**Carbon Dioxide Gas Loss and its Effect on Calcite Precipitation within Oil Wells: Relevance to Fault Cements**

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Carbon dioxide degassing may be a driving force for calcite precipitation in faults and well bores. Tubing scales are ideal for investigation of $CO_2$ degassing because pressure changes, temperature changes, and fluid composition are known, which limits the possible mechanisms of isotopic variation. Calcite scales from a suite of oil and hydrothermal wells were analyzed for carbon and oxygen isotopic composition, and these data were compared with the predicted isotopic effects from $CO_2$ degassing.

Rapid calcite precipitation can preserve a distinctive isotopic signature of $CO_2$ degassing. Degassing of $CO_2$ preferentially removes $^{12}C$ and $^{16}O$ from the solution, leaving solution enriched in $^{13}C$ and $^{18}O$. If crystallization of calcite is sufficiently rapid, $HCO_3^-$ enriched in $^{18}O$will be incorporated into calcite crystal before $^{18}O$ re-equilibration occurs between $HCO_3^-$ and the bulk water. The slope of $^{13}C/^{18}O$ in a $CO_2$ degassing system is predicted to be between 0.59 and 8.33 (Hendy, 1971). In an equilibrium-fractionated system, degassing will result in varying $^{13}C$ values and $^{18}O$ values dependent on the solution temperature and composition. Carbon species are less abundant in the system; thus, isotopic re-equilibration with dissolved carbon species is negligible.

The slope of $^{13}C/^{18}O$ from Kern River field calcite scales closely matches the predicted slope of 0.59 for rapid $CO_2$ degassing and calcite precipitation. Additionally, the carbon values present in the scale from Kern River are extremely enriched in $^{13}C$ ($^{13}C \approx +28$ per $mil_{PDB}$) consistent with $CO_2$ degassing. Most scales from North Coles Levee have positive $^{13}C/^{18}O$ slopes within the predicted range, suggesting that some kinetic fractionation effects are preserved in the scales. We conclude that effects of $CO_2$ degassing may be recorded by co-varying $^{13}C$ and $^{18}O$ in wells, and such effects could occur within fault zones, although preliminary data suggest the effects of $CO_2$ degassing are not preserved.