Stable oxygen isotopes and Mg/Ca ratios from the limpet Patella depressa Pennant, 1777: climatic and archaeological implications of the novel application of LIBS to mollusc shells

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Abstract

Isotopic and elemental composition studies are increasingly emerging as avenues for obtaining unparalleled, high-resolution insights into palaeoclimate and past seasonality. In coastal areas, such as the Atlantic façade of Europe, which is characterised by an increase in human littoral resource exploitation during the Early Holocene, accurately establishing the impact of abrupt climate changes and determining coastal exploitation patterns is crucial to properly understanding human resilience and foraging strategies. Traditionally, researchers have attempted to meet these goals through stable oxygen isotope analysis of carbonate from mollusc shells, though this methodology is expensive and time consuming. Increasing the number of shells analysed is critical for improving palaeoclimatalogical and archaeological insights available from sub-fossil samples. Previous investigations have highlighted the significant advantages of elemental analyses by Laser Induced Breakdown Spectroscopy

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(LIBS), which significantly decreases the time required for sample preparation and increases the number of shells that can be analysed. In this study, the LIBS technique is applied for the first time to limpet *Patella depressa* Pennant, 1777 samples live collected in northern Spain. In order to determine if Mg/Ca profiles obtained by LIBS are a usable proxy to reconstruct palaeoclimate conditions and seasonality in this species, a comparison between stable oxygen isotopic profiles previously derived from the same shells and LIBS Mg/Ca series were conducted. Results showed a significant correlation between elemental and isotopic sequences obtained, highlighting the archaeological and palaeoenvironmental potential of the novel application of LIBS on *P. depressa* species.

Keywords: Stable oxygen isotopes, Mollusc shells, LIBS, Trace element analyses, Climate proxy