Multi proxy elemental calibrations in biogenic carbonates (foraminifera, corals and sea urchins)

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We report on experimental calibrations of Na/Ca as a proxy for paleo calcium concentrations in the ocean using foraminifera, corals and sea urchins. The organisms were cultured in natural seawater except for variable Ca concentrations. The metals that are probably partitioned with Ca (Li, Na, Mg, Sr and Ba) showed negative trends of El/Ca_{shells} with increasing $Ca_{seawater}$. The distribution coefficients D_{El} however, were not constant and increased as the $El/Ca_{seawater}$ decreased. This has been reported previously for Mg in inorganically precipitated calcite and for some biogenic carbonates. Here we show similar behaviour in foraminifera and sea urchins calcite, where D is increasing with the decrease of El/Ca in seawater, not only for Mg but also for Na and Li while D_{Sr} is constant. Similarly for coral's aragonite D_{El} for Na, Mg, and Sr are changing while Li is constant. Therefore the term distribution coefficient $D_{EL}=(El/Ca_{shell})/(El/Ca_{seawater})$ is misleading, unless the fit is linear with zero intercept. Instead we propose a new term "distribution function" describing the El/Ca_{shell} as a function of the $El/Ca_{seawater}$ obtained from the derivative of the power function fit. Distribution coefficients (or functions) in biogenic carbonates are broadly consistent with those of trace element partitioning into inorganic calcite and aragonite, in agreement with the hypothesis that seawater is present at the biomineralization site. as indicated from the incorporation of Calcein and FITC-dex into the skeleton of these organisms.