



AN INVESTIGATION OF THE EARLIEST DANIAN PALEOCLIMATE USING STABLE ISOTOPE ANALYSIS OF A NON-MARINE FOSSIL ASSEMBLAGE AT THE FONTLLONGA-3 SITE (SOUTH CENTRAL PYRENEES, SPAIN)

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Here we present the first stable isotope results (¹⁸O and ¹³C) from the Fontllonga-3 site (South-Central Pyrenees, Tremp Formation, Spain), which constitutes one of the rare lowermost Danian European records of non-marine deposition.

The isotopic analysis of mammalian tooth enamel, formed at a constant body temperature of 37°C, is generally used to infer the oxygen isotopic composition of local water (¹⁸O_{lw})^[1]. The scarce amount of mammal teeth at Fontllonga-3, however, makes this an impractical method to use. Therefore a new approach to determining the ¹⁸O_{lw} value was developed. Extant relatives of the osteoglossid fishes discovered at Fontllonga-3 require a temperature range of between 24 to 35°C (mean 27-30°C) to survive. We used this mean water temperature range in the freshwater carbonate fractionation equation^[2] to infer ¹⁸O_{lw} values from the carbonate fossil content of Fontllonga-3. Applying this methodology to the charophyte and invertebrate carbonate remains (mean ¹⁸O value of -4.94‰ (PDB), $\sigma^2 = 0.32$) we obtained ¹⁸O_{lw} = -3 to -1‰ (SMOW). These ¹⁸O_{lw} values are in line with those expected from an estuarine environment previously interpreted for the Fontllonga-3 site^[3]. Furthermore, given that freshwater or low salinity conditions are suggested for Fontllonga-3, the relatively high ¹⁸O_{lw} values are compatible with a low precipitation rate. This supports other paleobotanical and mineralogical studies which propose the existence of a tropical seasonally dry climate for the Pyrenean and Tethyan realms during the Earliest Paleocene^[4,5].

In contrast to the charophytes and invertebrates, the analysis of the carbonate component of bioapatite remains from Fontllonga-3 results in a wide range of ¹⁸O values, which may suggest diagenetic alteration. Nevertheless, the bioapatite remains can still be used to infer palaeoclimatic conditions as bone or dentine tends to chemically equilibrate, on

timescales from 10-10kys, with the surrounding sediment during fossilization^[6]. On this basis we compared the ¹⁸O values of carbonate remains to that of other fossil skeletal remains in order to explore the potential to preserve the primary isotopic signature of skeletal growth. Mean values of complete lepisosteid scales (isopedine+ganoine) and pycnodont vomerine teeth (¹⁸O = -5.18‰ PDB, $\sigma^2 = 0.26$) are quite similar to those from charophytes and invertebrate remains. On the other hand, complete lepisosteid teeth, pycnodont branchial teeth and osteoglossid squamules have more depleted oxygen isotope values (mean ¹⁸O = -8.42‰ PDB, $\sigma^2 = 2.56$), which could suggest diagenetic alteration. However, the degree of diagenesis is probably minor as SEM studies indicate exceptional preservation and there is a low correlation between ¹⁸O and ¹³C (r = 0.27) values. Thus, the isotopic differences in the fish remains may reflect differences in environmental conditions between pelagic and benthic organisms.

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