12.18: Integrated geological and petrophysical interpretation of the upper Wolfcamp at Delaware Basin: Implication for production

Sebastian Ramiro-Ramirez, UT Institute for Geophysics

ABSTRACT

I describe the production behavior in the upper Wolfcamp through single-phase flow simulations. This interval is predominantly hemipelagic mudstones alternating with siliciclastic and calciclastic sediment gravity flow deposits (turbidites, debris flows). When dolomitized, carbonate turbidites act as permeable pathways that drain fluids from mudstones during production due to cross-facies flow. My flow simulations indicate that production is strongly controlled by the ratio between the permeable layer's horizontal permeability and the mudstone's vertical permeability. At high ratios, the permeable layer is an isopressure surface at early times; production time scales with the squared thickness of the low-perm layer and production volumes scale linearly with reservoir length (Fig. 1A). However, flow is restricted in the permeable layer at lower ratios, and production only scales linearly at shorter reservoir lengths (Fig. 1B). Hence, the permeability ratio between layers controls, at least to some extent, what the optimal spacing between hydraulic fractures is to maximize recovery factors (Fig. 2).

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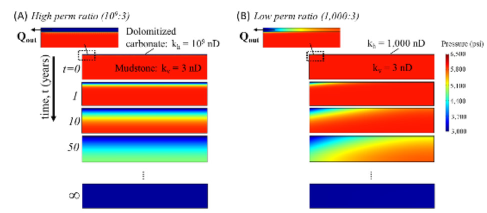

Fig 1: Pressure profiles of the 2-layered reservoir model at different production times. (A) The ratio between the high-perm layer's horizontal permeability and the low-perm layer's vertical permeability is sufficiently high (10^9:3) for the permeable layer to be an isopressure surface at early production times. Pressure contours are horizontal. (B) When the permeability ratio is much lower (10^3:3), flow is restricted in the permeable layer. Pressure contours are not horizontal.

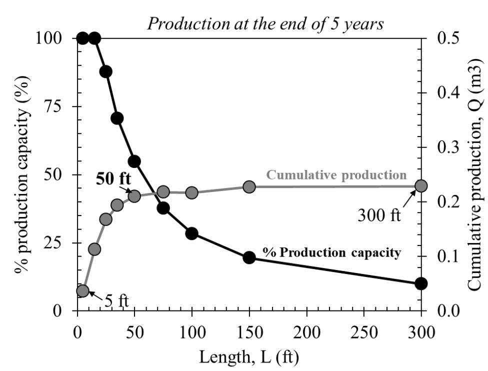

Fig 2: Chart showing percent production capacity (left y-axis) and cumulative production (right y-axis) at the end of 5 years, for different reservoir lengths. This chart can be used to optimize the spacing between hydraulic fractures (2x Length) in well-completion designs.

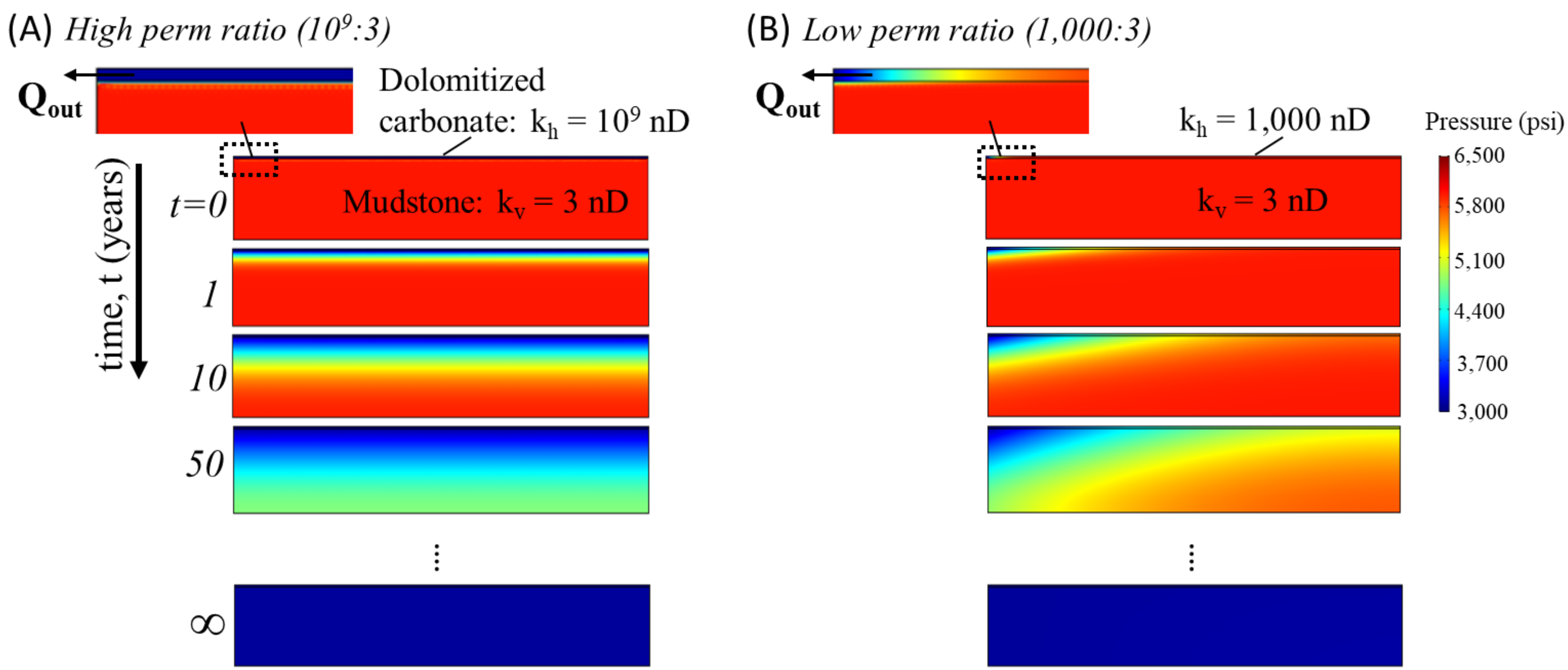

Fig. 1: Pressure profiles of the 2-layered reservoir model at different production times. The reservoir model consists of a thin, high-permeability layer (i.e., dolomitized carbonate) overlying a thicker, low-permeability layer (i.e., mudstone). At infinite production times, the pressure within the reservoir domain equilibrates with the pressure in the fracture (left boundary). (A) The ratio between the high-perm layer's horizontal permeability and the low-perm layer's vertical permeability is sufficiently high (10^9:3) for the permeable layer to be an isopressure surface at early production times. Pressure contours are horizontal. (B) When the permeability ratio is much lower (10^3:3), flow is restricted in the permeable layer. Pressure contours are not horizontal.

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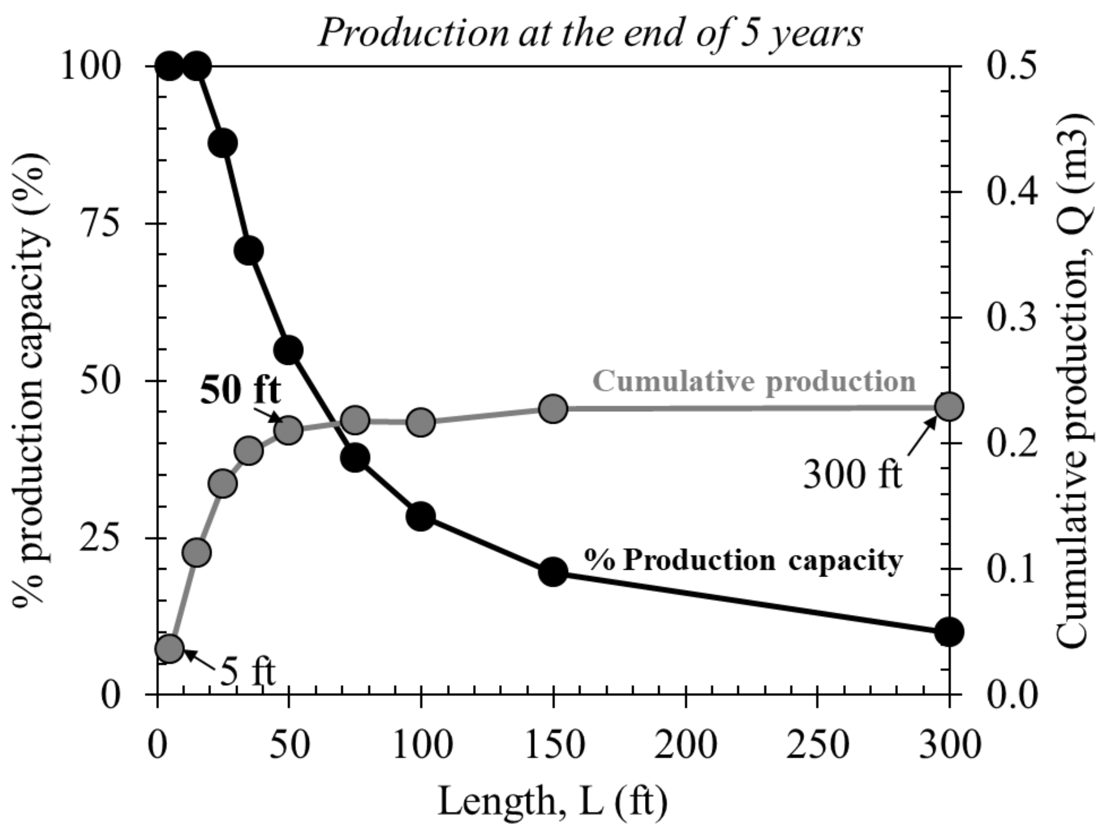

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