

Millennial-scale climatic variations in northwestern Iberia during the last 25.000 years from the MD99-2331 pollen-rich deep sea core

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Pollen percentages and concentrations, planktonic foraminifera assemblages, alkenone, oxygen isotopes and coarse fraction contents as well as temperature and precipitation estimations have been obtained from a deep sea core retrieved in the northwestern Iberian margin (MD99-2331, 42°09'00 N; 09°41'90W). This high resolution study records the climatic variability of the last 25.000 years detected elsewhere in the North Atlantic region: Heinrich 2, Heinrich 1 and Younger Dryas cold events, the Last Glacial Maximum, the Bölling-Alleröd interstadial, and the Holocene interglacial. Two cold Sea Surface Temperature (SST) episodes linked to iceberg discharges are related to the Heinrich 1 and 2 events. The oldest one is characterized by a peak of coarse fraction sediments and maxima in polar foraminifera *N. pachyderma* (s) percentages while the recent one only by the *N. pachyderma* (s) maximum. A slight increase in SST characterises the Last Glacial Maximum. The Bölling-Alleröd interstadial is marked by an increase in SST values and a decrease of *N. pachyderma* (s), while a subsequent return to cool oceanic conditions characterises the YD episode. A gradual increase in SST up to the middle part of the Holocene marks the first part of this interglacial.

Pollen percentage and concentration shifts are globally contemporaneous to these climatic changes. Heinrich 2 and 1 events are marked by heathland and grassland formations with almost no deciduous tree vegetation and by the reduction in *Pinus* forest. Pollen concentrations drastically increase during both events probably due to the enhancement of wind systems. Even if SSTs slightly increase over the LGM, no deciduous forest expansion is detected in northwestern Iberia during this time interval. A *Quercus-Betula-Corylus* forest succession along with the decrease in pollen concentrations are triggered by the Bölling-Alleröd warming phase. Drastic vegetation changes from open deciduous forest to heathland and grassland formations characterise the Younger Dryas event. The beginning of the Holocene is marked by the gradual expansion of the *Quercus-Betula* forest followed by the maximum development of *Quercus-Corylus* woodlands paralleling high values in pollen concentration. Suddenly and in synchrony with the *Alnus* development a drastic drop in pollen concentration is observed at ~ 6,000 years ago. This is probably due to the sand barrier formation which induces a strong decrease of the fluvial-borne pollen to the sea. At this time sand spits have been well documented in Iberian coastal areas associated to the sea level rise stabilization.

The succession of vegetation detected by MD99-2331 marine core mimics that recorded by northwestern Iberian peat-bog and lake sequences showing that marine pollen assemblages off Iberia derived from the vegetation communities of the adjacent continent.