

Baker Hughes Volatiles Analysis Services (VAS)

Supplied Through Advanced Hydrocarbon Stratigraphy (AHS)

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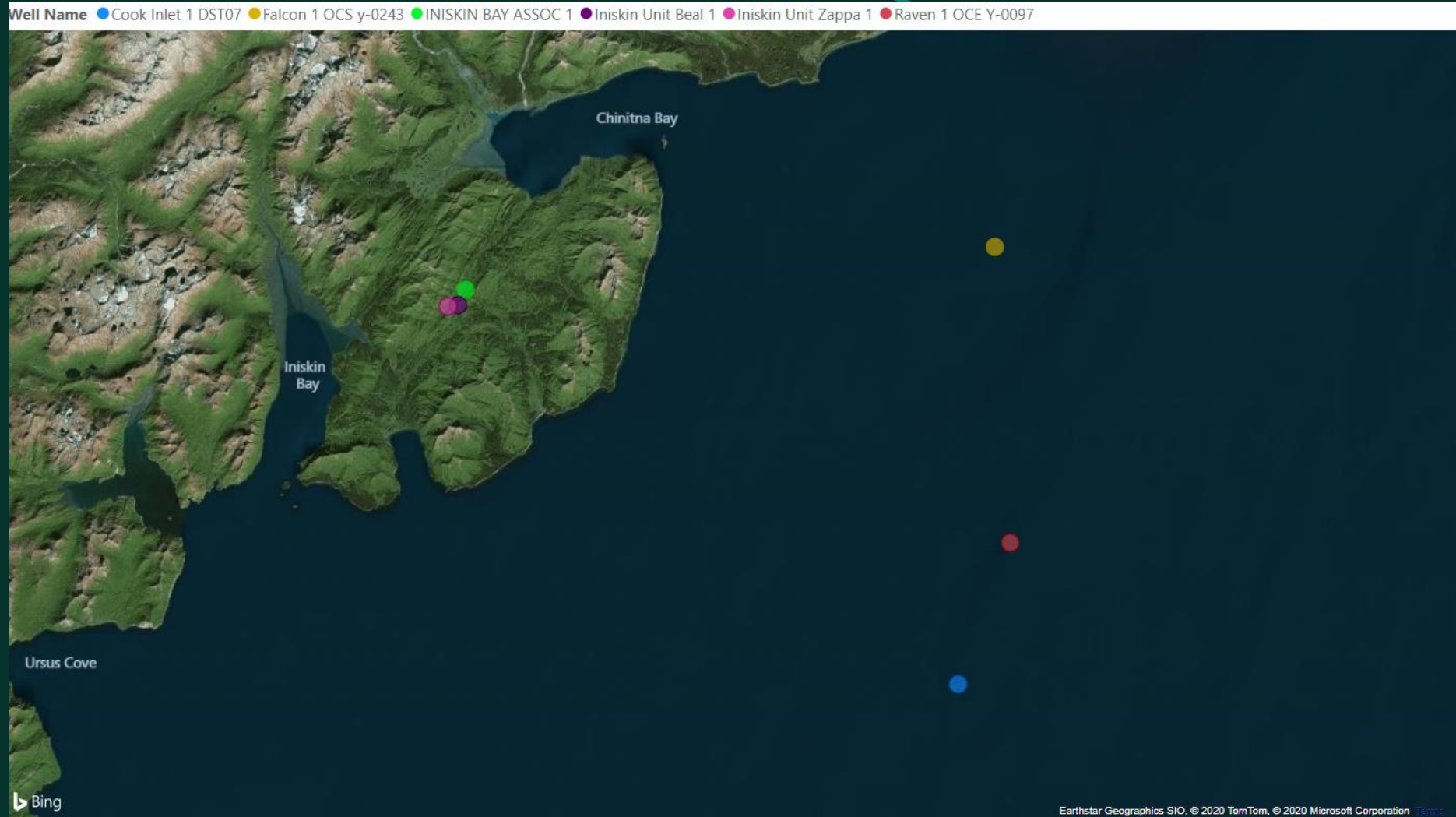
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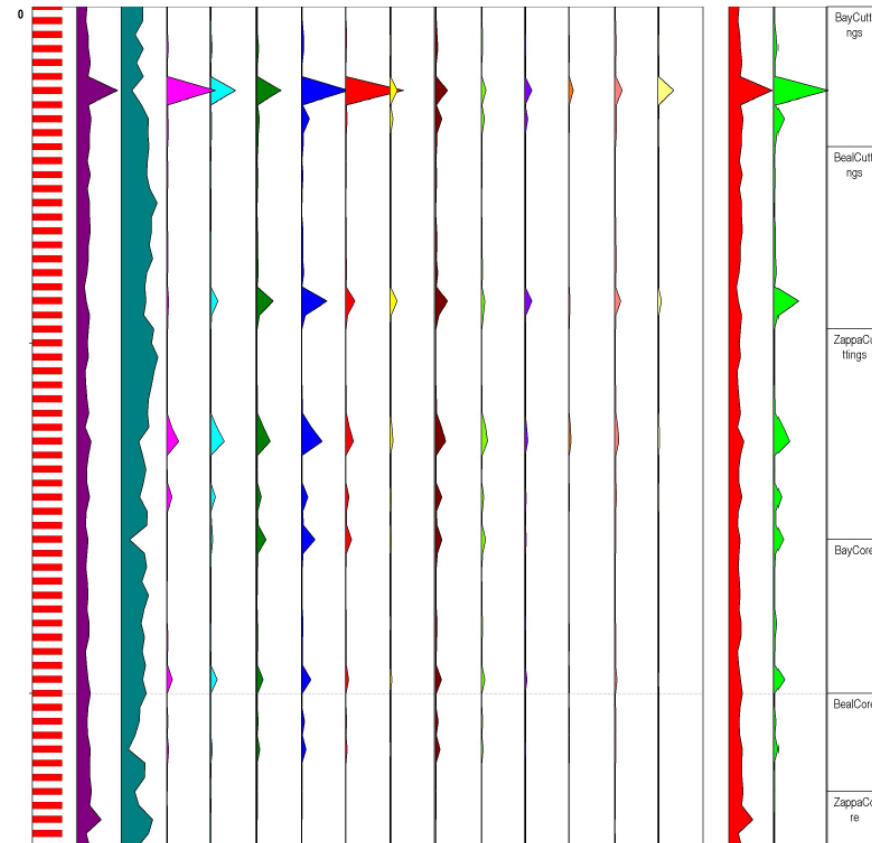
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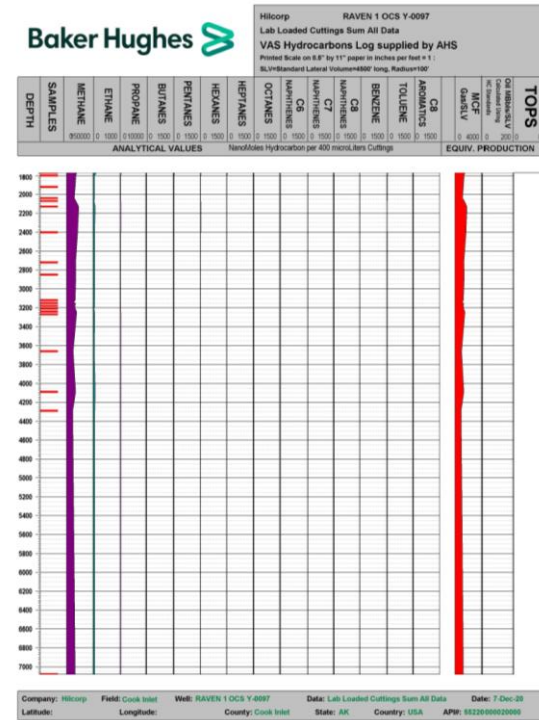
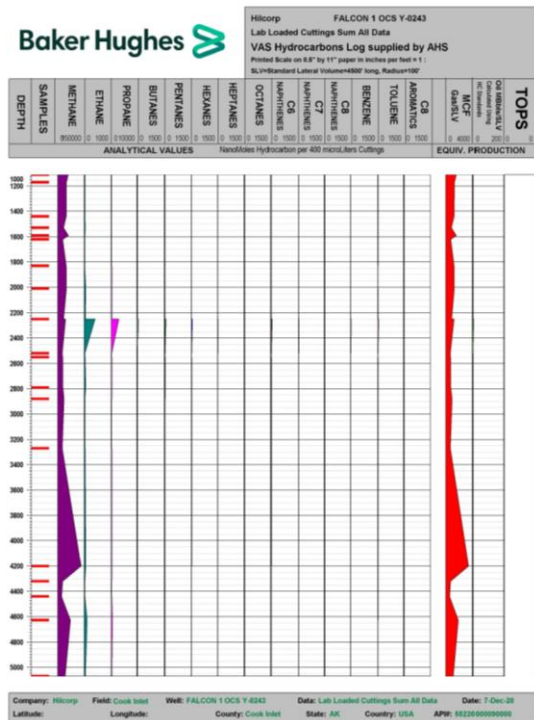
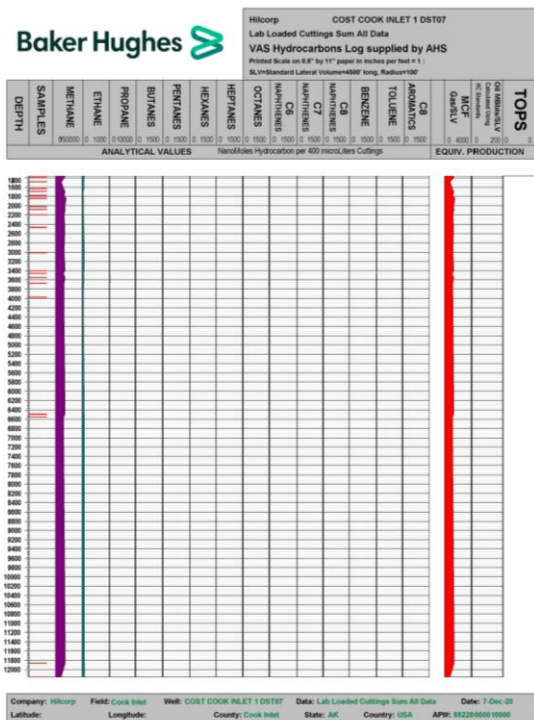
In making interpretations of logs, our employees will give the customer the benefit of their best judgement. But since all interpretations are opinions based on inferences from mass spectroscopic, electrical, or other measurements, we cannot, and we do not, guarantee the accuracy or correctness of any interpretation. We shall not be liable or responsible for any loss, cost, damages, or expenses whatsoever incurred or sustained by the customer resulting from any interpretation made by any of our employees.

Study Area



DEPTH	SAMPLES	METHANE	ETHANE	PROPANE	BUTANES	PENTANES	HEXANES	HEPTANES	OCTANES	NAPHTHENES	C6	C7	C8	BENZENE	TOLUENE	AROMATICS	C8	MCF	GasSLV	Oil MBRSLV	TOPS
		0 500000	0 1000	0 100000	0 1500	0 1500	0 1500	0 1500	0 1500	0 1500	0 1500	0 1500	0 1500	0 1500	0 1500	0 1500	0 1500	0 4000	0 200	0	0
ANALYTICAL VALUES																	EQUIV. PRODUCTION				
NanoMoles Hydrocarbon per 400 microLiters Cuttings																					





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.

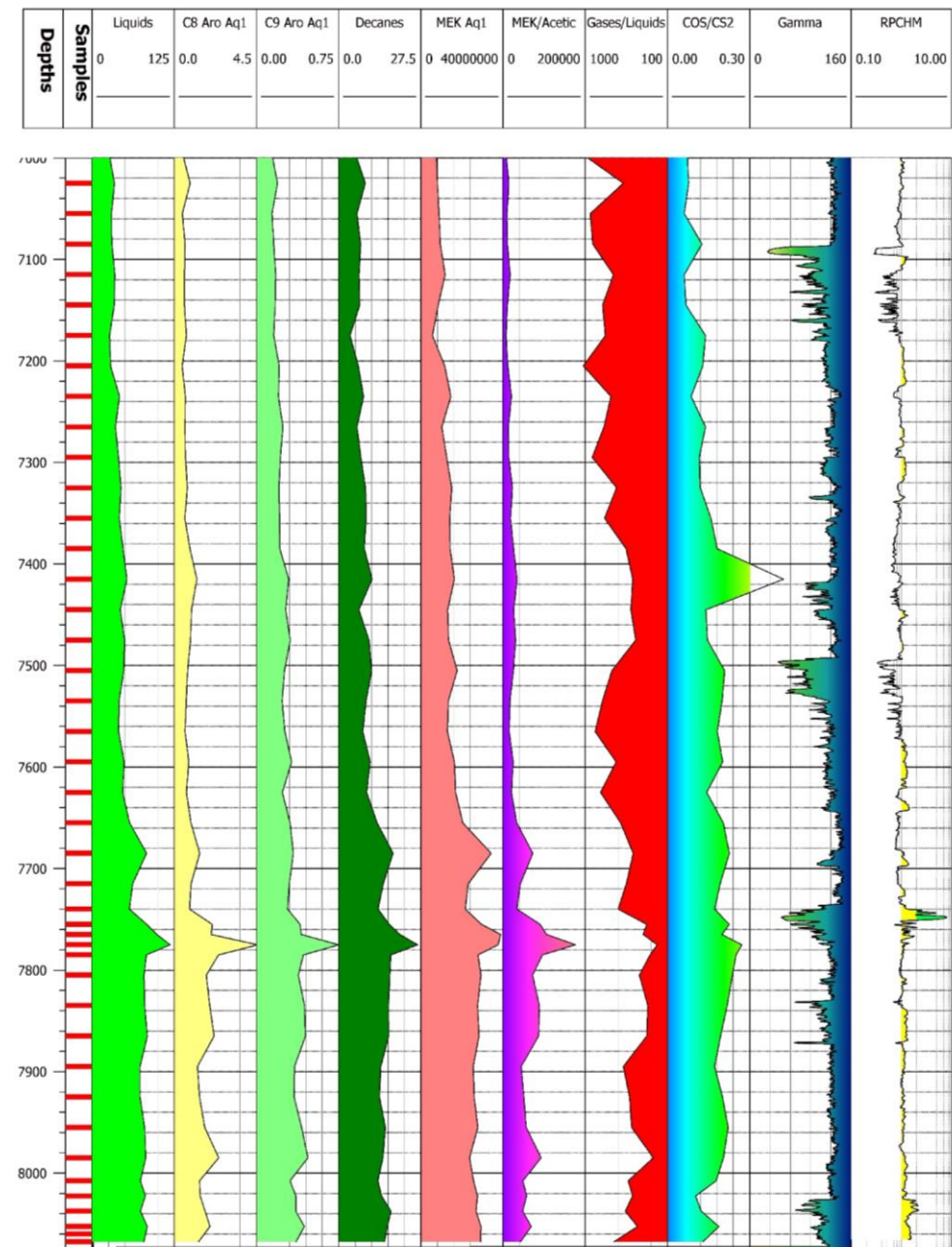
The ratio of MEK/Acetic acid has been used as an indicator to identify pay zones successfully in the Gulf of Mexico and the Bone Springs in the Permian Basin. With legacy samples trend assessment is typically more important than quantitative values. With the limited number of samples it is difficult 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.

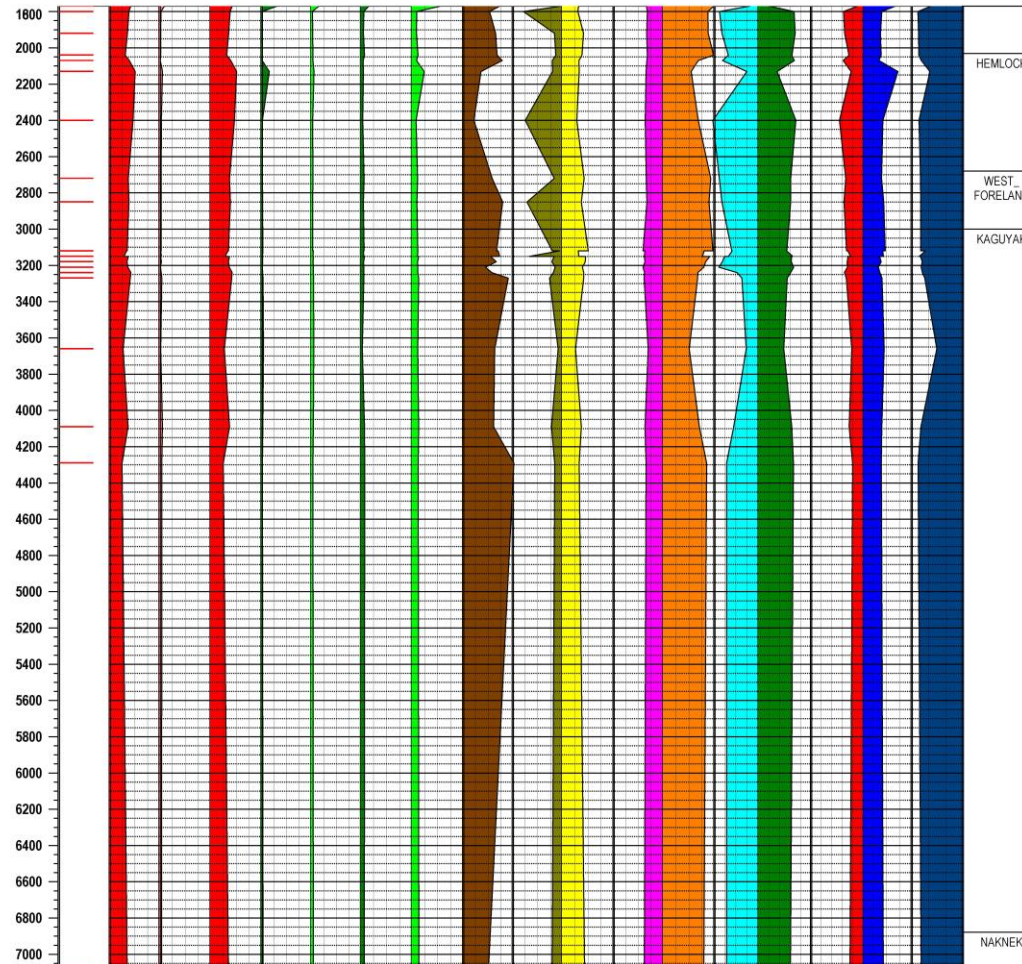
COS has been observed to be an effective pay zone indicator including in previous work for Hilcorp AK where it demonstrated a strong correlation with LWD resistivity data.

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

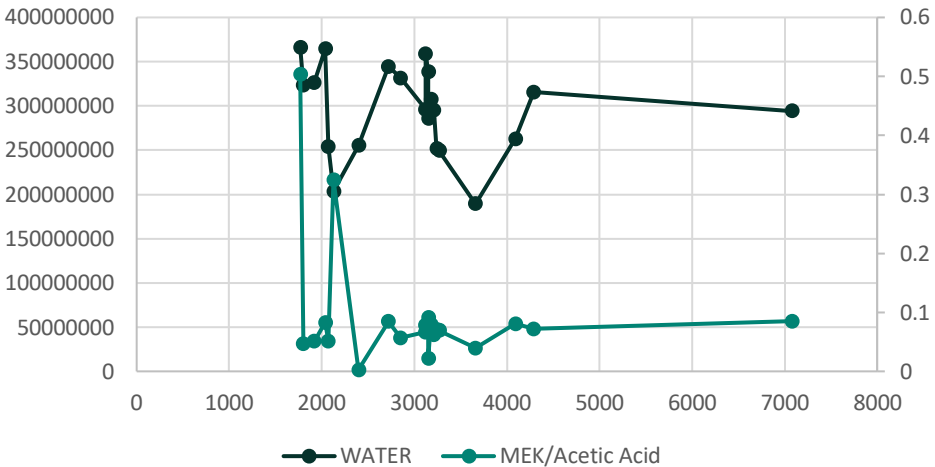
MEK can assist in picking out pay zones; the ratio of MEK to Acetic Acid is a strong pay zone indicator in VAS data

- 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.

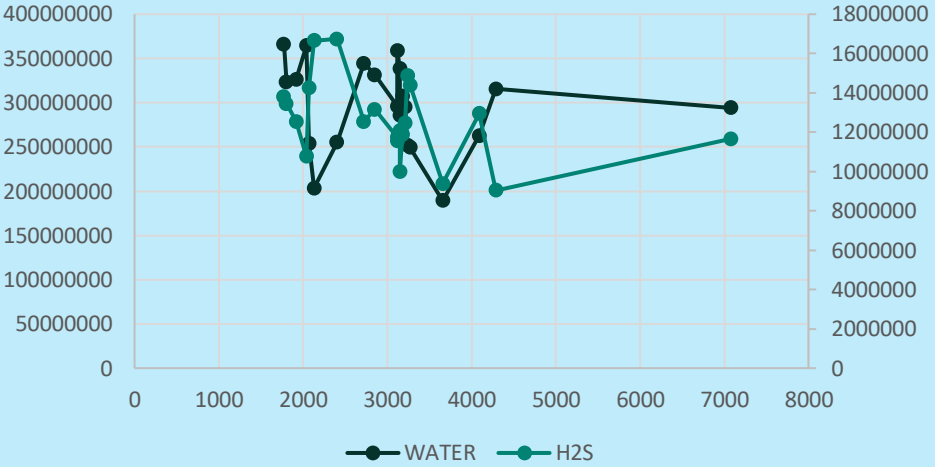


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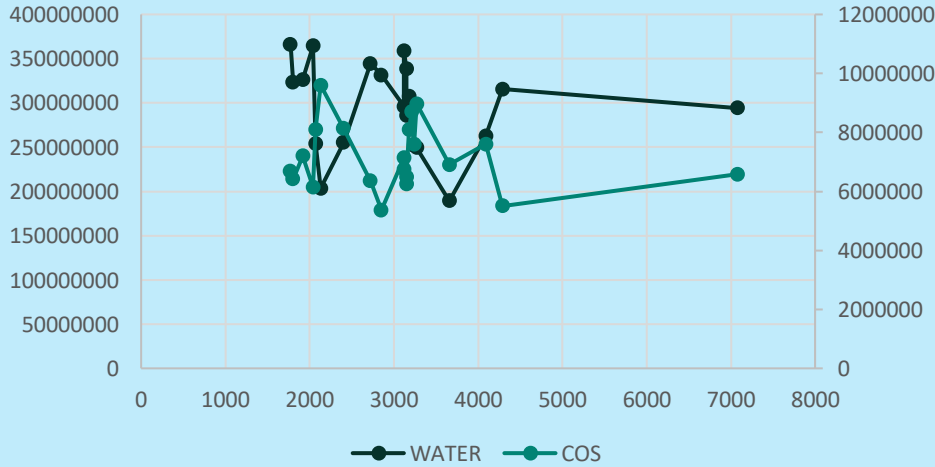
Raven Water vs MEK/Acetic Acid



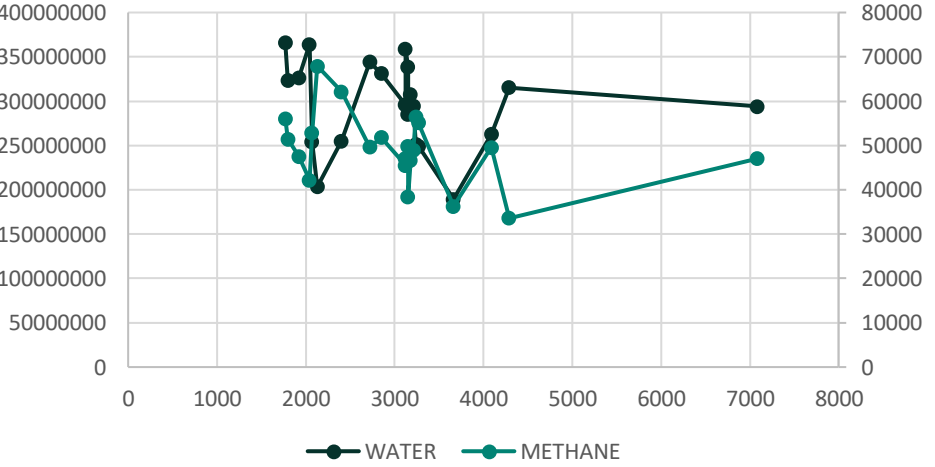
Raven Water vs H2S



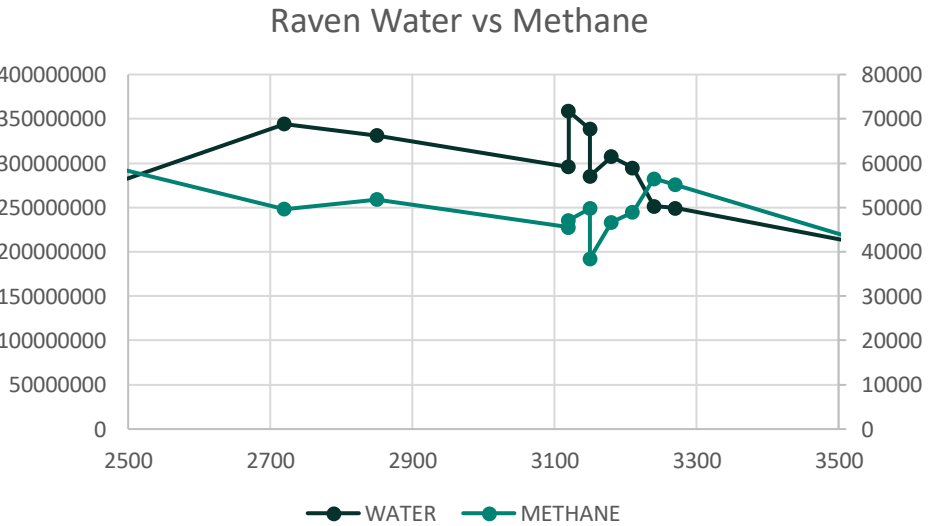
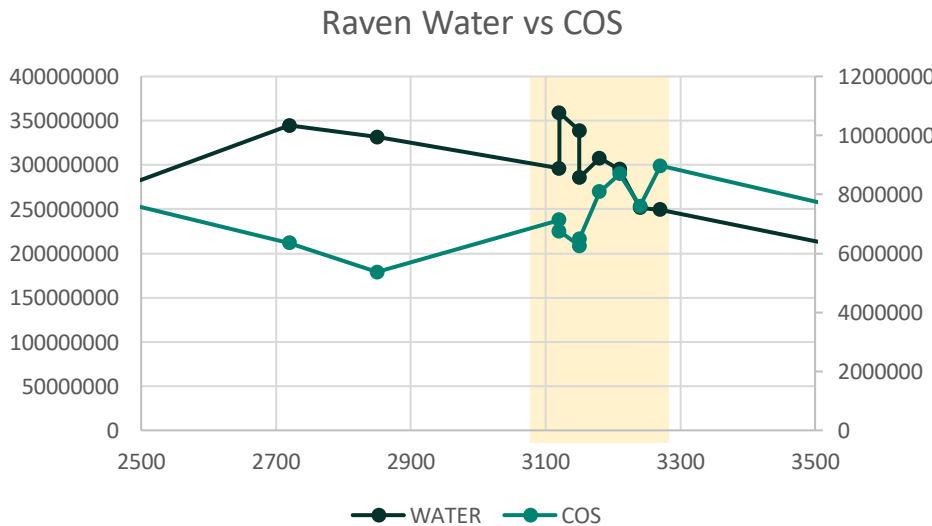
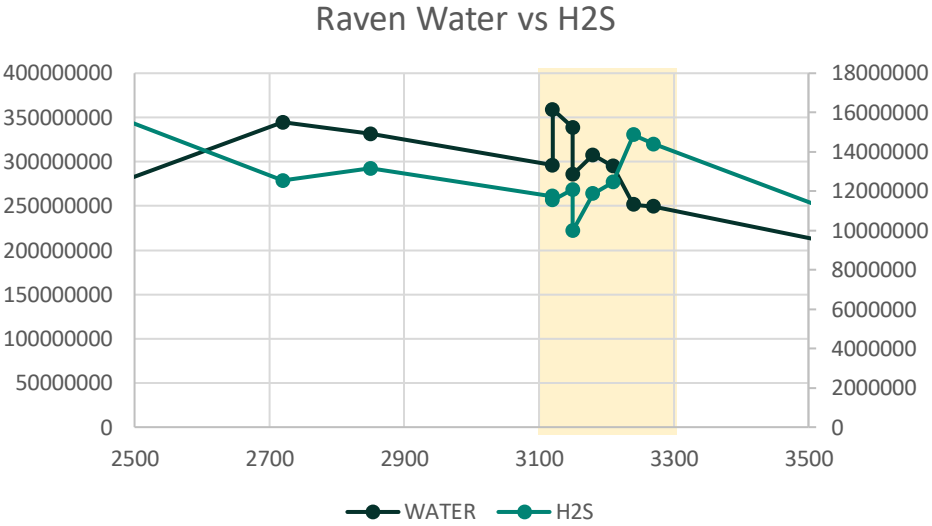
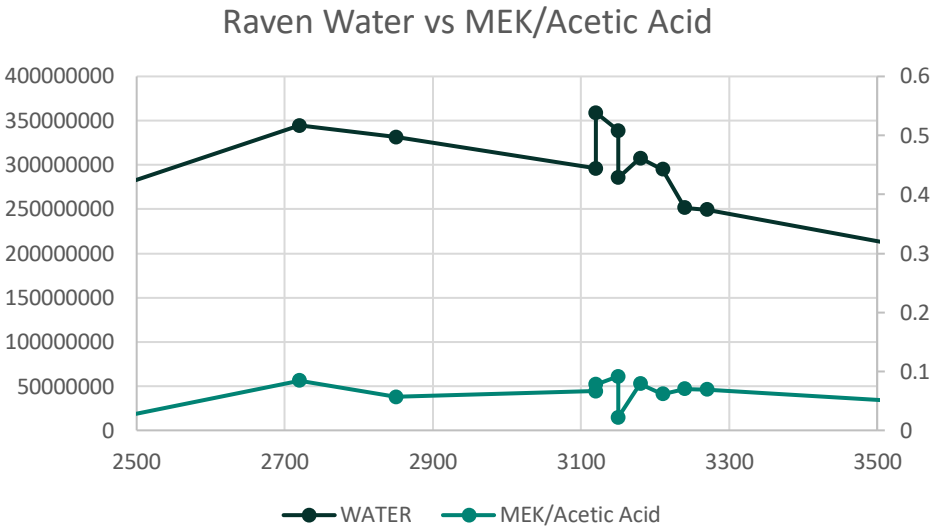
Raven Water vs COS



Raven Water vs Methane



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



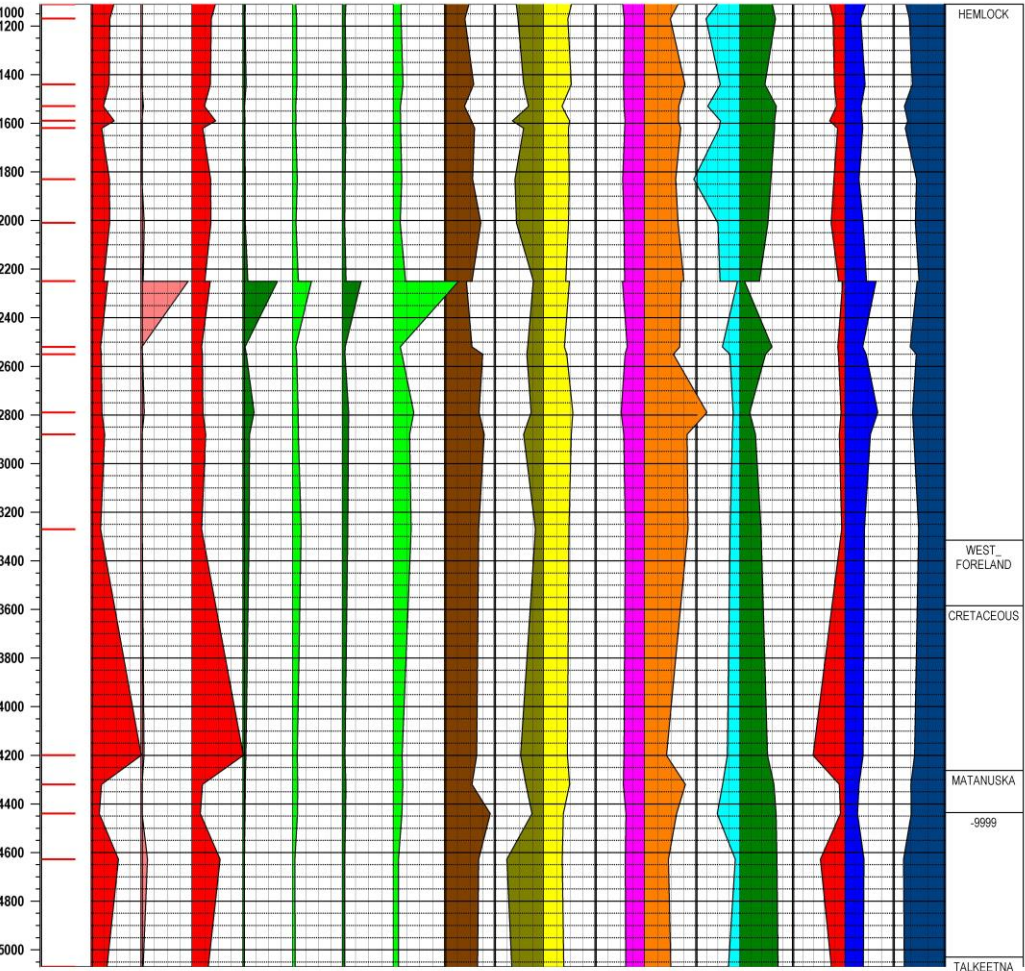
COS is an oil soluble compound that has a preference for the oil phase over the water phase

H₂S can be produced by sulfur reducing bacteria

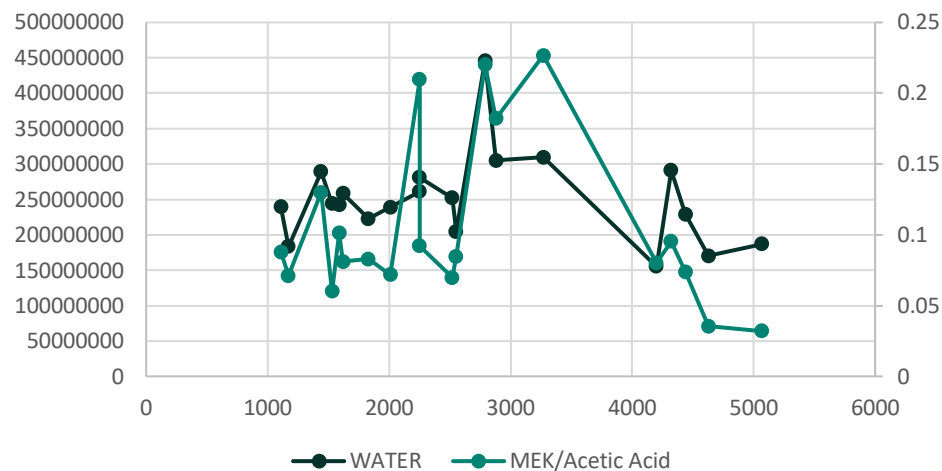
The high COS and the distribution observed by itself and in relation to the water data was noted as being potentially indicative of an oil phase in previous meetings.

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

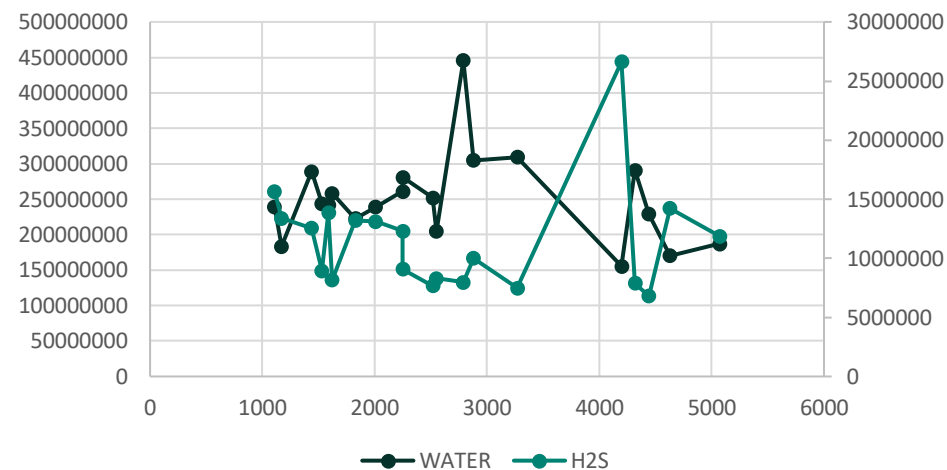
Hilcorp	FALCON 1 OCS Y-0243
Lab Loaded Cuttings Sum All Data	
VAS Property Log supplied by AHS	
Printed Scale on 8.5" by 11" paper in inches per foot = 1 :	
TOPS	Aromatics/ (Aromatics+ Naphthenes)
	Paraffins/ (Paraffins+ Naphthenes)
	GOR
	(C9+C10/ C3+...+C10)
	Water
	Total Acid
	Acetic Acid
	Formic Acid
	Permability
	Mechanical
	Strength
	TOTAL OIL
	Volume
	C6 to C8
	Aromatics
	C6 to C10
	Naphthenes
	C5 to C10
	Paraffins
	TOTAL GAS
	Volume
	C2 to C4
	METHANE
	Volume
SAMPLES	DEPTH



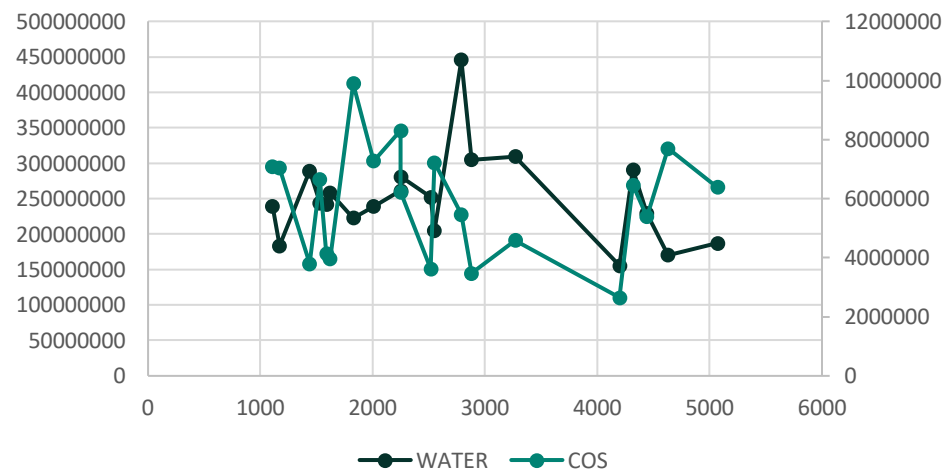
Falcon Water vs MEK/Acetic Acid



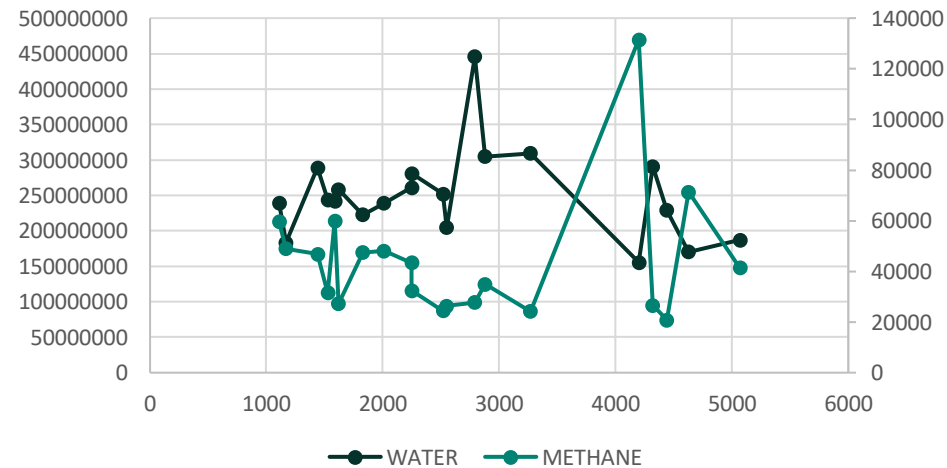
Falcon Water vs H2S



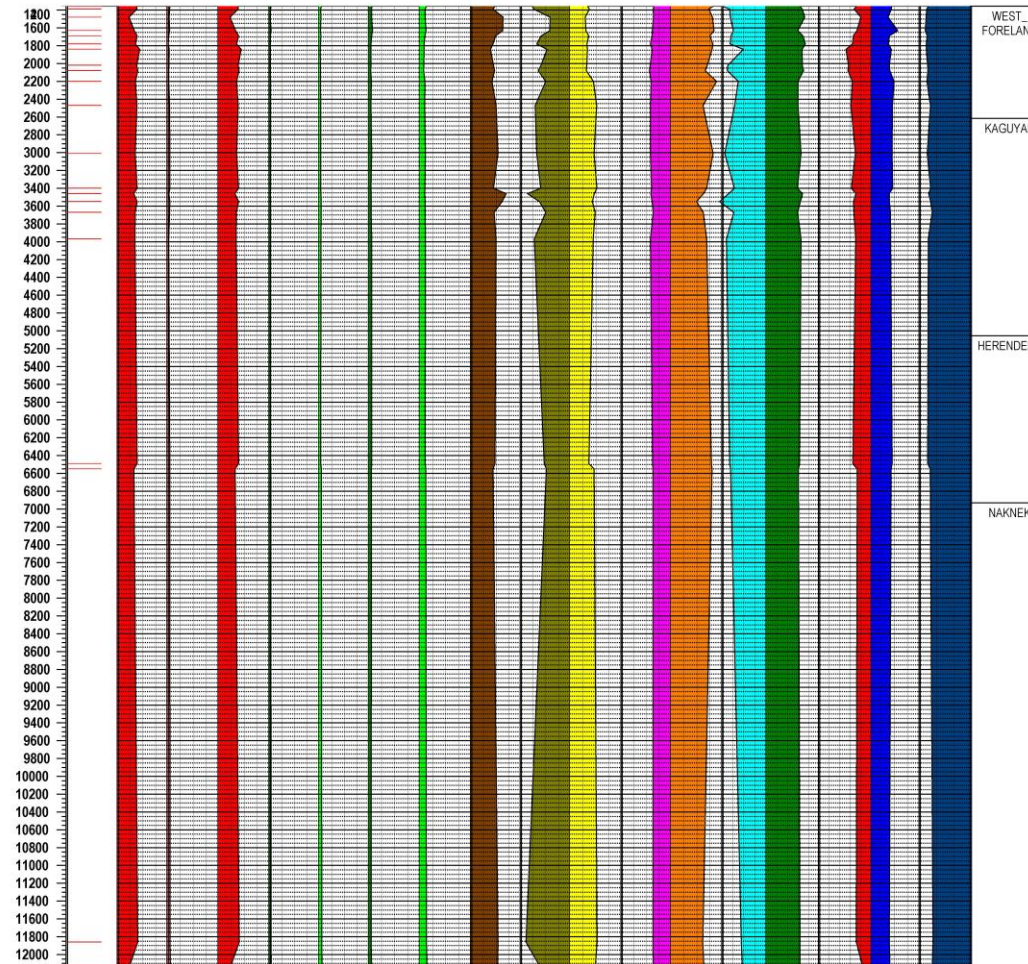
Falcon Water vs COS



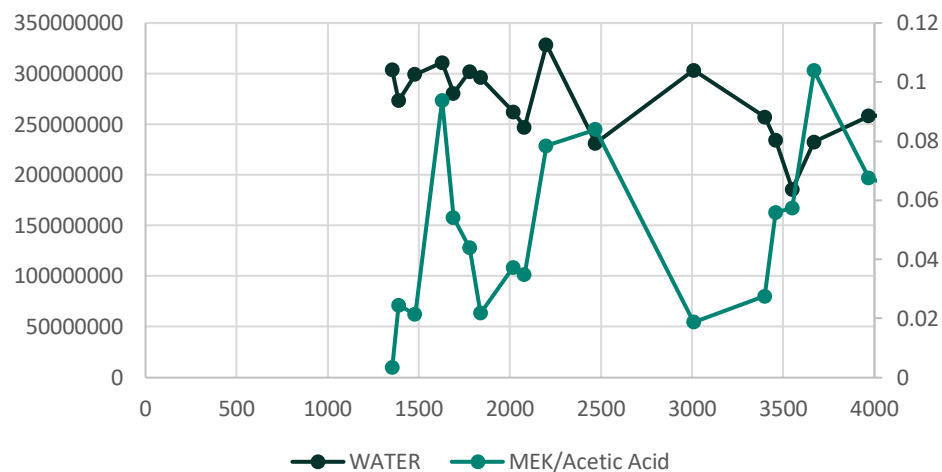
Falcon Water vs Methane



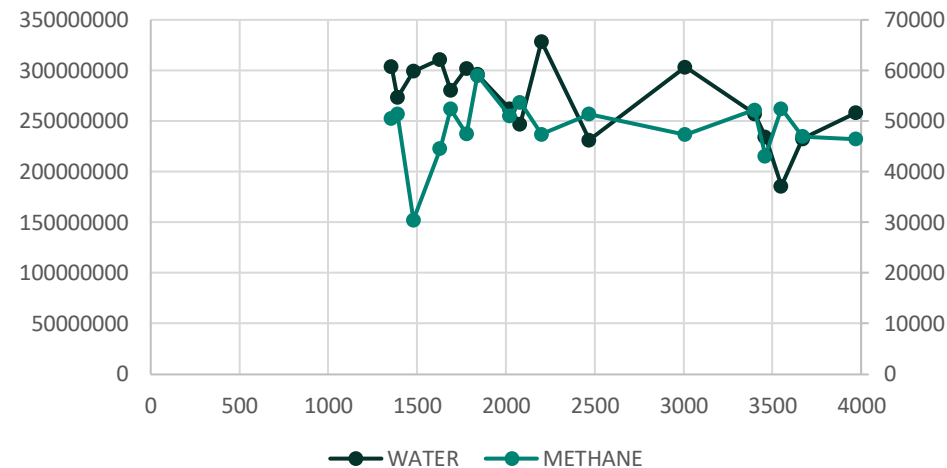
TOPS		Aromatics/ Aromatics+ Naphthenes)	Paraffins/ Paraffins+ Naphthenes)	GOR	Select Oil Loss (C9+C10) (C5+...+C10)	Total Water Absolute	Acetic Acid	Formic Acid	Proximity to Play	Permeability	Mechanical Strength	TOTAL OIL Volume	C6 to C8 Aromatics	C6 to C10 Naphthenes	C5 to C10 Paraffins	TOTAL GAS Volume	C2 to C4 Volume	METHANE Volume	SAMPLES	DEPTH
		100	0	100	0	375	0	0	8000	100100	2 vs 1	150	50	50	50	0	400	0150000		
		OIL RESERVOIR (THIS ALIQUOT)																		
		PRODUCT (THIS ALIQUOT)																		
		GAS <-Analytical Values, ppm(Rock Volume) THIS ALIQUOT->																		



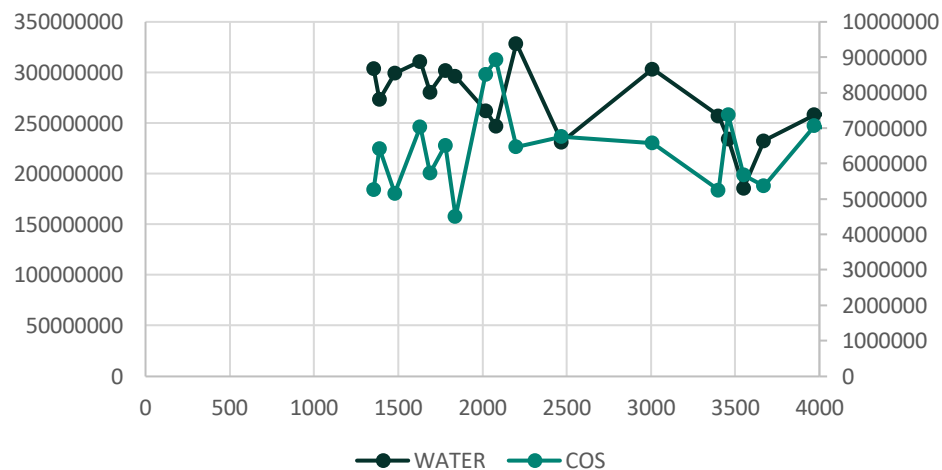
COST Water vs MEK/Acetic



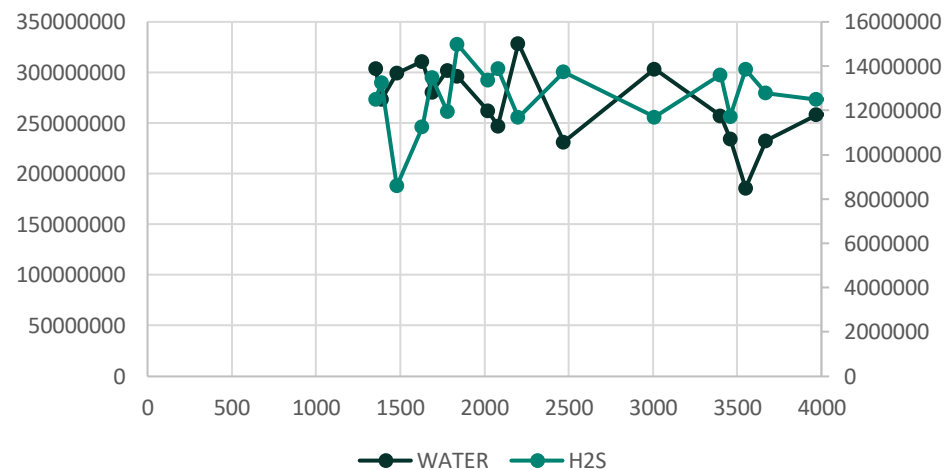
COST Water vs Methane



COST Water vs COS



COST Water vs H2S



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 were 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.

