



Limnolib: a transect of high-resolution lacustrine records of climate and environmental variability in Spain since the last glacial maximum.

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The LIMNOCLIBER project represents a multidisciplinary, international effort to recover, for the first time, long paleoenvironmental and paleoclimate records from relatively deep lakes in Spain. New records from the Iberian Peninsula during the last decade have changed our views on Holocene history from a generally benign climate punctuated by dry mid Holocene period and an amelioration afterwards, to a complex fluctuation of arid and humid periods. Lateglacial reconstructions have also shown large variability and a multifaceted regional pattern in the Iberian Peninsula. The fact that the maximum extent of mountain glaciers occurred much earlier than the global Last Glacial Maximum (LGM,) also underlines the differences in timing of the main climatic events in Southwestern Europe. To resolve the contradictory interpretations of available records and to reconstruct the effective moisture history of the region since the global LGM, long, high resolution, well-dated records from hydrologically-sensitive regions in Spain are needed. Although deep lakes are not common in Spain, numerous, relatively deep (up to 20 m), karstic lakes with carbonate-rich sediments occur in the Iberian Range and the Pyrenees, and deep terminal-moraine lakes appear

in the mountains of northern and western Spain. During the spring of 2004, over 200 m of lacustrine sediment cores were retrieved from eight lakes in Spain using a modified Kullenberg piston coring platform from the Limnological Research Center (U. of Minnesota, USA). The lakes were selected based on several criteria: accessibility, sedimentology (presence of authigenic carbonates) and limnology (karstic lakes deeper than 10 m), aimed to assure the presence of long, continuous paleoclimate records (> 20000 years) along a climatic and ecological transect in Spain. Three of them (Caicedo-Arreo, Estaña and Montcortes) follow a W-E transect in the Pre-Pyrenean Range. Laguna Taravilla, and El Tobar are karstic lakes in the Iberian Range. El Tobar is a saline, meromictic lake with a finely laminated sedimentary record. Preliminary studies based on ^{210}Pb and AMS ^{14}C - dated short cores from Taravilla have shown the potential of the lake system as an archive of paleohydrological events. Laguna Zoñar is the only accessible and relatively deep karstic lake in southern Spain, and short cores previously obtained had already shown the complex interplay of human impact and climate variability during the last 1000 years. The Lago de Sanabria, the largest glacial lake in Spain, lies behind a large terminal moraine complex deposited during the LGM in NW Spain. Lago Enol is also a glacial lake located in the Cantabrian mountains. Preliminary analyses and some dating have been performed in selected cores from the eight lakes. Magnetic and physical properties were measured with a GEOTEKTM Multi-Sensor Core Logger (MSCL). The cores have been split and imaged with a high-resolution scanner. Detailed sedimentological descriptions have allowed identification and interpretation of sedimentary facies and preliminary reconstructions of the depositional history of the lakes. Other paleohydrological-sensitive techniques are in progress: chemical composition of carbonate phases, stable isotopes of carbonates and organic matter, and a variety of biological indicators (pollen, diatoms, ostracods and chironomids). A detailed chronological framework based on AMS ^{14}C and U/Th analyses is in progress. Our goal is to provide long, high resolution, paleohydrological reconstructions from a region extremely sensitive to changes in effective moisture and atmospheric dynamics. The multiproxy-based reconstructed curves will provide new data to identify and date the main climate events, and to characterize the climate variability at century and millennium scale since the LGM. The regional distribution of the sites will enable us to discuss the climate and effective moisture patterns in Iberia during Last Glacial Maximum. The high resolution reconstructions will provide data for the timing, duration and geographical distribution of the cold and arid intervals during deglaciation, and the correlation of the Iberian Holocene arid episodes with world-wide periods of abrupt climate change. Our reconstructions will help to test possible causes for aridity in Iberia (enhancement of the north Atlantic High, a southwards displacements of the Azores high and the Mediterranean winter belt, local monsoonal-enhanced climate effects). Finally, the

occurrence of finely laminated intervals provides an opportunity to understand the significance of high frequency climate variability (NAO, ENSO) in the climate of the Iberian Peninsula. Lacustrine time-series are response records of sensitive regional systems to past global changes and the understanding of their natural variability and their thresholds will help and inspire our understanding of future climate changes. The LIMNOCLIBER project contributes to this global effort by focusing in the integration of sedimentological, biological and geochemical proxies for a number of time-series from the Iberian Peninsula, aimed to develop a coherent, comparative synthesis of the regional pattern.