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What's hydrodynamics done for me lately? Select case studies from the Conventional and Unconventional Montney Formation

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Summary

Hydrodynamic techniques have been used to aid exploration and development for decades. Primarily applied to conventional plays, we have historically pointed their application to reservoirs that could roughly be termed as dynamic (active fluid flow) or static (sluggish to very little fluid flow) and employed somewhat different techniques to further our understanding. In both cases, the techniques required some degree of reservoir permeability and hence pressure continuity. With the focus today on Unconventional (tight to very tight) reservoirs, the basic premise of these techniques no longer apply. Pressure continuity, what's that?

We use several case studies from the Montney Formation to exemplify how the application of hydrodynamics has evolved as exploration focus moved from Conventional to Deep Basin and Transitional hydrodynamic systems.

Hydrodynamic Definition of Conventional and Deep Basin Systems

In Conventional Systems, water is the continuous fluid phase and the assumption that pressure increases with depth as a function of the reservoir fluid density is the mantra for using tools such as Pressure vs. Elevation Graphs (P/E Graph). A hydrodynamicist's staple, the P/E graph is an excellent tool for identifying fluid contacts, reservoir continuity and discontinuities. Figure 1 shows examples of these in the Pine Creek and Fir gas pools.

On the flip side of Conventional Systems are the tight Montney siltstones that display rapid variances in pressure both vertically and laterally. Also referred to as the Deep Basin, pressure trends deflect both under and over those of the nominal water pressure gradients (Figure 2). The industry for the most part has focused on the Overpressured Deep Basin (ODP) where gas is the continuous saturating fluid. We will discuss a number of hydrodynamic methods that help constrain these boundaries.

Until recently, the Underpressured Deep Basin (UDP) has had little attention, due in part to its relative subtle hydrodynamic signature. Unlike the Cretaceous UDP, that is predominantly gas saturated and tends to be quite obvious on P/E plots, the Montney UDP is oil-dominated. The UDP in general has higher water saturation and water cuts, creating a more complex play requiring a thorough understanding of the interplay between stratigraphy, reservoir heterogeneity and hydrodynamics.

Economics and the Deep Basin

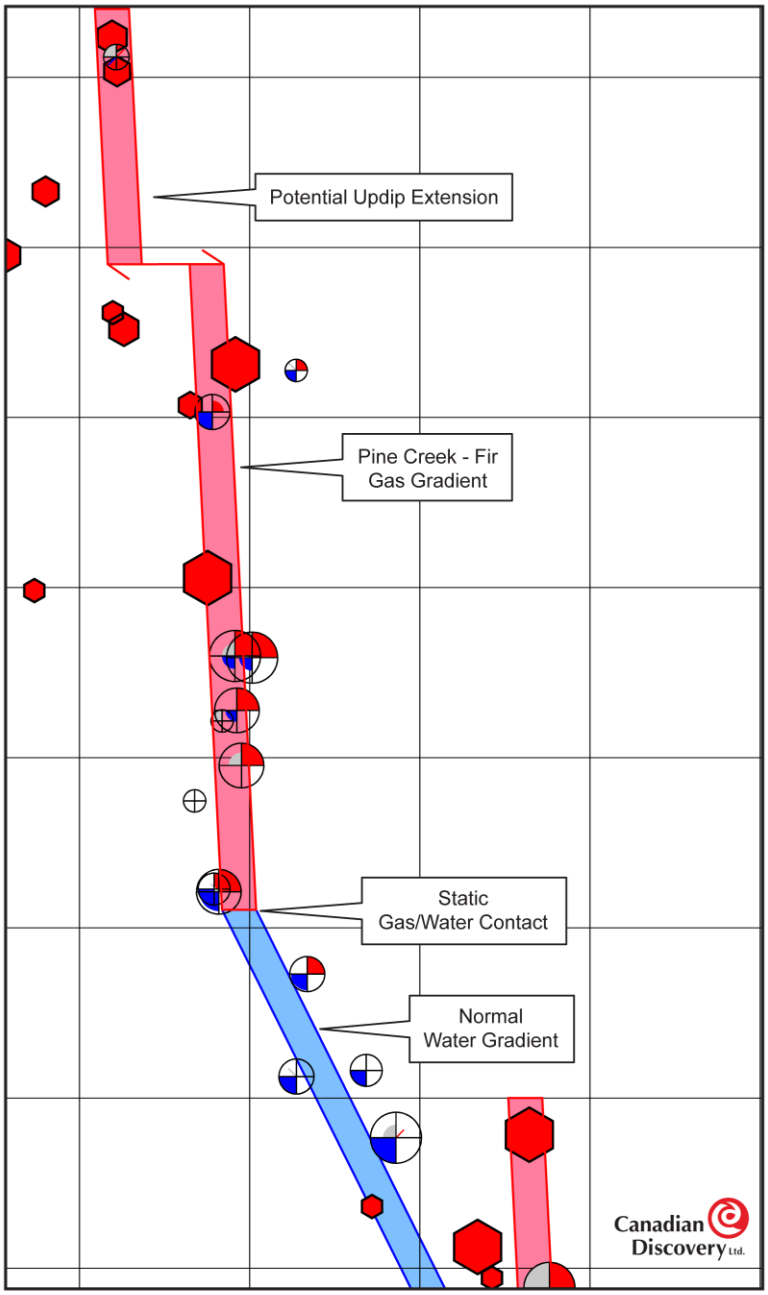
The economic significance of Conventional vs Deep Basin development is exemplified in Figure 3. First conventional production in the Montney started around 1961 and peaked in the late 80's at ~ 60 MMCF/D gas and 13,000 B/D oil. Discovery of Middle and Lower Montney Turbidites in the greater Elmworth area in the early 90's increased gas production to ~ 0.5 BCF/D. However, production from the ODP has ramped this production base to over 7 BCF/D and 115,000B/D condensate in less than 10 years. Although not as significant as the ODP, we note the substantial increase in oil production from the UDP in the last 6 years, which now exceeds the Bakken at ~ 63,000 B/D. We believe this number has significant upside growth potential under more favourable commodity prices.

References

Canadian Discovery Ltd. 2019. Montney Regional Hydrodynamics Study Phase III.

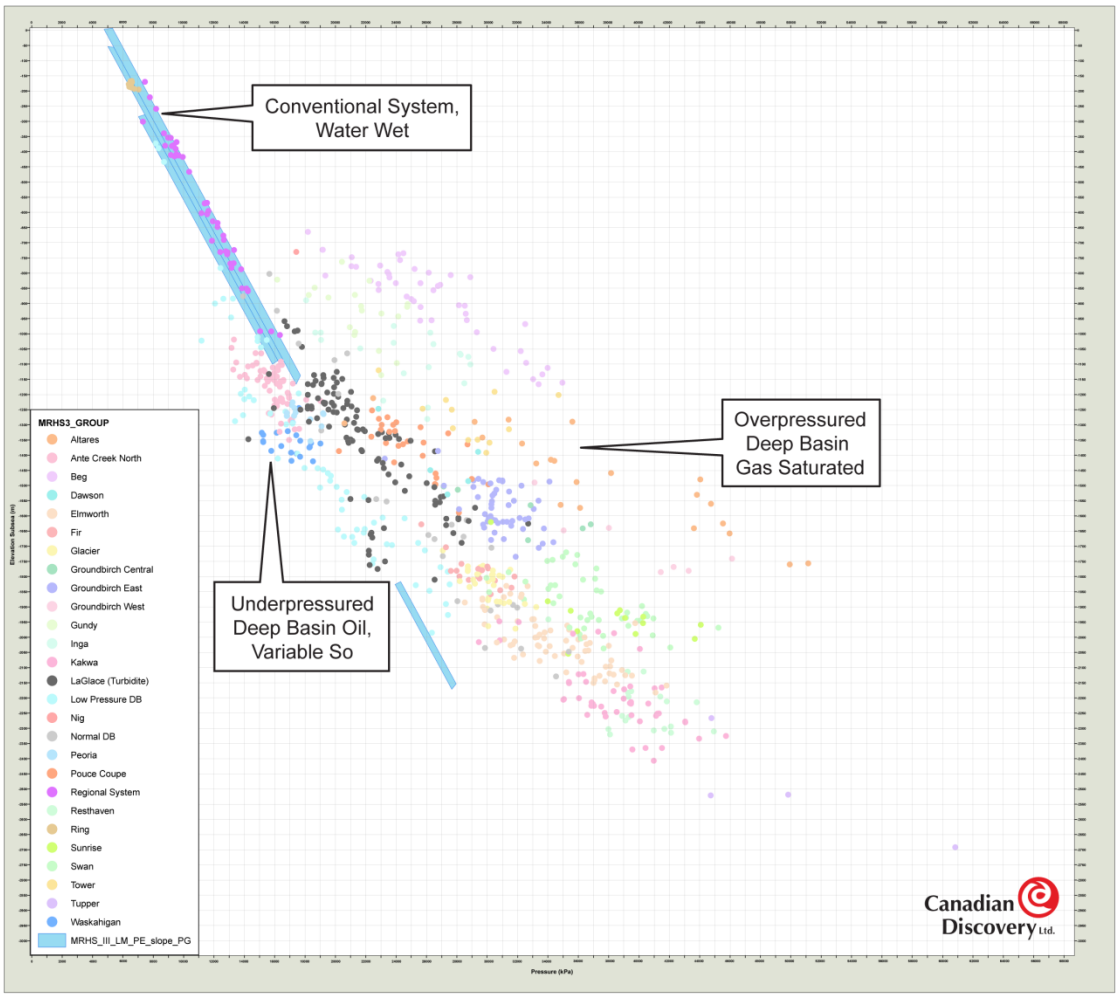
Canadian Discovery Ltd. 2008. Hydrodynamics and Regional Facies of the Montney Formation.

Figure 1
Hydrodynamics signature of a stratigraphic trap;
Pine Creek and Fir gas pools



Source: CDL's Montney Hydrodynamics Project, 2008

Figure 2
Pressure vs Elevation Graph of the Upper Middle Montney



Source: CDL's Montney Hydrodynamics Project Phase III, 2018

Figure 3
Historical Montney production by play type