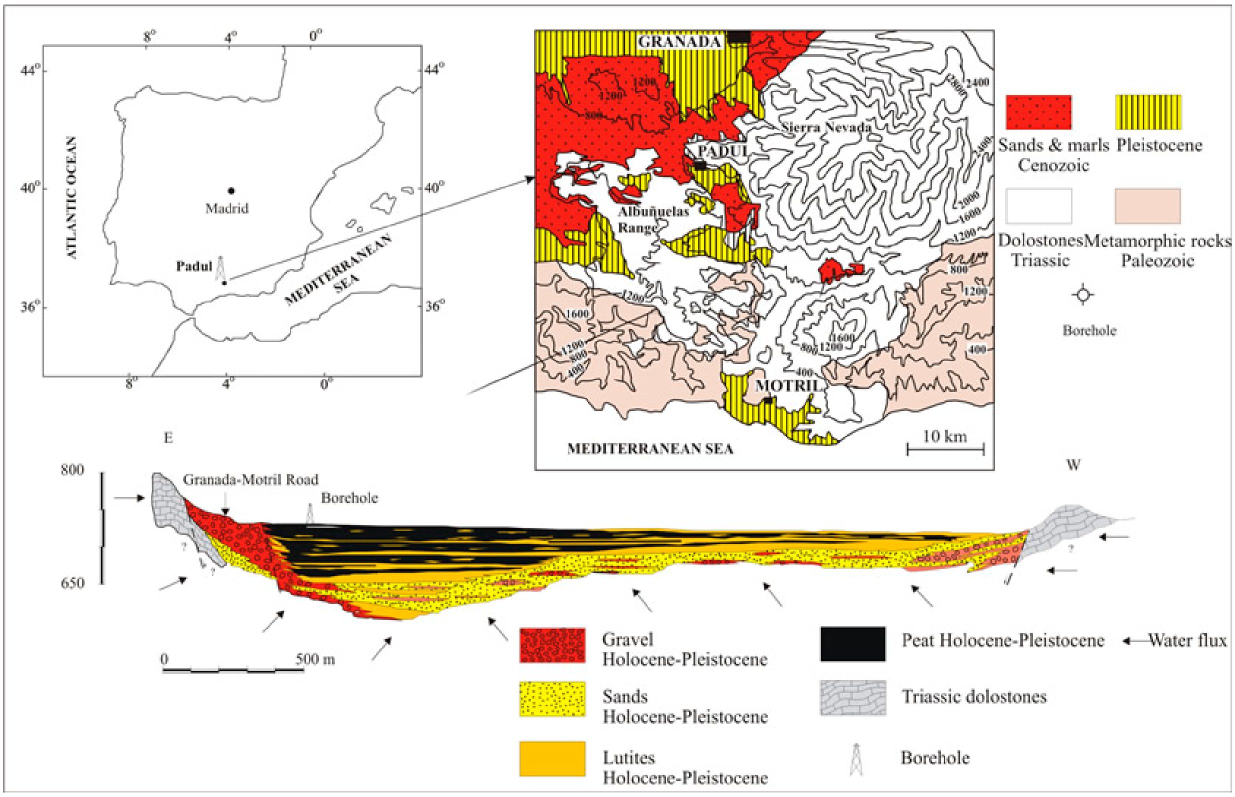

**Figure 1**. Geographical location and Geological setting of the Padul Basin.

Padul Basin is a discharge area for the groundwater flow of the surrounding aquifers. The flow directions change from sub-horizontal, in the Mesozoic aquifers adjacent to the basin, to essentially upwards discharge inside the peat-containing depression.

Present rainfall in the area is a minor factor in the water balance of the peat deposit and run-off input of water is estimated to contribute only about 8% of the total (Cañada, 1984). Consequently, changes in the water table in the peat are controlled indirectly by infiltration of water from the surrounding mountains.
Padul Basin receives an integration of vegetation debris coming from Sierra Nevada where it is possible to recognize a series of vegetation belts.

The stratigraphic record of the Padul borehole (Latitude: 37º01´01´´ N; Longitude: 3º36´07´´ W; Elevation: 714.20) can be divided in two equivalent-in-thickness parts ( Fig. Padul2 ). The lowermost par of the record begins with very unmature poorly cemented conglomerates of alluvial origin followed by lacustrine marls with some sandy/conglomeratic interbed of fluvial origin as well as peat seams. The marls can be cemented or not and their terrigenous content is higly variable. Their organic matter content is also very variable: from scattered phytoclasts, carbonaceous particles or simple dots to gray organic rich beds. Lamination, if developed, was not preserved due to bioturbation. The uppermost parte of the Padul peat record can be simply described as massive peat with some marly intercalations.

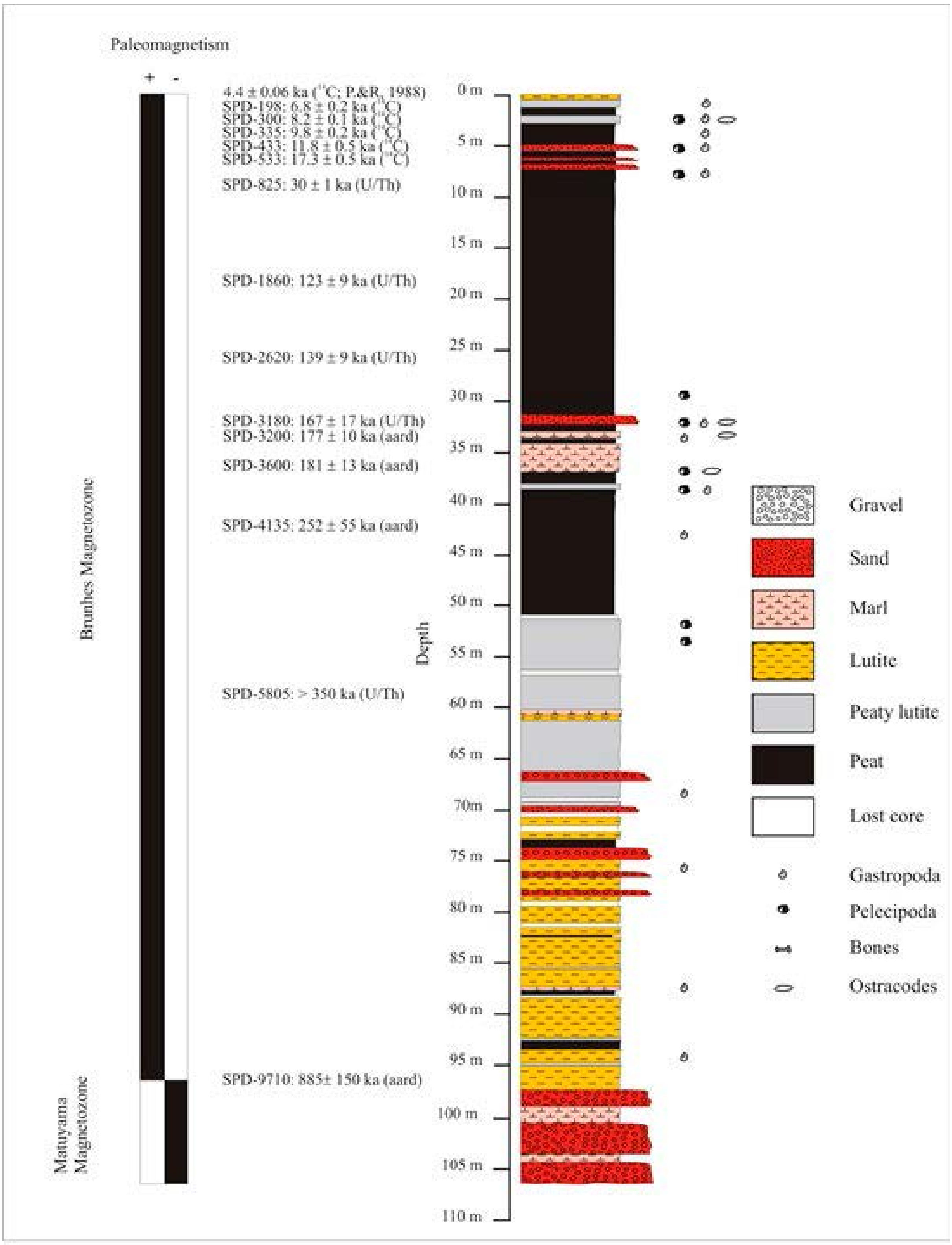

**Figure 2.** Stratigraphy and chronology of Padul peat bog borehole core. Datings are followed by the method used for their calculation: 14 C, U/Th, aard (amino acid racemization).

# Results

In the Padul Peat Bog, the concentration of organic carbon, the atomic H/C and C/N ratios, the d 13 C and CPI values and the predominant n- alkane chain, proved to be excellent palaeoenvironmental proxies for the study of the palaeoclimatological and palaeohydrological evolution along the last 1 Ma ( Fig. Padul3 ) ( Ortiz et al. , 2004). . The chronostratigraphy was obtained based on radiocarbon, U/Th, paleomagnetism and amino acid racemization dating method (Pons and Reille, 1988; Ortiz et al. , 2004).

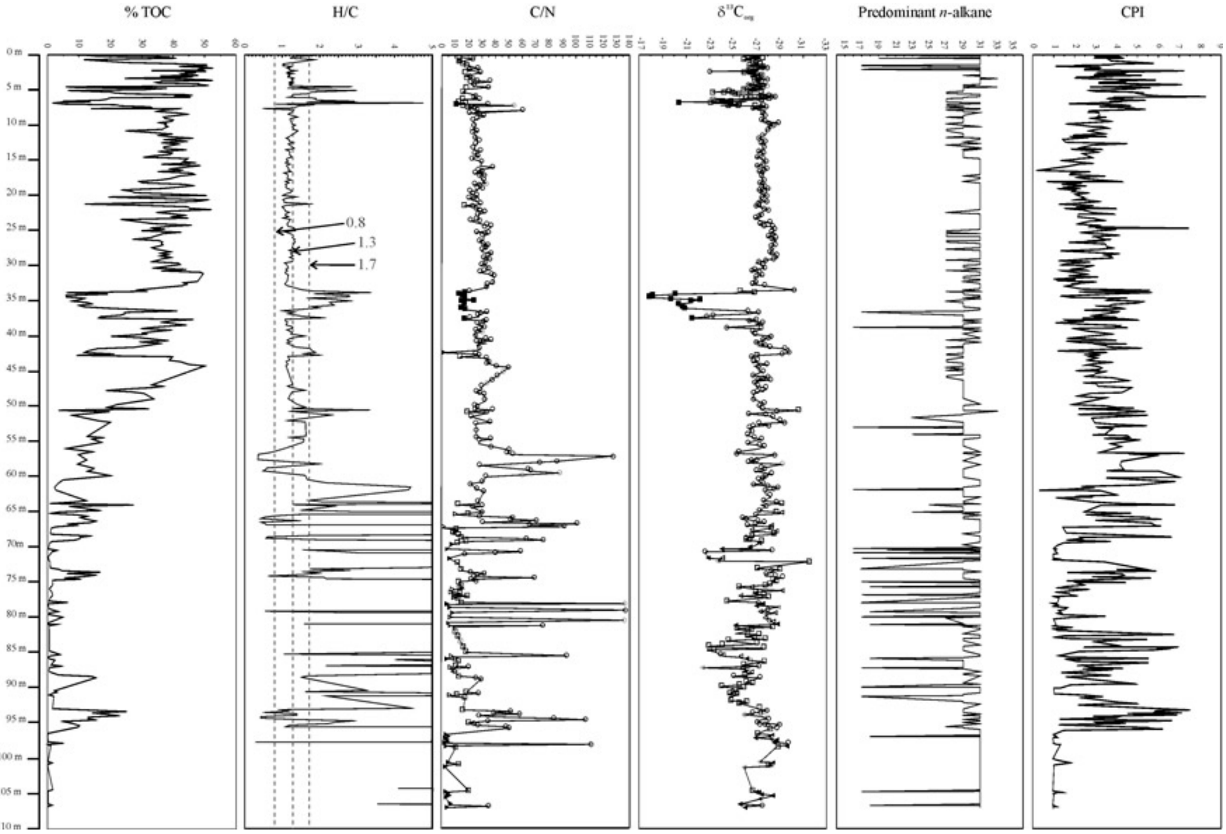

**Figure 3**. Concentration of organic carbon (%TOC), H/C, C/N, d 13 C, CPI and predominant n- alkane chain logs. H/C ratios are represented up to 5, although there are some greater values, especially at the bottom of the core (in some cases >100). We have preferred to use a smaller scale (0 to 5) in order to show the cut-off values of different groups (0.8; 1.3 and 1.7). When H/C values are greater than 5, they are beyond the scale upper limit. In the d 13 C and C/N logs.

The atomic H/C ratios and CPI values indicate that little diagenesis during transport and after deposition occurred in the Basin.

These proxies provide evidence of two markedly different hydrogeological scenarios in the Padul Basin. From the bottom ( ca . 1 Ma B.P.) to metre 60 ( ca . 400 ka B.P.), an important run-off recharge made the water-body deeper than in the rest of the record. From metre 60 metre to the uppermost part ( ca . 400-4.5 ka B.P.), the Padul Basin became a peat bog s.s. , with the main water input coming as groundwater inflow.

Samples with low C/N ratios and intermediate-low d 13 C values (Group 1) as well as with high values of H/C and abundance of low molecular weight n- alkanes, were interpreted as deriving from phytoplankton. These values are predominant in the lower part of the core ( ca . 1Ma-400 ka B.P.) and can be related to wet episodes which caused the water-body level to rise.
From ca . 400 ka to ca . 180 ka B.P. (metres 60 to 36.0), alternating episodes linked to wet/dry phases with dominancy of grasses or trees and aquatic macrophytes, respectively, were identified by the atomic H/C ratio.

Two important warm-wet episodes, interpreted from low C/N and high d 13 C org values (Group 3), occurred at ca . 180 to 170 ka B.P. (metres 36-33.6) and at ca . 20 ka B.P. (metre 6.7). The former can be correlated with the marine isotopic stage (MIS) 7a; and the latter with the climatic optimum published by Florschütz et al . (1971). The latter was also interpreted in the study of Valle et al . (2003).

The global climatic changes occurring from ca . 170 to 25 ka B.P. (metres 33.6 to 7) were not recorded in some proxies. In this period, H/C and C/N ratios and d 13 C org values varied little, although significative variations occurred in the pollen log and in the relative percentages of C 27 , C 29 and C 31 n- alkanes.

However, important changes linked to the Last Glacial Maximum and the beginning of the Holocene were detected (metres 7-4.5). Samples with lower d 13 C org values coinciding with high atomic C/N ratios, atomic H/C ratios between 1.3 and 1.7 and with predominant n- alkane chains of 31 carbon atoms represent cold-dry phases which caused the recession of temperate forests and the extension of grasses. After these periods, both temperature and precipitation recovered, causing the expansion of temperate forests and a rise in water level, with a major production of lacustrine algae.

These latter episodes are characterized by samples with intermediate C/N ratios and d 13 C org values as well as by H/C ratios characteristic of phytoplankton or trees, and C 27 or C 29 predominant n-alkanes.

Few changes during the Holocene (uppermost 4.5 metres) were recorded in the palaeoenvironmental proxies, though there were alternating wet and dry episodes.

The predominant n- alkane chain provides evidence of organic matter origin and, in general, is consistent with the interpretation made from the other proxies.

# References

Florschütz, F., Menéndez Amor, J, Wijmstra, T.A., 1971. Palinology of a thick Quaternary succession in southern Spain. Palaeogeography, Palaeoclimatology, Palaeoecology 10, 233-264.

Ortiz J.E., Torres, T., Delgado, A., Julià, R., Lucini, M., Llamas, F.J., Reyes, E., Soler, V., Valle, M., 2004. The palaeoenvironmental and palaeohydrological evolution of Padul Peat Bog (Granada, Spain) over one million years, from elemental, isotopic, and molecular organic geochemical proxies. Organic Geochemistry 35(11-12), 1243-1260.

Pons, A., Reille, M., 1988. The Holocene and upper Pleistocene pollen record from Padul (Granada, Spain): a new study. Palaeogeography, Palaeoclimatology, Palaeoecology 66, 243-263.

Valle, M., Rivas, M.R., Lucini, M., Ortiz, J.E., Torres, T., (2003). I nterpretación paleoecológica y paleoclimática del tramo superior de la turbera de Padul (Granada, España) a partir de datos palinológicos. Pollen 13, 85-95 .