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# Using stable Mg isotopes to distinguish dolomite formation mechanisms: A case study from the Peru Margin

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Early diagenetic processes in marine sediments lead to formation of authigenic carbonates with distinctive chemical and isotopic compositions. Such environments represent one of the few geological settings where contemporaneous dolomite formation can be observed. In this study we examined diagenetic dolomites and their adjacent pore fluids in a 250 m thick sedimentary section drilled into the Peru Margin during Ocean Drilling Program (ODP) Leg 201 (Site 1230) using stable Mg isotopes. Previous studies revealed the presence of two types of dolomite: type (I) dolomite forms at ∼6 m below seafloor (mbsf) due to an increase in alkalinity associated with anaerobic methane oxidation, and type (II) forms at focused sites below 230 mbsf due to episodic inflow of deep-sourced fluids into an intense methanogenesis zone. The pore fluid $\delta^{26}$Mg values progressively increase with depth from values similar to seawater (i.e. –0.8 ‰) in the top few meters below seafloor (mbsf) to 0.8±0.2 ‰ within the sediments located below 100 mbsf. Type I dolomites have a $\delta^{26}$Mg of -3.5 ‰ and exhibit apparent dolomite-pore fluid fractionation factors of about -2.6 ‰ consistent with previous studies of dolomite precipitation from seawater. In contrast, type II dolomites have $\delta^{26}$Mg values ranging from -2.5 to -3.0 ‰ and exhibit apparent dolomite-fluid fractionation factors of -3.1 to -3.6‰The larger apparent fractionation factor of the type II dolomite could stem from 1) Rayleigh fractionation in a semi-closed system or 2) changes in fluid composition following dolomite precipitation. The difference in the Mg isotope composition of the studied dolomites demonstrates that Mg isotopes can aid to evaluate whether diagenetic phases formed under open or closed-system conditions in marine sediments. Hence they provide an additional tool to reconstruct geochemical conditions conducive to early diagenetic processes that can now be applied to the geological record.