

THERMAL DECOMPOSITION OF VARIOUS CARBONATES: KINETIC RESULTS AND GEOLOGICAL TEMPERATURES OF CONVERSION

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The standing paradigm in carbonate decomposition is that thermal decomposition does not occur until geological temperatures of 300°C+ are reached. However, measured kinetic parameters for various carbonates suggest a range of thermal decomposition temperatures for carbonates ranging from 100°C to 280°C using calculated kinetic parameters and an arbitrary heating rate of 3.3°C/Ma. The decomposition profiles at geological heating rates of various source rocks enriched in a given carbonate minerals are shown in Figure 1. Siderite decomposes at lower temperatures contemporaneous with oil generation, whereas calcite decomposition occurs at very high temperatures (280°C). Dolomites and dirty carbonates are much more complex showing a range of decomposition profiles and, in many samples, multiple decomposition profiles due to the presence of various carbonate mineral types.

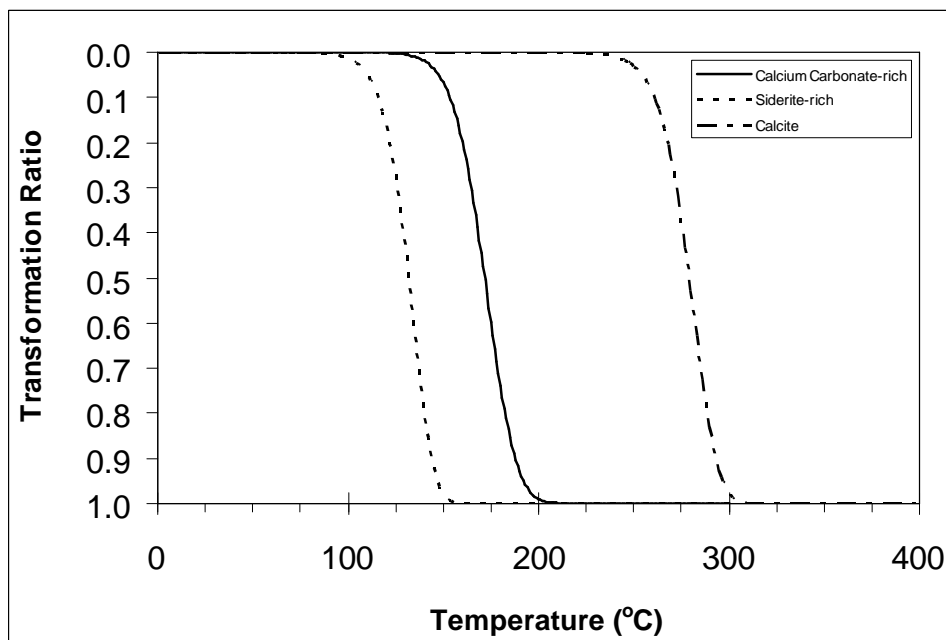


Figure 1. Decomposition profiles of various dirty carbonates contained in a variety of source rocks. These data are derived from open-system pyrolysis experiments and calculated Gaussian kinetic parameters. The kinetic data are modeled at an arbitrary heating rate of 3.3°C/Ma. Error functions are relatively high in these data (± 3000 cal/mole).

From these data it can be seen that thermally labile carbonates such as siderite decompose at temperatures contemporaneous with oil generation, calcium carbonates with

early gas generation, and calcites at the dry gas deadline. While CO₂ may be part of a given gas pool, it is reactive so it may not necessarily result in increased yields of carbon dioxide itself in a source rock or via migration into a conventional reservoir. Increased acidity of formation waters via reaction with CO₂ could result in decarbonation of some carbonates, thereby increasing further CO₂ release. Shale gas reservoirs have variable percentages of CO₂ (<1%) to upwards of 15% of the total gas, but it is not known whether this gas is from diagenetic reactions releasing CO₂ from kerogen or if some of the gas is derived from labile carbonate decomposition either from thermal or decarbonation processes.

Generation of carbon dioxide also impacts saturation of available adsorption sites in organic matter. As carbon dioxide has stronger adsorption affinity than methane, but lower than other gaseous hydrocarbons such as ethane, propane, and butanes, it can displace methane or restrict methane from being adsorbed by solid organic matter surfaces. This enhances the release of methane for production or migration and is a useful parameter to evaluate for unconventional shale gas and coalbed methane production and stimulation.