Hydrogeologic Explanation for Occurrence of "Updip" Oil Fields and Postulated Coalbed Natural Gas in the Wilcox Group in Central Texas, Gulf of Mexico Basin, USA

Alan R. Dutton[1] and Leigh A. Symank[2]

[1]Department of Geological Sciences, The University of Texas at San Antonio, One UTSA Circle, San Antonio, Texas 78249

[2]LBG-Guyton and Associates, 1101 S. Capital of Texas Hwy., Ste B-220, Austin, Texas 78746

ABSTRACT

The downdip part of the Wilcox Group beneath the western Gulf of Mexico coastal plain is a major oil and gas reservoir; the updip part, where the Carrizo Formation is mapped separately from the Wilcox Group, hosts a major aquifer system. Data on fluid pressure and chemical composition of water from petroleum and groundwater industries show that the convergence zone in Central Texas between the petroleum- and freshwater-producing parts of this regional fluid-flow system is marked by (1) a regional minimum in hydraulic head and a hydraulic-gradient reversal, (2) mixing between recharging meteoric water from the formation outcrop and basinal brine leaking updip out of the Wilcox geopressured zone, and (3) so-called "updip" oil fields.

To test questions about variable-density fluid flow in the convergence zone we constructed a cross-sectional numerical model using SUTRA, a public-domain model for 2D or 3D saturated-unsaturated, variable-density ground-water flow with solute or energy transport. Model properties were taken from a calibrated water-resources model. Prescribed fluxes were assigned to the recharge zone, the updip limit of the growth-faulted geopressured conditions in the Wilcox Group, and the contact with the underlying Cretaceous section. Head-dependent leakage into overlying aquifers also was included. Simulation results show that a lateral-flow stagnation zone separates (a) downdip-directed flow from the recharge zone from (b) updip-directed flow from the geopressured zone. Upward-flow is simulated-across a broad convergence zone, which is consistent with the gravitational model of petroleum entrapment. Deep-basin Wilcox lignite might have been charged with thermogenic natural gas while crude oil accumulated in the updip oil fields. Sensitivity analysis, however, shows that inversely varying the inflows from the recharge and the geopressured zones yields non-unique solutions for the salinity profile. The model lacks adequate characterization of flow-scale heterogeneity and overestimates the speed at which Eocene seawater was displaced from the updip aquifer system.

Dutton, A. R., and L. A. Symank, 2009, Hydrogeologic explanation for occurrence of "updip" oil fields and postulated coalbed natural gas in the Wilcox Group in Central Texas, Gulf of Mexico Basin, USA: Gulf Coast Association of Geological Societies Transactions, v. 59, p. 243.