Using Ultra-Sensitive Hydrocarbon Mapping to Elucidate the Carbonate Dahl Reef Complex

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ABSTRACT

Dahl Reef is an isolated carbonate patch reef complex located in British Columbia. Production is gas and chiefly focuses on the up-dip northern end of the reef margin. Surface geochemistry acquired from microseepage was used to delineate areas of gas hydrocarbon accumulations and to define the extent and boundaries of those accumulations. It is important to note that the mechanism that affect microseepage hydrocarbons and their transport to the surface are a combination of reservoir pressure, porosity, and net pay thickness. Thus, as the combination of these three variables increases, so does the hydrocarbon response at the surface.

Amplified Geochemical ImagingSM is a high-end surface geo-chemistry technology that uses passive adsorbent sampling which contains a specially engineered hydrophobic adsorbent encased in a layer of microporous expanded polytetrafluoro-ethylene (ePTFE). This proprietary membrane has pores that are specifically engineered to allow hydrocarbon molecules to pass through while excluding soil particles and water droplets. Consequently, Amplified Geochemical Imaging is able to obtain a thousand fold increase in sensitivity as compared to traditional methods. Additionally, the technology has the ability to measure approximately 90 compounds from C2 – C20 that not only measure hydrocarbon intensity, but also provide a probability map of hydrocarbon presence over an area. That probability factor is the probability of finding hydrocarbons similar to a referenced or modeled signal. In the Dahl Reef survey multiple gas well and dry well signatures were used for modeling purposes. Examples will be shown that these probability percentages can be proxies for reservoir pressure, porosity, and/or net pay in a field.

In the case of the carbonate Dahl Reef complex both hydrocarbon probability and intensity were used to map gas hydrocarbon influence over the reef structure. At the northern reef margin, where the majority of the drilling had taken place, probability factors ranged between 80% - 100% indicating strong fingerprint similarities to the model wells. Butane intensities ranged from 300 -900 ion counts, which appeared to be the norm for the Dahl Reef gas trapped in the conventional lime-stone reservoir.

The gas signatures from the anomaly in the center of the reef complex displayed probability factors between 80% - 100% as well, however, butane intensities for these samples were approximately 1,500 ion counts. It was believed the higher intensities were indicative of larger accumulations in natural fractures within the dolomitized core section.

Additionally, the survey results identified gas accumulations off-reef that were initially believed to be patch reef systems. However, some of these accumulations had significantly different hydrocarbon intensities than the known reef complex. While the composition of the gas was similar at all locations of the survey, as indicated by probability factors ranging from 80% - 100%, the hydrocarbon intensities over the reef

complex had a maximum value of 900 ion counts, and the anomaly to the southeast of the reef had a maximum value of almost 5,000 ion counts, and the gas anomaly to the northeast had a maximum value of 125,000 ion counts.

When placed in a geologic context, the data was interpreted to mean the anomaly to the southeast was actually not a carbonate patch reef complex, but rather the Muskwa Shale with a higher porosity than the Dahl Reef. Thus the increased porosity in the shale resulted in a higher butane intensity at the surface.

It was also believed the higher butane intensities of 25,000 in the northeast anomaly were a result of increased porosity from hydrothermal dolomitization of carbonates. The carbonate dissolution from the influx of hot brine solutions resulted in a dramatic increase in porosity which would release significantly larger amounts of gas to the surface through microseepage.

In conclusion, the high probability factors for the gases in the survey area suggested a similar hydrocarbon gas was found throughout the survey area. The implication being that the detected gas throughout the survey was from a similar source, possibly the Muskwa Shale. The varying butane intensities, when combined with important geologic and seismic data, inferred differing combinations or pressure/ porosity/ net pay across the survey area. For example increased intensity in the center of the Dahl Reef may be due to increased fracture porosity. The southeast anomaly may have been Muskwa Shale instead of a patch reef as previously thought, and the increase in butane intensities in the northeast anomaly may have been a result of increased porosity due to hydrothermal dolomitization. Thus, the probability factors and hydrocarbon intensities from the Amplified Geochemical Imaging survey provided insightful information in clarifying the Dahl Reef carbonate complex.