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Please fill in your author name(s) and company affiliation.

Given Name	Surname	Company
Lyndon Anderson	Yose	ExxonMobil
Hisham	Al Qassab	ExxonMobil

Abstract

Objectives/Scope:
Prediction of carbonate reservoir performance and recovery can be challenging due to variability in pore system types and their impact on permeability architecture. This paper presents a multidisciplinary approach for pore system characterization that emphasizes early integration of dynamic data. The objective is to focus reservoir characterization and modeling on the geologic details that have the largest impact on flow and recovery.

Methods, Procedures, Process:
The workflow discussed in this paper includes the following elements: 1) definition of business objective (what business decisions will the work inform?), 2) screening of available data with focus on dynamic data (reservoir diagnostics – what matters to flow?), 3) pore system characterization (includes quantitative digital petrography and integration of Special Core Analysis (SCAL) data), 4) pore system distribution and connectivity (geologic concept models and scenarios), 5) integration into geologic model(s) (includes alternative scenarios to bracket range of uncertainty, 6) simulation models that link pore system types and distribution to SCAL properties, and 7) simulation feedback and evaluation of alternative scenarios, and 8) assessment of reservoir development and management implications.
The workflow requires integration across static and dynamic data, and close collaboration between geologists and reservoir engineers prior to building reservoir models. Well test data provide information on larger-scale permeability magnitude and architecture away from the well bore, and often indicate greater permeability than measured in core data (“excess permeability”). Production and injection logs provide information which zones are contributing to flow (often a small portion of the perforated interval) and thus provide information on allocation of excess permeability derived from well tests. Production and injection logs can also be calibrated to pore system types based on core and log data. Pressure data provides information on reservoir connectivity, and distribution of flow baffles and barriers. Special Core Analysis (SCAL) provides information on relative permeabilities and capillary pressures, both of which impact flow and recovery.

Results, Observations, Conclusions:
Results and benefits of the integrated workflow include: early alignment of reservoir engineers and geoscientists on geologic controls on flow and modeling strategies, simpler reservoir rock typing schemes that are based on flow behavior and tied to SCAL data, better understanding of reservoir uncertainties and alternative scenarios impacting flow and recovery, and more accurate models that better match historical performance and are more predictive. This approach also impacts field development strategy by tailoring well types and placement relative to maximize production and recovery.

Novel/Additive Information:

Traditional rock typing methods can result in complicated models with multiple rock types that overlap in properties and are not predictive. Dynamic rock types as defined this study are based on pore systems with characteristic flow properties, are often limited in number (3-4), tied closer to fundamental geologic controls (easier to distribute) and more predictive of reservoir performance.