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Hydrodynamics, Deep Basin Systems and Exploring Downhole Geochemical Interactions in Unconventional Reservoirs: An Introduction

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Introduction

Water management has become an increasingly important part of the conversation for managing operating costs and maintaining profitability. Operators seek not only optimal performance and low-cost water management strategies, but also predictability in the expected water production.

The purpose of this presentation is to introduce the topic of hydrodynamics and discuss its role in helping to predict areas with a higher risk of water production in unconventional reservoirs. Hydrodynamics plays a key role in the formation of regional low permeability tight gas and hydrocarbon liquid systems, such as the Lower Triassic Montney Formation located in northeastern British Columbia and west-central Alberta. Variable reservoir quality, multiple source rocks, occurrences of fluid migration, and structural history have all contributed to a complex hydrodynamic system in the Montney. This presentation provides several examples of areas of higher water production across the unconventional reservoir.

Background and Theory

In the first part of this presentation, we will discuss the stages of theorized evolution of “Deep Basin style” unconventional systems, first introduced by Law (2002) and based on work by Masters (1984). The process involves the generation, migration and leakage of gas, and accompanied by the regional de-watering of the system. All of this is summarized as four distinct stages - genesis, transition, steady-state and imbibition (Burnie et al., 2008).

Understanding the mechanisms involved with de-watering of the system allows us to understand both the degree of desiccation and distribution of formation water in the reservoir. These characteristics affect the flowback of hydraulic fracturing fluids, formation water production, and relative permeability to hydrocarbons. The fluid saturation distribution within the system is affected by reservoir heterogeneity and the associated variation in capillary entry pressure, where capillary by-passing can result in isolated wet spots within the system. Recently introduced concepts, such as secondary dry gas migration (Wood and Hanei, 2016), are important to consider as well, as these mechanisms can further affect fluid saturations within high permeability reservoir pathways and permeable fracture networks within the system.

Applications

The second part of the presentation will focus on key controls on the transition from the Deep Basin to the conventional system, and how an integrated approach using multiple data sets—such as pressure and water salinity—can be used to de-risk water production in these transition

areas. The talk will focus on quantifiable formation water characterization, data interpretation methods and flowback fluid chemical profiling techniques that can be used to better understand the downhole geochemical interactions between the reservoir, formation fluids, drill fluids and fracturing fluids in these unconventional reservoirs (CDL, in progress). Examples of plots from throughout the Montney unconventional system will be presented, encompassing a variety of fluid maturity and reservoir quality scenarios, from the edge of overpressured gas-dominated fairway into the underpressured oil dominated fairway, and toward the regional conventional system.

References

Burnie Sr., S.W., Maini, B., Palmer, B. R., and Rakhit, K. 2008. “Experimental and empirical observations supporting a capillary model involving gas generation, migration, and seal leakage for the origin and occurrence of regional gasifers”, in Cumella, S. P., Shanley, K. W. and Camp, W. K. eds., “Understanding, exploring, and developing tight-gas sands”, 2005 Vail Hedberg Conference: AAPG Hedberg Series, no.3: 29-48.

Canadian Discovery Ltd. In Progress. Montney Underpressured Fairway Water Analysis Project (MUFA). Calgary, Alberta, Canada.

Law, B. E., 2002, Basin-centered gas systems: AAPG Bulletin, v. 86, no. 11, p. 1899 –1911.

Masters, J. A., ed., 1984, Elmworth— Case study of a deep basin gas field: AAPG Memoir 38, p. 1 –33.

Wood, J. M. and Sanei, H. 2016. Secondary migration and leakage of methane from a major tight-gas system. Nature Communications, v7, no 13614.