Baker Hughes Volatiles Analysis Services (VAS)

Supplied Through Advanced Hydrocarbon Stratigraphy (AHS)

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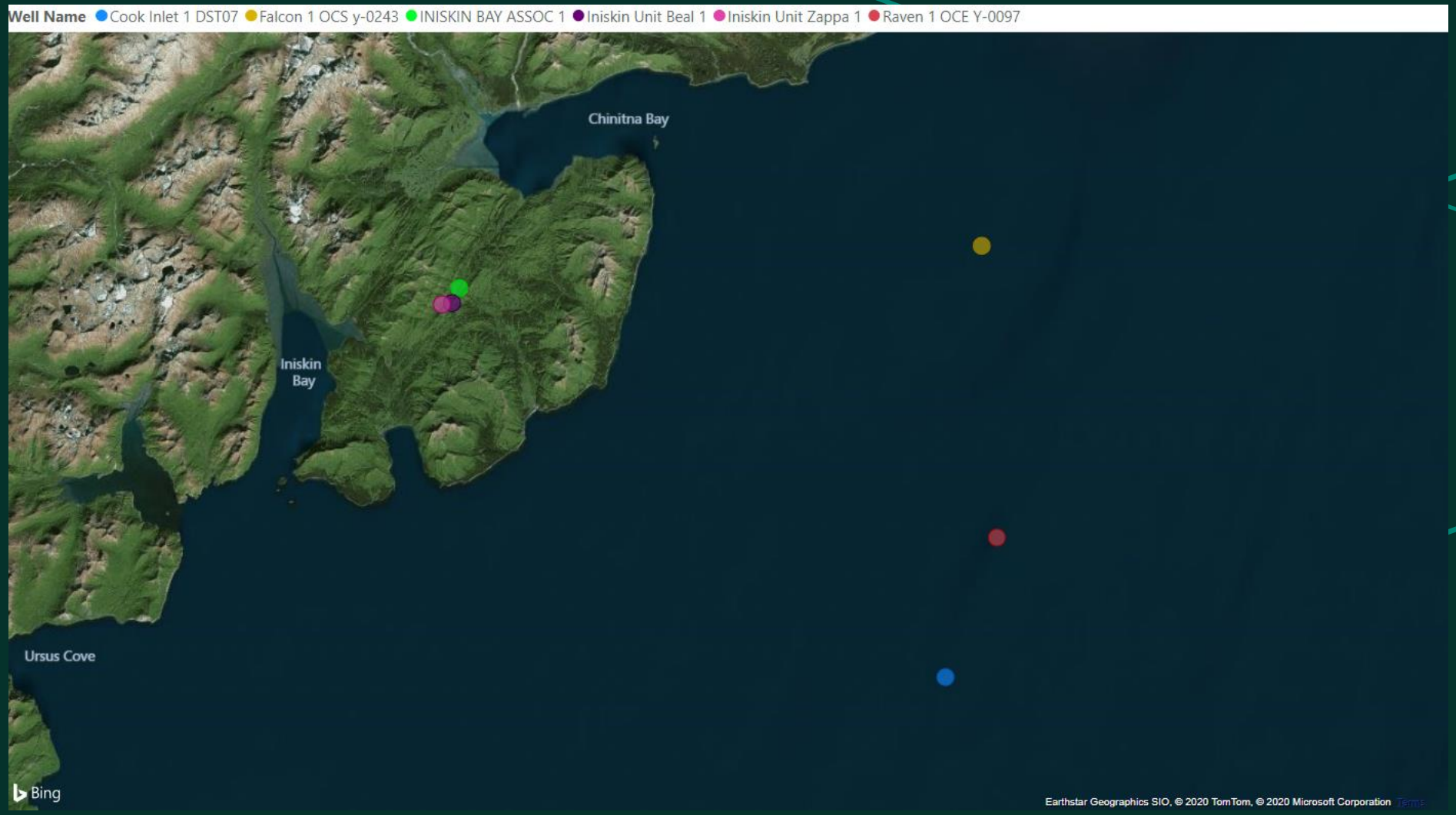
Study Area



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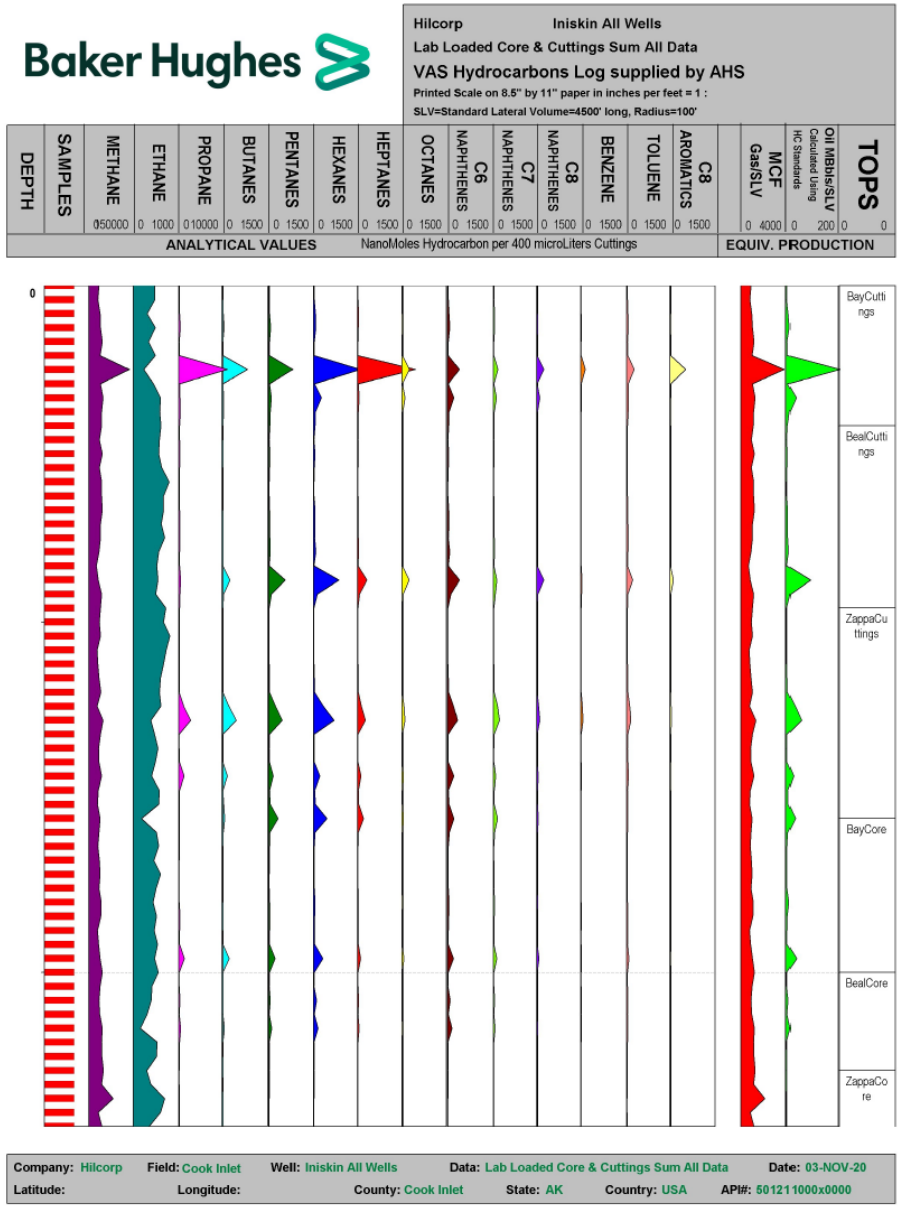

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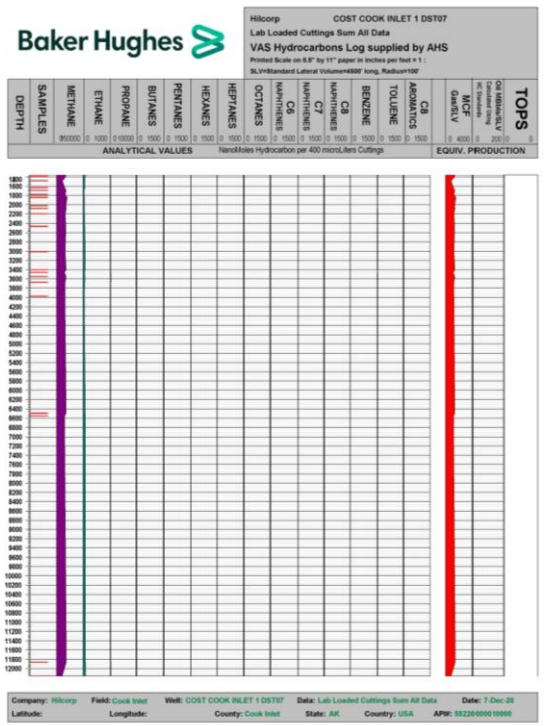

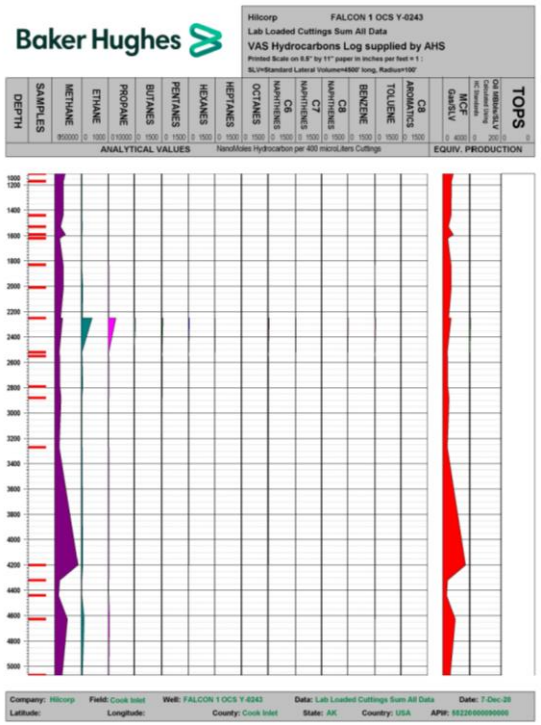

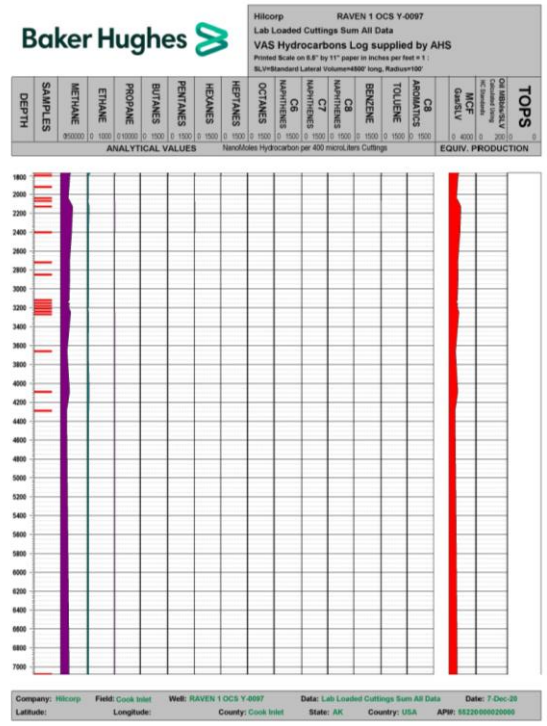

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Compared to the three onshore wells the absolute quantities of hydrocarbons being measured are markedly less in the offshore wells.

This may be attributable to the nature of the samples, different drilling technology, sample preparation/cleaning at well site, transport, storage conditions, etc. This could also be due to sample bias given the small number of samples per well versus the amount of section being covered and “represented” by the limited number of samples in that section.

Looking at various chemistries in relation to the water data can provide some assistance in assessing the samples.

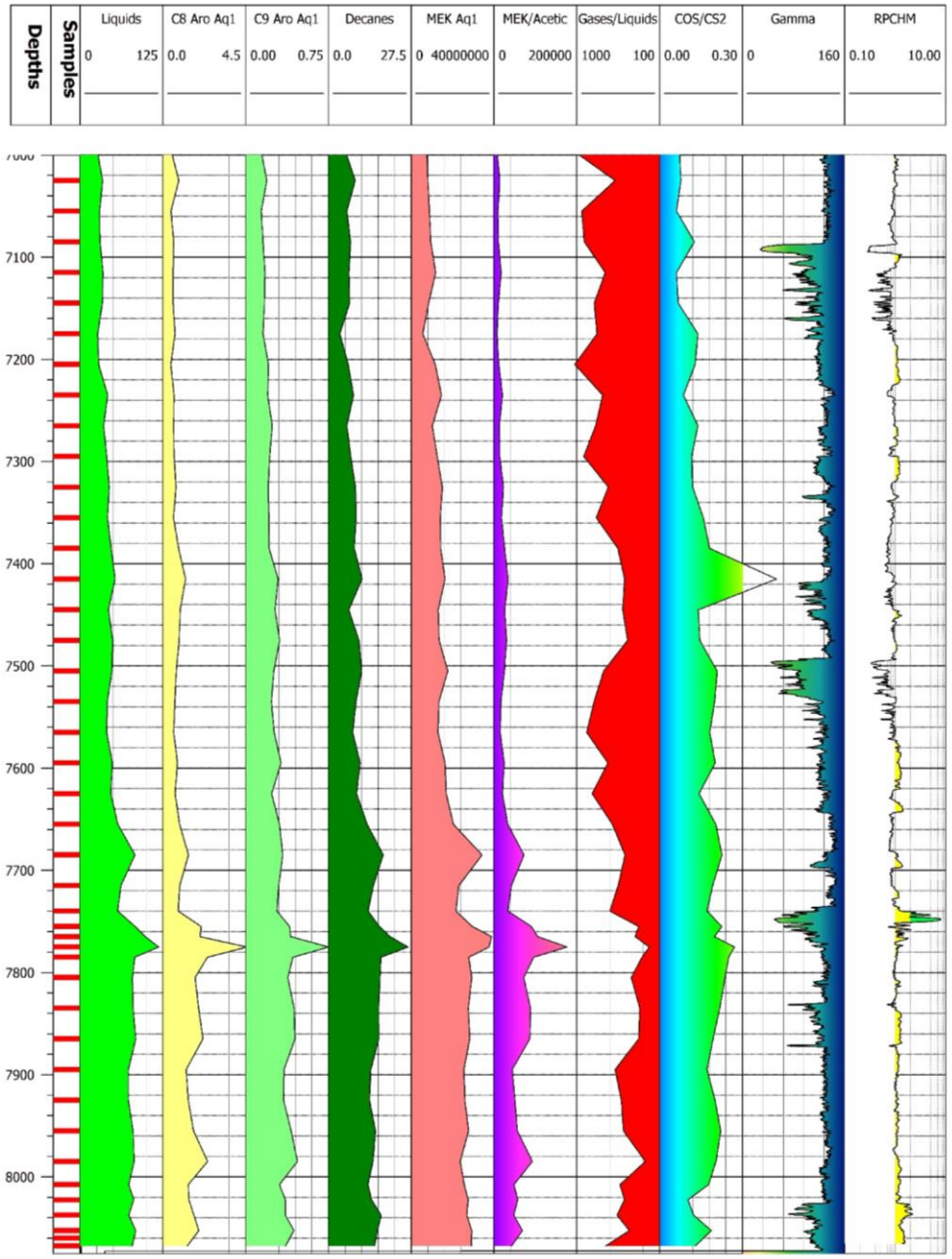
The ratio of MEK/Acetic acid has been used as an indicator to identify pay zones successfully in the Gulf of Mexico and the Bone Springs in the Permian Basin. With legacy samples trend assessment is typically more important than quantitative values. With the limited number of samples it is difficult to assign high confidence to any position based on just the MEK/Acetic acid ratio, but depths that show a low water response and an associated high MEK/Acetic Acid response at either that depth or a neighboring depths are potentially strong candidates for hydrocarbon pay zones; see example on next slide.

COS has been observed to be an effective pay zone indicator including in previous work for Hilcorp AK where it demonstrated a strong correlation with LWD resistivity data.

Example of Ratio of MEK/Acetic Acid as Pay Zone Indicator

MEK can assist in picking out pay zones; the ratio of MEK to Acetic Acid is a strong pay zone indicator in VAS data

- Comparison of pay zone indicators from OBM legacy cuttings in a shallow offshore Gulf of Mexico well compared to wireline
- The ratio of MEK/Acetic acid was one of the best pay zone indicators determined, MEK is also notably enhanced at the pay sand depth.



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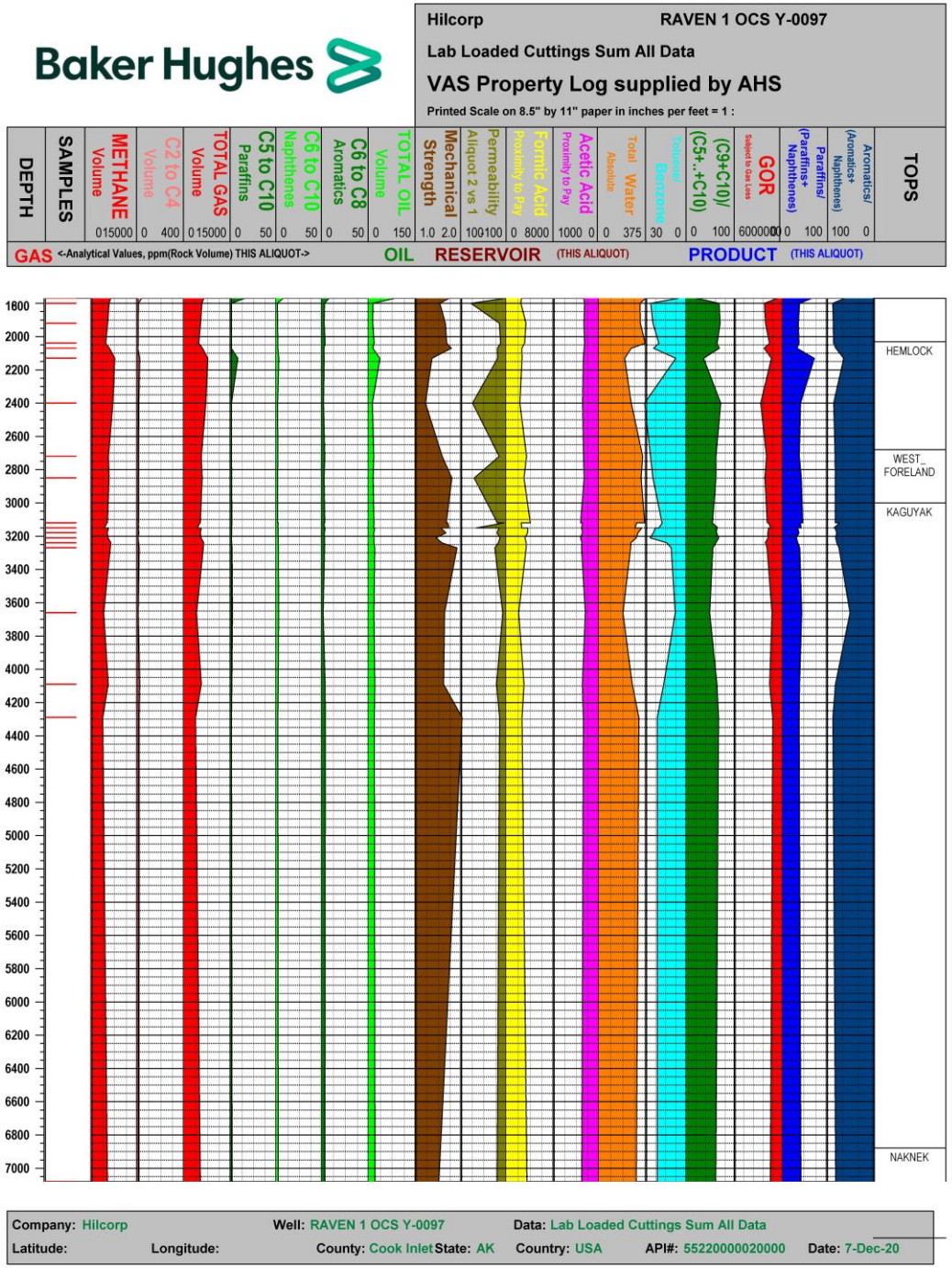

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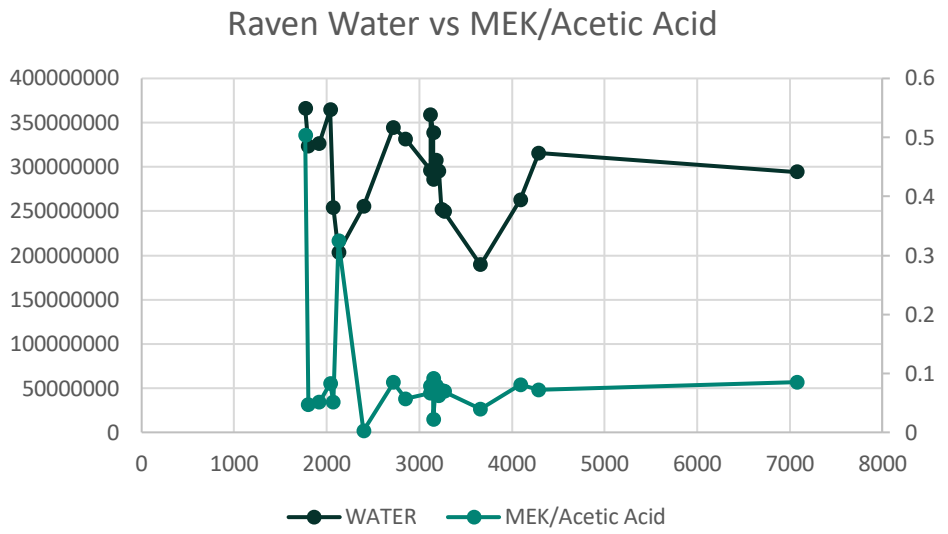
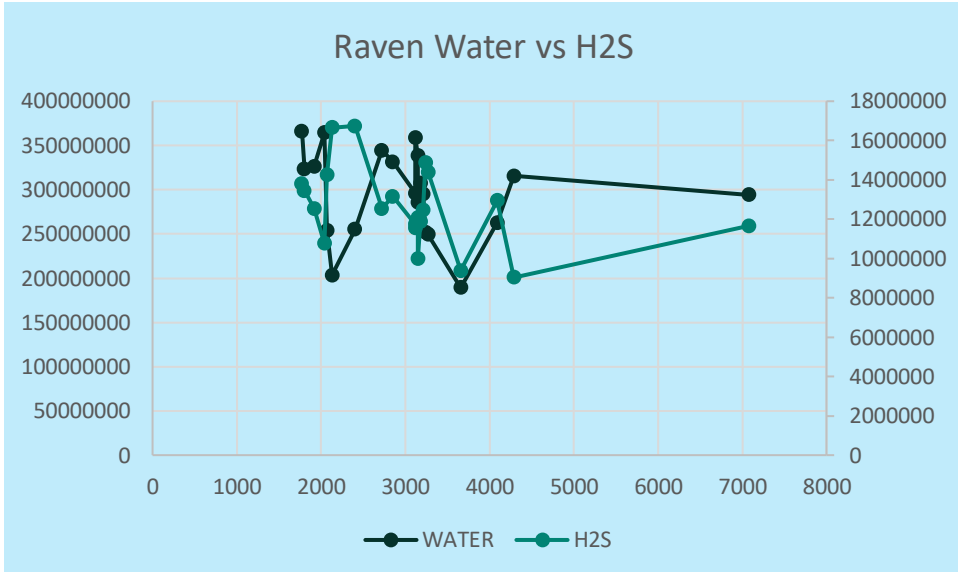
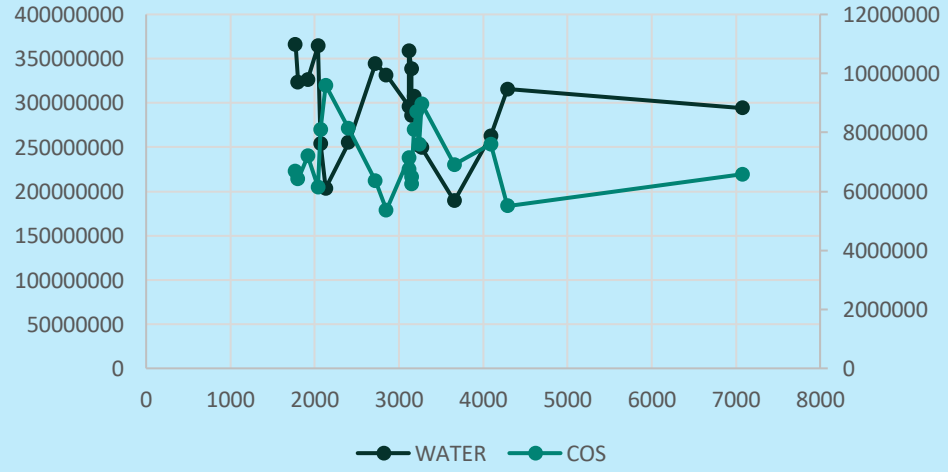
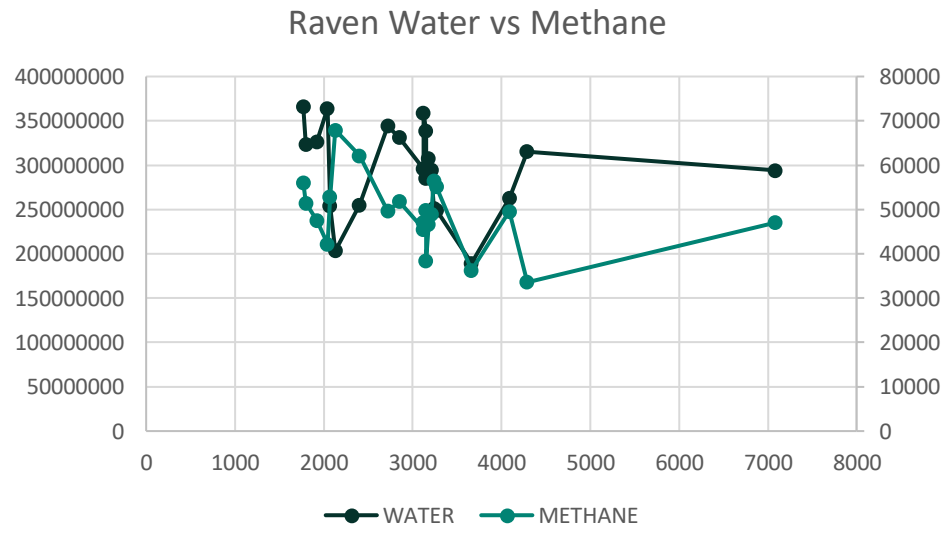
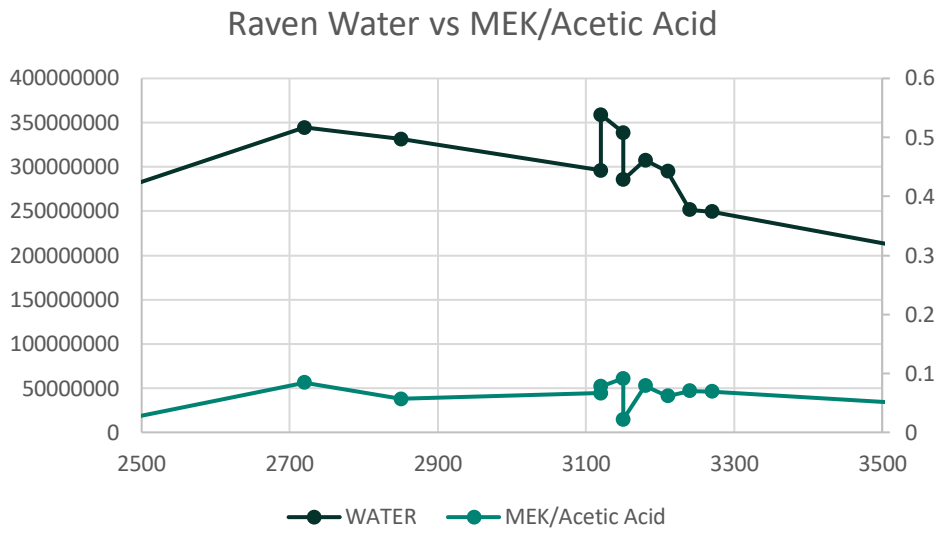


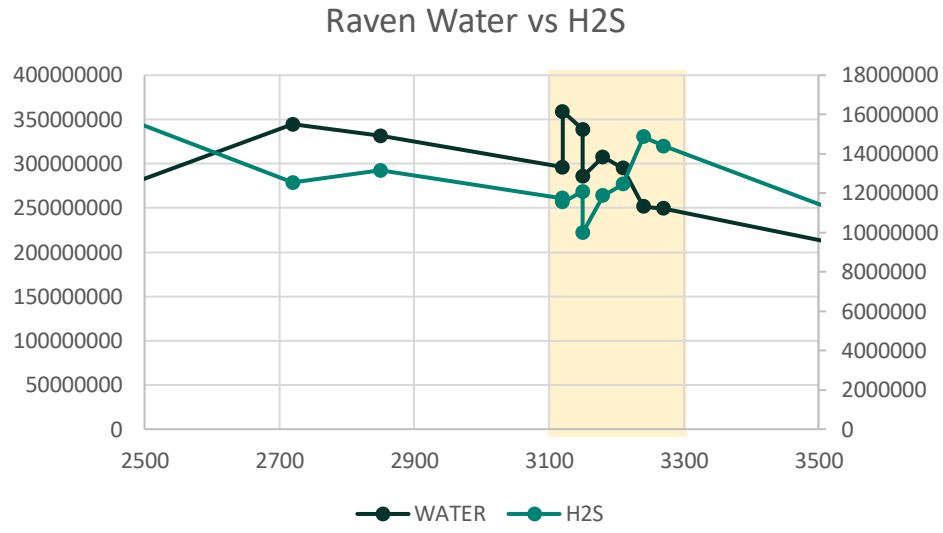


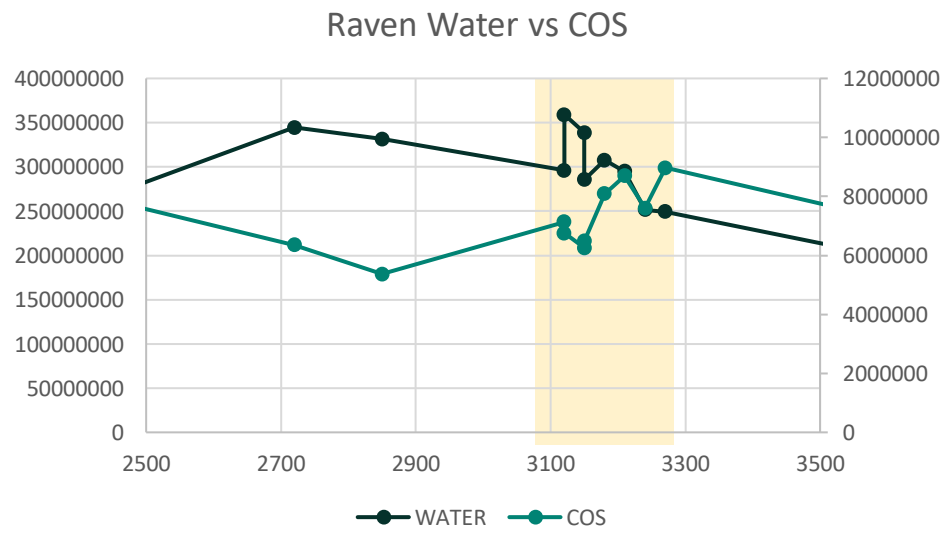


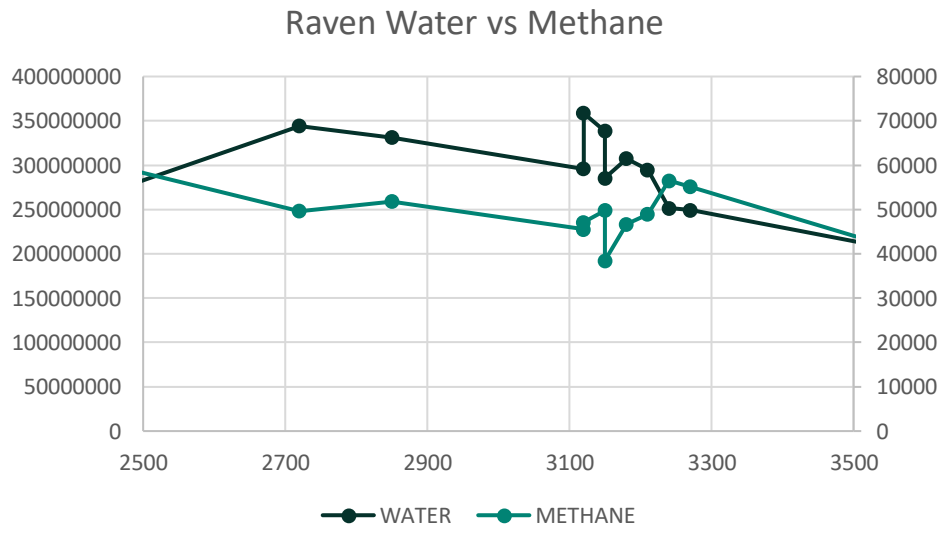


Added in relation to question about DST in this section of Raven









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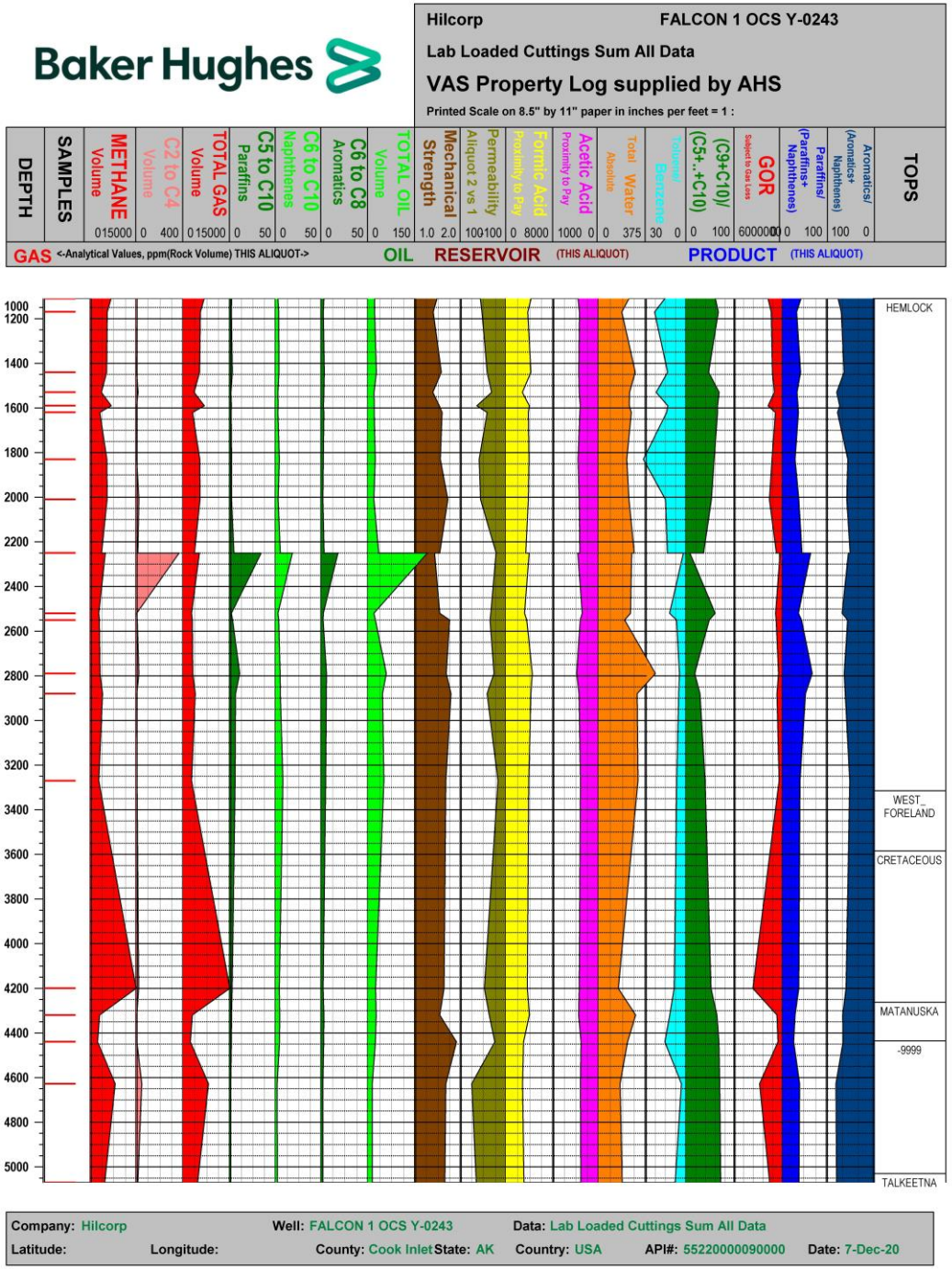
COS is an oil soluble compound that has a preference for the oil phase over the water phase

H2S can be produced by sulfur reducing bacteria

The high COS and the distribution observed by itself and in relation to the water data was noted as being potentially indicative of an oil phase in previous meetings.

The presence of the H2S and the methane speak to possible biological activity, but that activity may not be aerobic, use oxygen, which is why it is not picked out on MEK data



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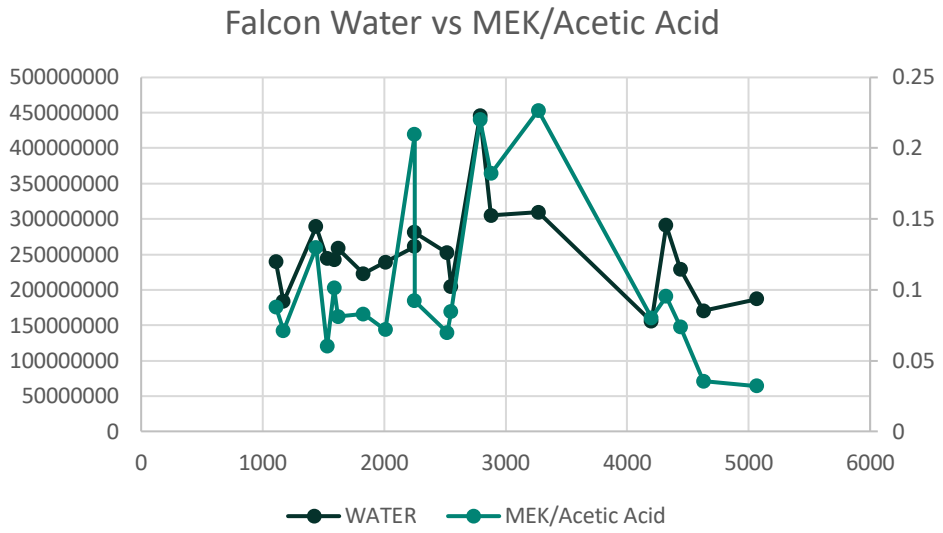

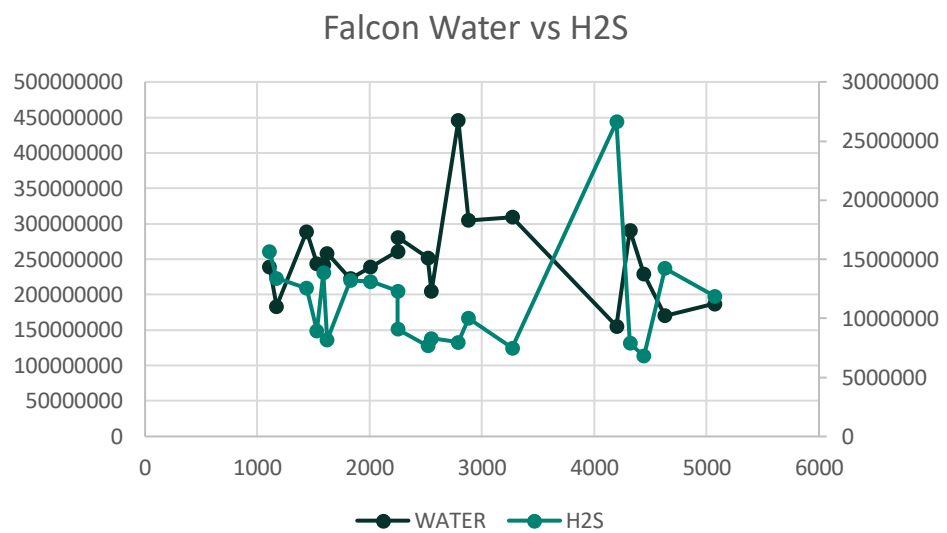

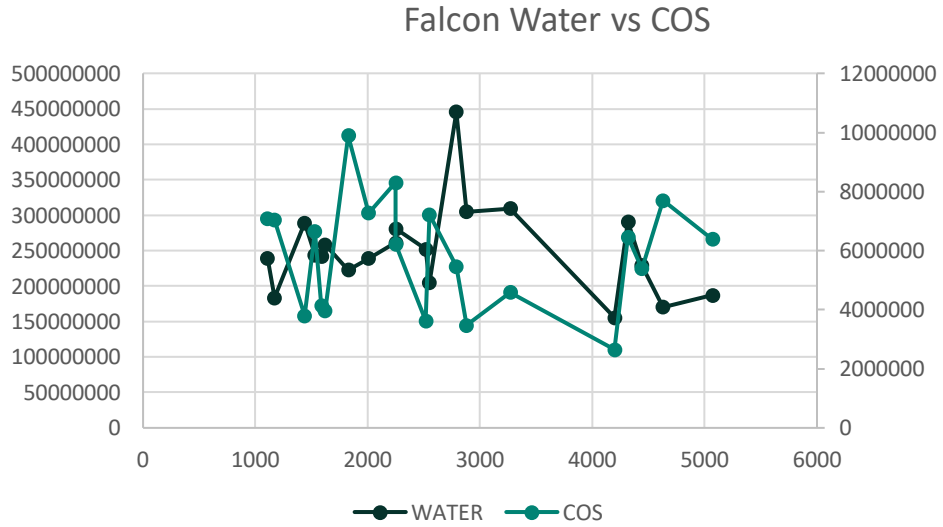

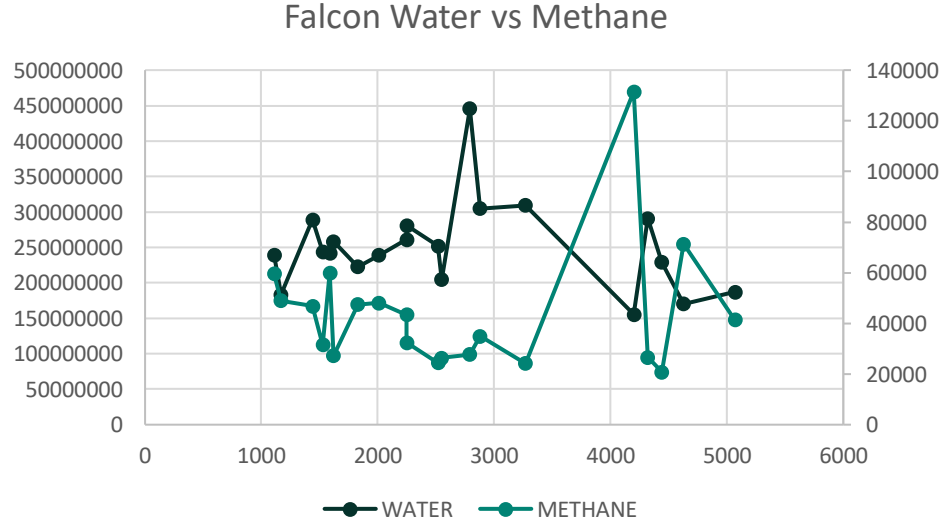

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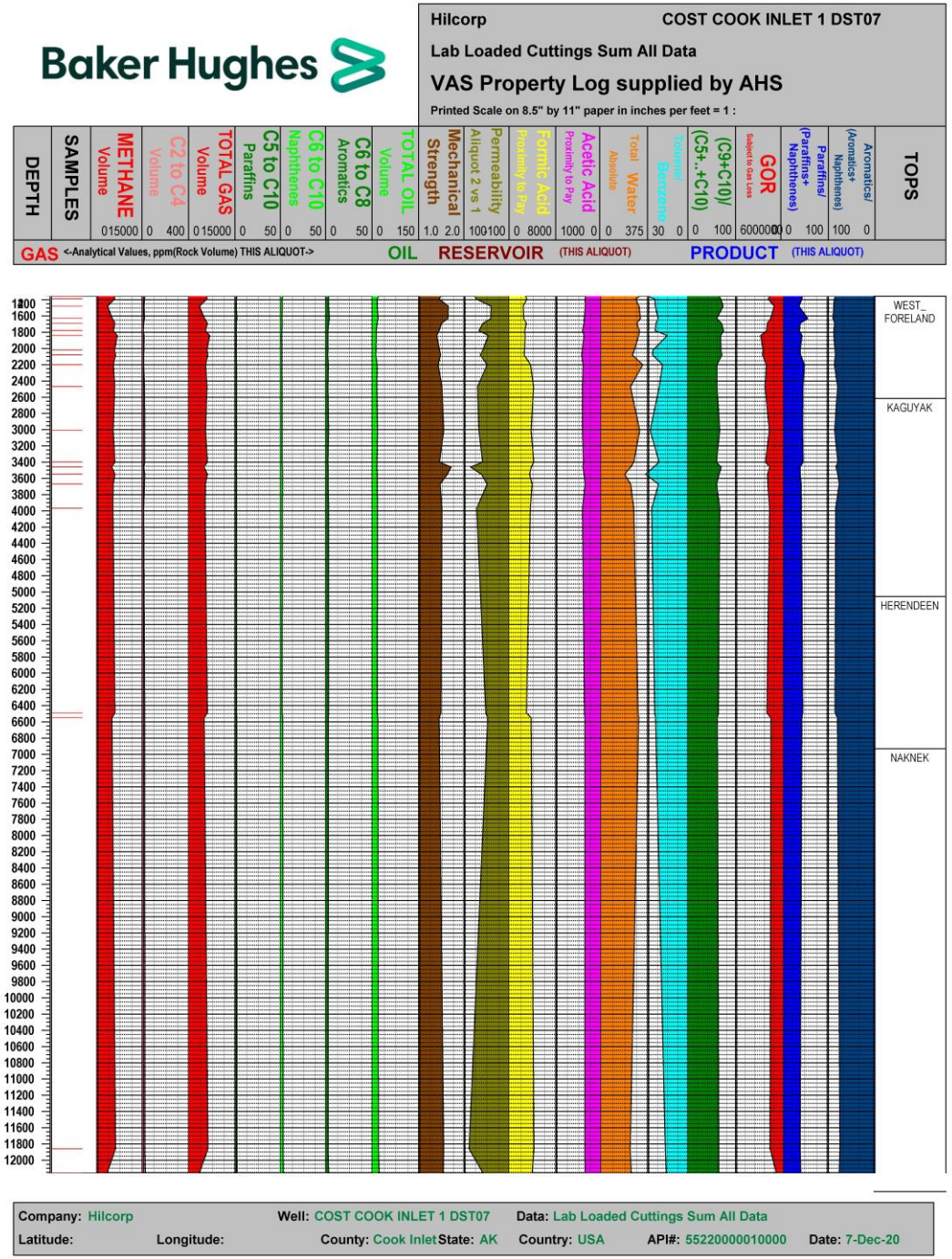

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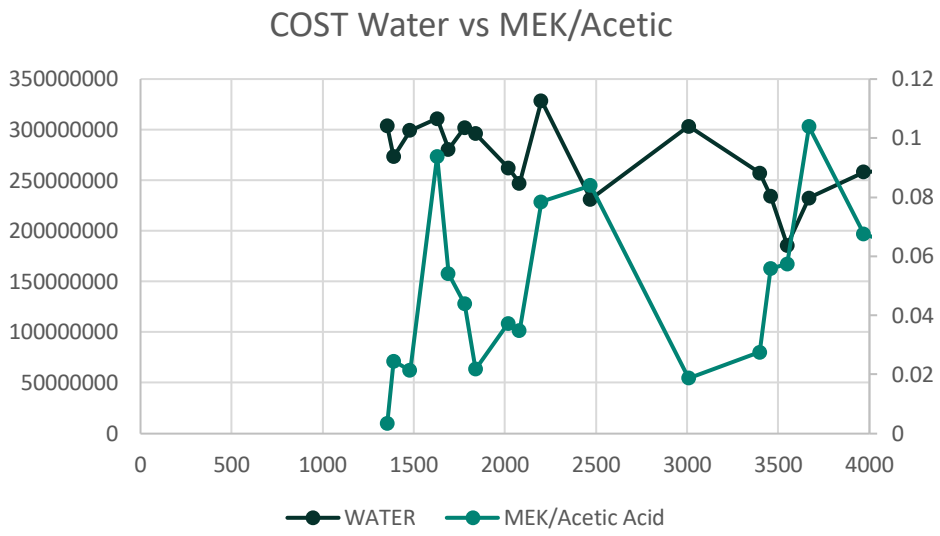

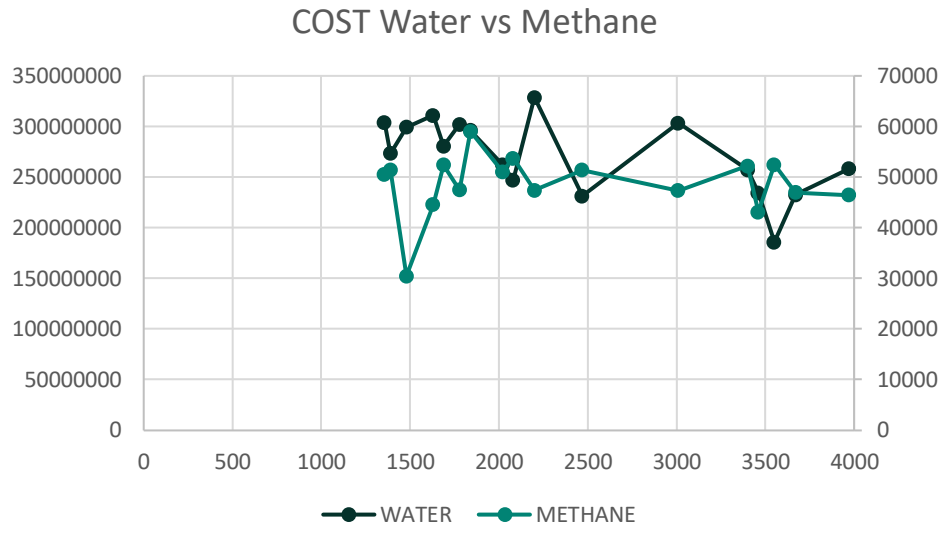

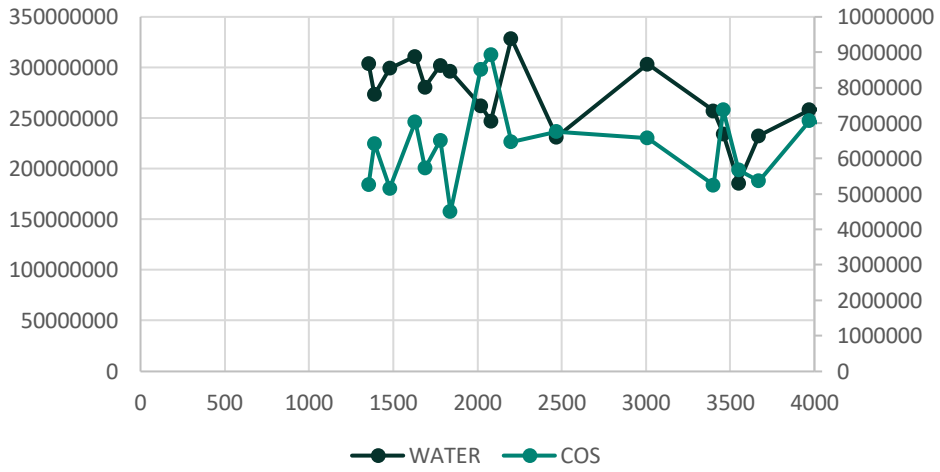

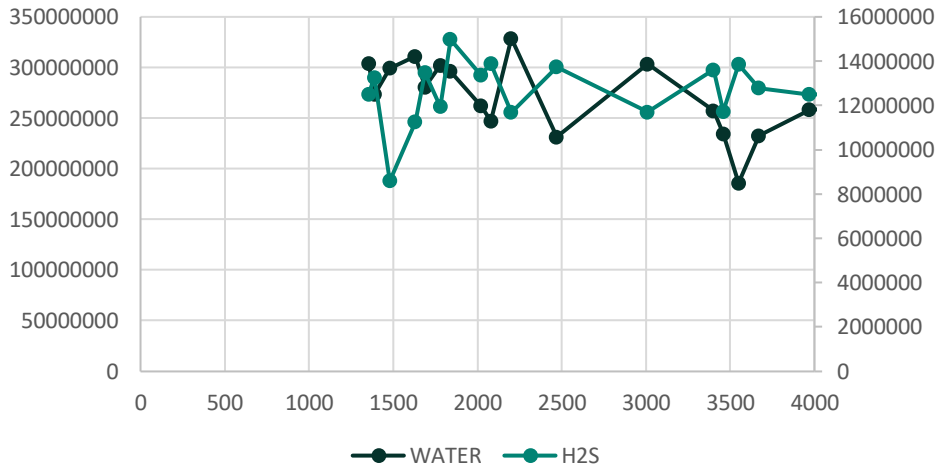

Thoughts:

Attention should be paid to positions where changes that correlate to low water response are observed. COS and MEK/Acetic Acid may be the most promising for correlation with low water in terms of being indicative of oil, though depending on the nature of the microbes both signatures may not be simultaneously present. Other similar relationships between more and less water-soluble molecules in relation to one another and the low water response may also be of value in identifying locations that may indicate potential hydrocarbon pay zones.

The low amount of hydrocarbons observed in the offshore samples may be due to a variety of reasons but is still a data point that should not be ignored. Our experience in conventional plays, especially Alaska, is that tight rocks, especially reservoir seals, hold significantly more hydrocarbons back than high quality reservoir rocks, especially in the case of older legacy unsealed materials. There are significant notes of calcite cementation and other tight lithologies in the onshore wells; such lithology descriptions where not available for the offshore wells. The nature of the lithology of the rock may also play a role here and analysis of rocks that may be sealing features could have additional value and may have higher hydrocarbon responses than what were observed here if sampling was biased toward high quality reservoir rocks.

All of this should be viewed through the lense of a relatively small number of samples which may be open to potential over interpretation compared to a more complete stratigraphic analysis which we would recommend being employed as a follow up analysis in relation to potential areas of interest identified in this survey study.

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