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Fluid Inclusion Stratigraphy on Montney Well Cuttings

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Introduction

Cuttings are an under-utilized source of information. Fluid inclusions contained in the cuttings are representative of past or near-present-day pore fluids. This allows us to access both rock and fluid information from essentially waste material of the drilling process over the whole drilled length. Fluid inclusions are the only direct records of paleofluids existing in the subsurface, and as such, have the potential to record conditions accompanying geologic processes, including petroleum migration. By studying the subsurface distribution of paleo fluid chemistries with Fluid Inclusion Stratigraphy (FIS), one can obtain valuable and unique information on three major exploration topics: a) petroleum migration or paleocharge, b) seals, c) proximity to undrilled pay, and two major production topics: a) pay zone and bypassed pay delimitation, b) reservoir compartmentalization.

Fluid Inclusion Stratigraphy involves the rapid, complete analysis of volatiles trapped as fluid inclusions in rock samples using quadrupole mass analyzers attached to an automated, high-vacuum sample introduction system. The technique documents the presence and relative bulk abundance of ionized volatile fragments that have been released from the fluid inclusions by crushing the samples. This includes most geologically important inorganic species as well as organic species with less than or equal to 13 carbon atoms. The resulting dataset can provide a nearly continuous log of present and past pore fluid chemistry through the stratigraphic section penetrated by a well, and, given adequate sample coverage, the data can be mapped in two or three dimensions.

Results & Observations

FIS analysis was performed on a total of 71 cutting samples from a vertical well, drilled in the Alberta Basin from 2400-2827m spanning the Fernie to Taylor Flat formations with a sample gap between the Coplin Unconformity and the Upper Montney (2495-2575m). According to the mud log, some oil shows were recorded within the analyzed section at 2475-2520m (Charlie Lake to Doig) and 2810-2827m (Taylor Flat).

The upper portion of the analyzed section at 2400-2495m (Fernie to Coplin Unconformity above the sample gap) showed dry gas to wet gas FIS responses above 2445m (Fernie to Charlie Lake) and gas-condensate to oil-like spectra below 2445m (most of the Coplin Unconformity) (Fig. 1). Higher concentrations of liquid hydrocarbon species are documented in the Charlie Lake and Coplin at 2475-2480m, while the highest methane and ethane responses occur in the Nordegg at 2425-2445m. Helium concentrations are elevated at 2425-2445m as well, suggesting helium is part of the volatile hydrocarbon phase.

FIS data from the intermediate interval at 2575-2710m (Upper Montney to base of the Montney B) indicate mostly gas-condensate to oil-like responses. Elevated methane concentrations are noted at 2660-2665m (Montney B). Liquid petroleum signals are most prominent at 2615m (Montney C) and 2630-2670m (Montney C and Montney B). Methane does not always covary with liquid-range species. This could indicate contributions from intercalated kerogen or a dual-stage charge history involving oil and gas. Samples displaying anomalous acetic acid are recorded at 2595-2710m (Montney C and B). In general, these anomalies suggest the nearby presence (or penetration) of reservoired liquid petroleum (oil or condensate) and possible elevated water content. Minor concentrations of CS are documented at 2615 m and 2685m, but sulfur species (H_2S, CS_2 and SO_2) and CO_2 are more broadly elevated to some extent below 2610m. Highest H_2S values occur at 2630-2645m (Montney C and B), and 2685-2690m (Montney B). Helium covaries with methane, for the most part, with highest recorded concentrations in the Montney B at 2660-2670m.

The bottom section of the well at 2715-2827m (Montney A to Taylor Flat) exhibits wet gas to gas condensate to the base of the Montney A at about 2790m, and at 2810-2815m (bottom of the Belloy). Dry gas is identified at other depths. Strongest methane responses are documented at 2790-2810m (lowermost Montney A and Belloy). Liquid hydrocarbon signals are elevated at 2755-2775m (Montney A) and 2810m (Belloy). Again, a possible dual-stage charge history involving oil and gas may be indicated by decoupled gas and liquids responses. Anomalous concentrations of acetic acid (with or without benzene) are identified at 2715-2750m and 2785-2825m, which could be sensing a nearby (or penetrated) liquid petroleum accumulation at elevated S_w. Sulfur species continue to be present with the highest H_2S signals at 2760-2785m (Montney A).

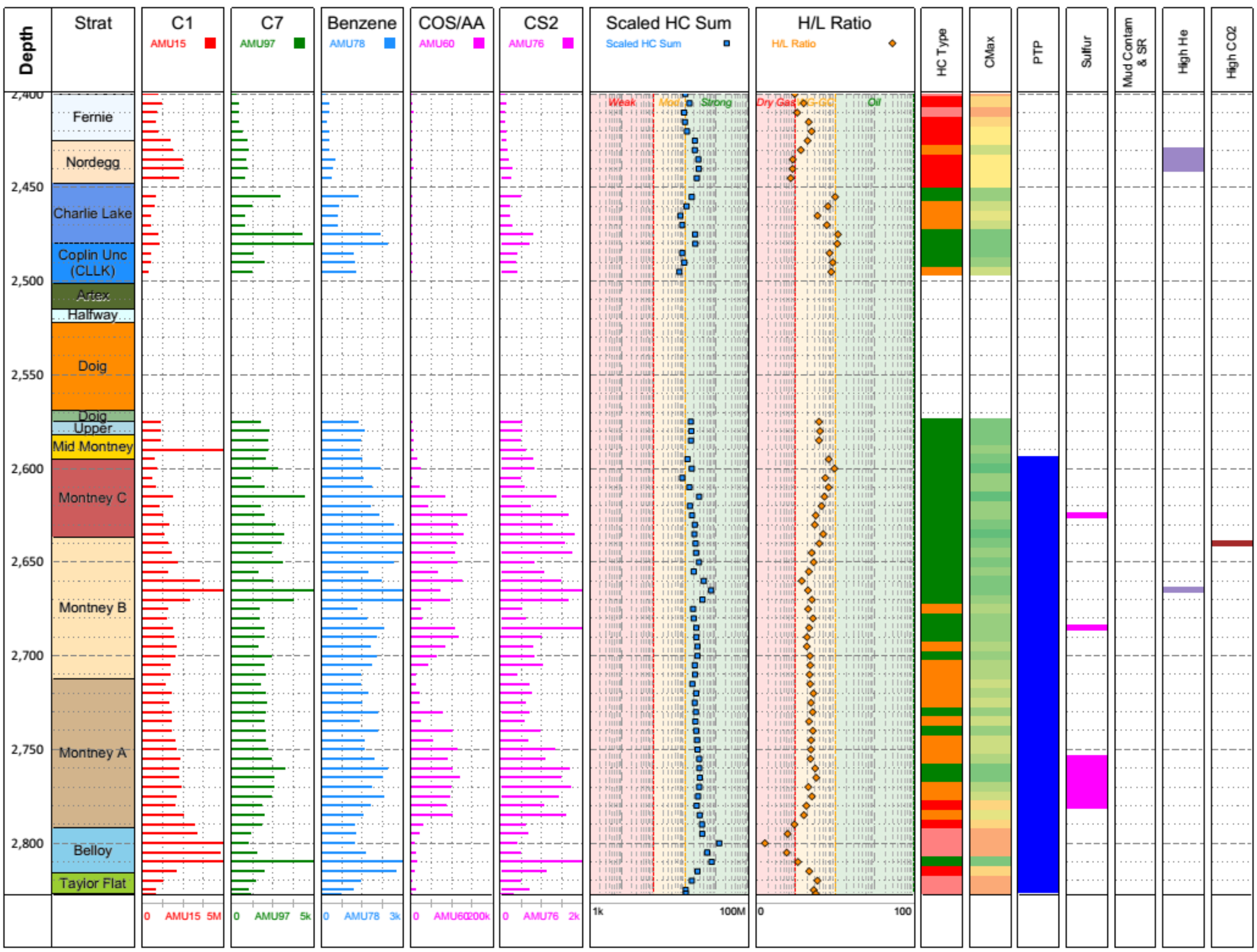

Figure 1: Summary overview of FIS responses

Conclusions

The unconventional Montney in NuVista's development area is complex ad both geologically and hydrodynamically variable. Given the potential economic returns from unlocking this resource, having a solid understanding of the fluids in the reservoir is critical to developing the resource.

NuVista has performed fluid inclusion testing to further validate conclusions from other tests (including isotope analysis, gas chromatography, and fluid analysis) that were previously run to improve understanding of the fluid systems. Preliminary results confirmed conclusions from previous studies and aligned well with our assumptions and interpretations of the fluids in the well. Given the minimal cost and relative ease of acquisition, Fluid Inclusion Stratigraphy is an effective tool at our disposal to help us better understand the fluids in the Montney reservoir in our area.