# Depositional and Diagenetic Controls on Reservoir Quality in Source-Rock Reservoirs: An Eagle Ford Example

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## Abstract

We integrated multiple datasets and analytical techniques to define diagenetic and depositional controls on reservoir quality in the Upper Cretaceous Eagle Ford Formation of South Texas. We began by building a wireline log- and core-based stratigraphic framework for the study area. In our study area, the Eagle Ford is divisible into Lower and Upper members that have chronostratigraphic significance, the former (Cenomanian-age) being more enriched in organic-rich marlstones and the latter (Turonian) having a greater abundance of organic-poor limestone and less marlstone. We established a paragenetic history for the samples by examination of ion-milled SEM imagery. Petrographic evidence for several discrete diagenetic events (e.g., diagenetic quartz overgrowths, clay compaction) can be observed, but the key diagenetic control on reservoir quality was the precipitation of an early calcite cement that preferentially developed in the calcite-rich limestones rather than the mixed mineralogy (calcite, clay, organic matter) marlstones. This cement reduced porosity and hence permeability more in the limestones prior to deep burial and hydrocarbon generation. With burial and transformation of organic matter, oil and/or bitumen migrated over scales of microns within the marlstones, from clay- and organic-rich particles deposited as marine snow and into inter-particle pores present in coccolith-rich fecal pellets. Although several different types of pores are present in the Eagle Ford, the dominant type in our samples consists of pores developed in organic matter. We next integrated Rock-Eval results (defining thermal maturity) with quantitative measurements of pore-size distributions defined from SEM imagery. In the oil window,

pores in organic matter are dominated by a unimodal distribution of "bubble pores" having diameters of several 100 nm. With progressive maturation, "foam pores" having diameters of a few 10s of nm become more abundant, and two distinct pore-diameter modes are present. Eventually, in the gas window, these foam pores become so abundant that they amalgamate with other foam pores and the bubble pores to create a single, broad distribution of pore sizes. The development and amalgamation of these foam pores formed a connected network of pores that increased bulk permeability by one or two orders of magnitude, depending in part on the original lithology. The increase in permeability with thermal maturation was greatest in the marlstones rather than the limestones because porosity in the latter had been reduced prior to hydrocarbon generation and migration within the Eagle Ford itself.

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