

An Experimental Model for the Origin of Underpressured and Overpressured Shallow and Basin-Centered Gas Pools: Rate Competitive Gas Generation, Drainage, Gas Leakage and Imbibition.

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ABSTRACT

A laboratory analogue of gas migration into a formation sealed at the top by capillarity was used to study the pressure behavior of gas accumulating in the trap. A one-half metre plexiglass column was fitted with a capillary tube at the top and base and a gas inlet port at the base. The diameter of the top capillary tube was substantially larger than the diameter of the bottom capillary. The top and bottom capillary tubes were connected to a large reservoir with a constant level that was higher than the outlet of the upper capillary. Pressure was monitored inside of the plexiglass column using a transducer. The pressure at any point in the system outside of the plexiglass column was determined from the vertical distance to the constant water level in the reservoir. Initially water filled the entire system and gas was then bubbled into the plexiglass column through the bottom inlet. As the gas column grew, pressure increased inside of the plexiglass column and water was pushed-out through the bottom capillary. Eventually the pressure at the top of the growing gas column exceeded the capillary pressure of the upper capillary and gas began leaking to the “up-dip” reservoir. The gas supply was then shut-off. However, gas never stopped leaking from the upper capillary tube. Water influx from the bottom capillary was very slow and the gas column lost pressure and became “underpressured” with continued gas leakage through the upper capillary. As the pressure in the gas column at the top of the upper capillary approached the pressure in the exterior contiguous water system, the rate of gas leakage slowed to a point of almost stopping. The slow influx of water through the lower capillary eventually pushed all of the gas out of the plexiglass column from below, and the system was returned to the initial conditions. Pressure vs. Elevation plots of the data defined overpressured conditions within the plexiglass column prior to gas leakage and then underpressured conditions as the gas leaked from the system when the gas

supply was shut-off. Normally pressured conditions prevailed at the end when all of the gas had been pushed out of the plexiglass column.

The various pressure stages that developed through time in the capillary model can be seen in the Deep Basin and shallow gas pools in Alberta and British Columbia.