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Nickel and Cobalt incorporation in aragonite as a function of mineral growth rate

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The chemical and isotopic compositions of carbonates minerals allow to reconstruct the composition of the reactive solutions at the time of their formations and are thus of first importance for paleoenvironmental reconstruction over geological time. In this regard, a huge effort was addressed during the last five decades to study the incorporation, and the associated mechanisms, of traces elements in carbonates minerals. Deciphering the effect of particular physical or chemical parameters on the incorporation of traces in natural CaCO3 is not straightforward and in this respect, experimental studies under highly controlled conditions can provide important insight into our understanding of the chemical signatures of natural samples. In this study, we experimentally investigated the incorporation of Ni and Co in aragonite as a function of mineral growth rate using the constant addition technique at 25°C and 1 bar $p\mathrm{CO_2}$. Our results show a linear correlation between the distribution coefficients of Ni and Co and the mineral growth rate suggesting that the latter is likely an important parameter controlling the Ni and Co incorporation in aragonite. In both cases, the distribution coefficients of Ni and Co (i.e., D_{Ni} and D_{Co}, respectively) between aragonite and the reactive solution are always lower than unity and increase with increasing growth rate following the trend of incorporation of elements incompatible with the host mineral structure. Based on the dependency of D_{Ni} and D_{Co} with the saturation indices (SI) of the reactive solution with respect to aragonite, it was possible to estimate a distribution coefficient at equilibrium for both Ni and Co. These experimental values are several orders of magnitude lower than the theoretically estimated ones in the literature. Furthermore, as for other incompatibles elements the correlation between SI and D_{Ni} and D_{Co} point toward the importance of the defect sites in the incorporation of these two elements in aragonite. Finally, our results suggest that D_{Ni} and D_{Co}in aragonite could be used to rebuild the saturation state of the reactive solution.