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High-resolution elemental records of *Glycymeris glycymeris* (Bivalvia) shells from the Iberian upwelling system: Ontogeny and environmental control

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The great potential of bivalve shells as a high-resolution geochemical proxy archive of environmental conditions at the time of growth has been known for several decades. The elemental composition of bivalve shells has been studied with the purpose of reconstructing environmental conditions: e.g. seawater temperature (Sr and Mg), primary productivity (Li, Mn, Mo and Ba), redox conditions (Mn and Mo), terrigenous inputs (Li) and pollution (Cu, Zn, Cd and Pb). However, the interpretation of such records remains extremely challenging and complex, with processes affecting element incorporation in the shell (e.g. crystal fabrics, organic matrix, shell formation mechanisms and physiological processes) and the influence of more than one environmental parameter affecting elemental composition of bivalve shells. Nevertheless, bivalve shells remain an underused source of information on environmental conditions, with the potential to record high-resolution (sub-weekly to annually), multi-centennial time series of geochemical proxy data.

The relatively long-lived bivalve (>100 years) *Glycymeris glycymeris* occurs in coastal shelf seas of Europe and North West Africa and is a valid annually resolved sclerochronological archive for palaeonvironmental reconstructions. The temporal framework provided by absolute annually dated shell material makes *Glycymeris glycymeris* a valuable, albeit unexplored, resource for investigating sub-annually resolved geochemical proxies. We present a first evaluation on the potential of Ba, P and U, the latter two elements rarely studied in bivalves, in *Glycymeris glycymeris* shells to record variations in the environmental conditions, respectively primary productivity, dissolved inorganic phosphorus and carbonate ion concentration/pH.

High-resolution (31 to 77 samples per year) profiles of elemental/Ca ratios (E/Ca) over four years of growth (2001 to 2004) were obtained by LA-ICP-MS on two shells (13 and 16 years old) live-collected in 2010 at 30 m water depth on the Iberia upwelling system. In both shells, clear E/Ca annual cycles with significant higher-frequency variability (weekly to sub-monthly) were observed over the four years of growth analysed. However, E/Ca ratios and the amplitude of the annual E/Ca cycles were lower in the older shell and showed decreasing trends with age (ontogenetic effects). E/Ca ratios were age-detrended using statistical techniques derived from dendrochronology, resulting in similar and coherent profiles in both shells. It seems unlikely that enough variability in E/Ca ratios will be recorded in the shell after 15 to 20 years of age to allow the retrieval of an environmental signal by age-detrending E/Ca ratios. Detrended P/Ca, Ba/Ca and U/Ca in *Glycymeris glycymeris* shells showed coherent variations with coeval modelled and instrumental oceanographic series from the Iberia upwelling system that suggest a robust potential as an archive of environmental conditions in the first 15 to 20 years of growth. Nevertheless a robust calibration is required to distinguish between the influences of multiple environmental parameters.

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