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Characteristics of Tight Gas Sands and Causes of Overpressured and Underpressured Tight Reservoirs

For several years the U.S. Geological Survey has been studying tight gas reservoirs in the Rocky Mountain Region. This work is being done in cooperation with the U.S. Dept. of Energy. Many problems remain to be solved; however, some characteristics of these reservoirs are known. The majority of the gas occurs in lenticular, fluvial sands of Late Cretaceous and early Tertiary age. The porosity is low, generally less than 10%. The sands are generally clayey, sometimes carbonate cemented, and commonly contain abundant feldspar and rock fragments. Most of the porosity is secondary. The pores are connected with small (commonly about 1 μm) capillaries. Capillary pressures are generally high. The grain densities of the sands are generally 2.68 to 2.70 gm/cc due to an abundance of minerals with densities higher than quartz. The reservoirs are stress sensitive; therefore, convectional laboratory permeabilities are usually 60 to 80% too high.

The gas reservoirs are frequently either overpressured or underpressured. Overpressuring is present in many deep basins in the Rockies. Deep reservoirs with pressures of 0.5 to 0.8 psi/ft are common. For reference a pressure of 0.43 psi/ft is considered normal. This conclusion is based on analyses of detailed geochemical, vitrinite, temperature, and pressure data. The gas is generated by temperature-related thermochemical breakdown of humic kerogen in source beds (shales and coals). The pressure builds up to the natural fracture gradient of the rocks and then is expelled by gas fracing into adjacent reservoir sandstones. Underpressuring ($<$0.4 psi/ft) in some areas such as the San Juan Basin and the Alberta trough, is caused by cooling of gas in discontinuous gas-saturated reservoirs and is not related to hydrodynamics. Both basins were originally much hotter than at present. Many of the conventional concepts of hydrodynamics need to be revised when interpreting data from low-permeability reservoirs.