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Carbonate Reservoirs: How Important Is the Late Diagenesis?

Different types of vugs, molds, enlarged fractures and caverns are reported as predominant in at least 80% of carbonate petroleum reservoirs around the world. A review of rock data from numerous fields (e.g., Indonesia, China, India, Middle East, Mediterranean, North Sea, Caribbean) indicates that, at least in 40% of cases, the role of late burial porosity has been underestimated or ignored in favor of the early porosity interpretation.

Vertical porosity distribution in the reservoir, degrading downwards from the top unconformity or sequence boundary, is commonly mentioned as a circumstantial argument in favor of an early diagenetic origin. However, this porosity distribution can also be demonstrated to originate from late diagenetic fluids preferentially trapped under the seal at the top of the reservoir. Petrographic observations reveal that observed porosity postdates: (i) late cements, (ii) dissolution seams or stylolites, (iii) late cemented fractures. Late porosity produced by corrosive fluids terminated most carbonate cementation and deposited minor quantities of fluorite, dickite, quartz, pyrite, solid bitumen, sulfates and other precipitates. Much of this late-diagenetic corrosion occurs near the time of (and follows the same trends as) hydrocarbon migration.

This review of case histories signals the need for careful re-evaluation of the early-late porosity balance in carbonate reservoirs. With current models of predominant early porosity development, exploration and production strategies emphasize the control of subaerial exposure and depositional facies. In the case of mostly late porosity development, predictive strategies should be based on models of hydrocarbon maturation and migration during late structural development.