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Cenozoic dolomites of carbonate islands: their attributes and origin

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Abstract

Dolomites found on and below carbonate islands, atolls and oceanic platforms provide useful insights into the origin of dolomite; insights that may not be attainable from the study of more ancient cratonic dolomites. For this reason they have been the subject of study for decades. A critical mass of case studies now exist and some significant conclusions can be drawn from the cumulative data. In most cases the association with an island is causal and not genetic, nevertheless, these dolomite occurrences are referred to herein as island dolomites.

One type of dolomite on carbonate islands is penecontemporaneous dolomite, a phase that forms while the host sediment is in its original depositional setting. Island examples are Holocene in age, occur in Holocene sediments and originate as a direct precipitate [illegible] aporated seawater. These are microcrystalline, poorly ordered, [illegible] and geochemically unstable phases that are susceptible to

Ca-rich ^{18}O-enriched and geochemically unstable phases that are susceptible to recrystallization in the setting in which they formed.

Post-depositional dolomite is the other type of dolomite associated with carbonate islands. This type of dolomite replaces older precursors and forms as cement. Distinctive characteristics include a dominance of fabric-preserving texture, pore-lining cement rims that may exhibit micron-scale banding with low-Mg calcite, and formation in association with precursor dissolution. Sr-isotopic dating indicates that all examples are Neogene or Quaternary in age. Those formed during the Middle Miocene through Pliocene are massive, laterally continuous, and often multigenerational. In contrast, younger examples tend to be localized partial replacements of a single generation. Sr-isotope ages also suggest global synchroneity in many dolomitization events, which suggests a connection between dolomitization, global eustacy and/or global climatic factors.

Geochemical attributes of post-depositional island dolomites are Ca enrichment, positive $\hat{I}'^{18}$O and $\hat{I}'^{13}$C, low Sr contents (150â€“300 ppm) and low Fe (< 300 ppm) and Mn (< 35 ppm) concentrations. Exceptions to these characteristics occur, but are in the minority and can be explained by local enrichment of ^{12}C from sulfate reduction or oxidation of methane, excess Sr from aragonite precursors, and allochthonous Fe and Mn from nearby siliclastics or volcanics.

Global similarity in petrography and geochemistry of replacive island dolomites argues for a similar origin. Inferred origins, however, depend primarily on how $\hat{I}'^{18}$O and Sr data are interpreted. Values for $\hat{I}''^{18}$O and D_{Sr} must be assumed due to uncertainties in oxygen isotope fractionation and Sr partitioning. There is no consensus or uniformity in those assumptions, thus interpretations can vary and be biased to a desired result.

Covariant trends in $\hat{I}'^{13}$C and $\hat{I}'^{18}$O, some negative $\hat{I}'^{13}$C values, and high Sr all favor a mixing-zone origin, but examples with these attributes are few. Lack of covariance in the isotopes, mean $\hat{I}'^{18}$O of +2.0% to +3.5% and low Sr (< 300 ppm) favor an origin from normal or slightly evaporated seawater. Examples with these attributes are in the vast majority, and dolomite geometries and ages relative to overlying limestones indicate that seawater derived laterally is the parent fluid for most of these dolomites. Many interpreted as mixing-zone or hypersaline reflux products are probably misinterpretations based on unreasonable or extreme assumptions about D_{Sr}, $\hat{I}''^{18}$O or the chemistry of hypothetical end-member dolomites.

Future studies should standardize the type of data collected and the analytical techniques

employed. Multiple geochemical attributes should be measured on microsampled components and quantitative modeling should be employed in order to constraint interpretations as much as possible. Also needed are a better understanding of the kinetic processes that form these dolomites, more careful assessment of their recrystallization status and an improved understanding of D_{Sr} and $\hat{I}''^{18}O$ at low temperature.

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Keywords

dolomite; islands; Cenozoic; stable isotopes; trace elements; 87Sr86Sr,

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