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Impact of diagenetic alteration on brachiopod magnesium isotope signatures

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Carbonate rocks are amongst the most commonly exploited archives in palaeo-environmental studies. However, diagenetic processes overprint these carbonate rocks to different degrees, thus, the interpretation of individual proxy data sets such as element concentrations and isotope signatures is hindered. Furthermore, the process of diagenesis is still insufficiently understood. In order to shed light on diagenetic processes alteration experiments under controlled conditions were performed. Therefor, recent brachiopods of the species Notosaria nigricans were collected at Friday Harbour, USA. These shells were artificially altered using different solutions representing meteoric, marine and burial conditions. All three solutions were spiked with 16O-enriched water. Half of the shells were altered under 100°C, whilst the other half experienced a temperature of 175°C. This resulted in six different experimental setups. The duration of the experiments varied for each shell. Eighteen shells were selected in total for the analyses. Furthermore, two unaltered shells and four fossil brachiopod shells were used for comparison with the artificially altered ones. The Magnesium concentration as well as the Mg isotopic composition of the fluids and the shells were measured, whilst carbon and oxygen isotopes were analysed only on the shells. The oxygen isotopic composition of the altered shells exhibit a change in their values only at 175°C and not at 100°C. The same pattern is observed for the Mg isotopic composition of the shells, which were altered in the marine and burial solutions. The meteoric solution, however, is an exception. The original solution was Mg free and both at 100°C and 175°C the altered brachiopod shells are enriched in the lighter isotope compared to the unaltered shell. Thus, the heavier Mg isotope is preferably leached under meteoric conditions. However, solutions (marine and burial at 175°C) with a higher isotopic composition than the brachiopod shells exchange the isotopes in a way that the heavier isotopes are incorporated into the shells' crystal lattice, whilst the lighter ones are leached from the shells and pass into the solution. This pattern is more pronounced for the burial solution than for the marine one. No trend is observed for the Mg isotopic composition of all experiment setups over time. The Mg isotope signatures of the recent brachiopod shells display a range of ca. 0.5‰ whilst the altered shells and the fossil ones have a broader range of 1.5‰ and 1.2‰ respectively. Thus, the alteration experiments seem to represent natural diagenesis. Brachiopod shells experienced diagenetic alteration at 175°C under marine and burial conditions as displayed by oxygen and magnesium isotopes and under meteoric (Mg free) conditions at 100°C and 175°C as it is shown by the Mg isotopic composition. Thus, it is important to note that different proxies seem to be susceptible to diagenetic alteration in a diverse manner depending on temperature. (100°C versus 175°C) as well as fluid composition (meteoric versus marine and burial).