





**Hurricane**  
Basement Reservoir Specialists

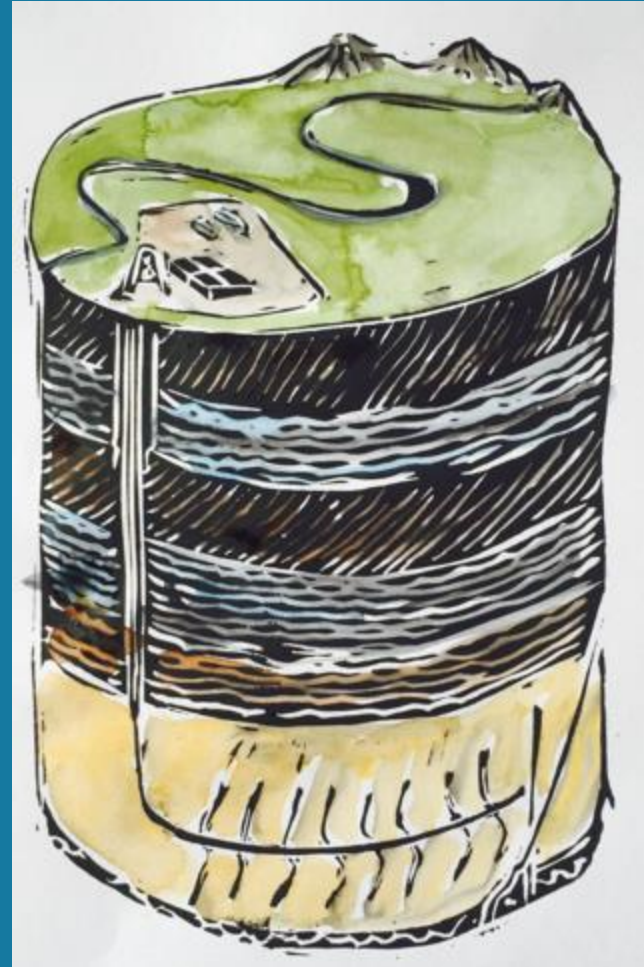
**Fractured Basement  
WoS**

The Rona Ridge Play



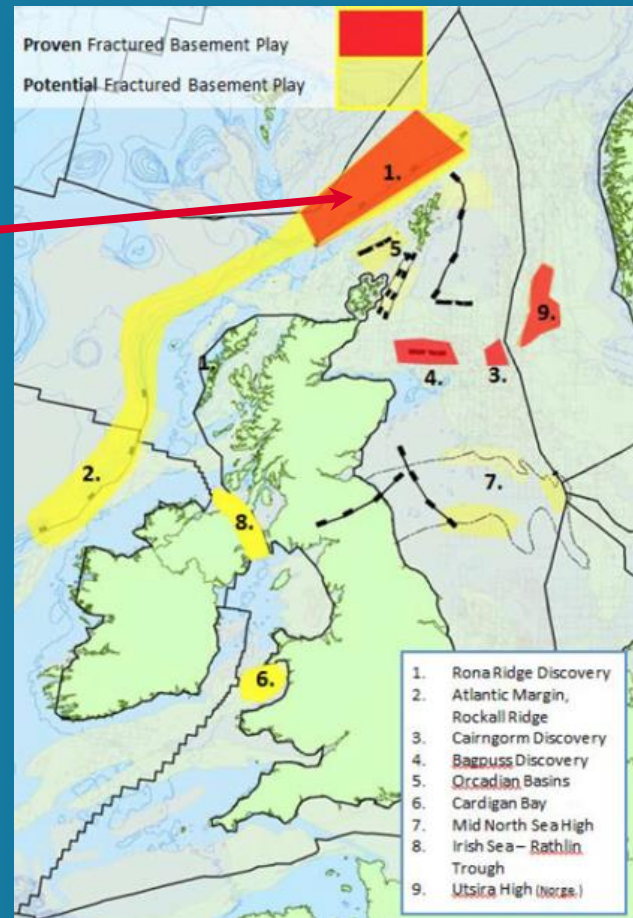
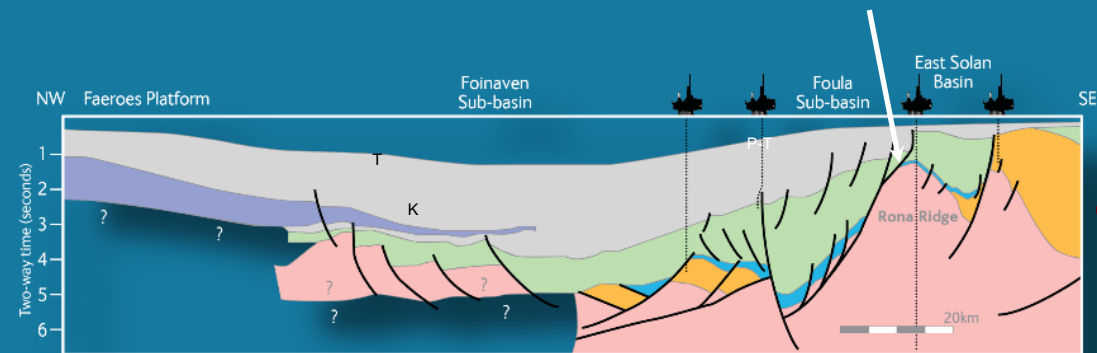
Is the Lancaster fractured  
basement discovery a one-off?

Is there an extensive fractured  
'basement' province WoS?



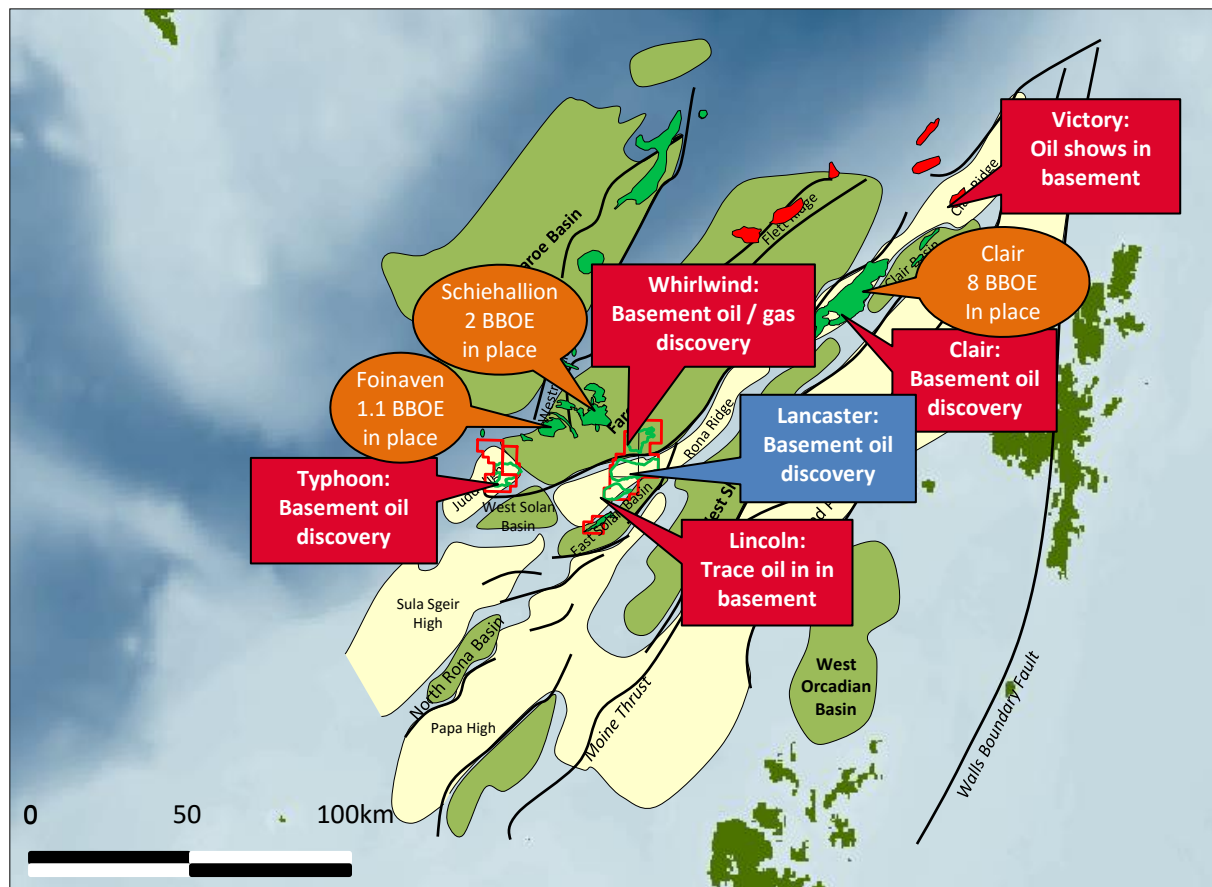
# Rona Ridge

## Lancaster

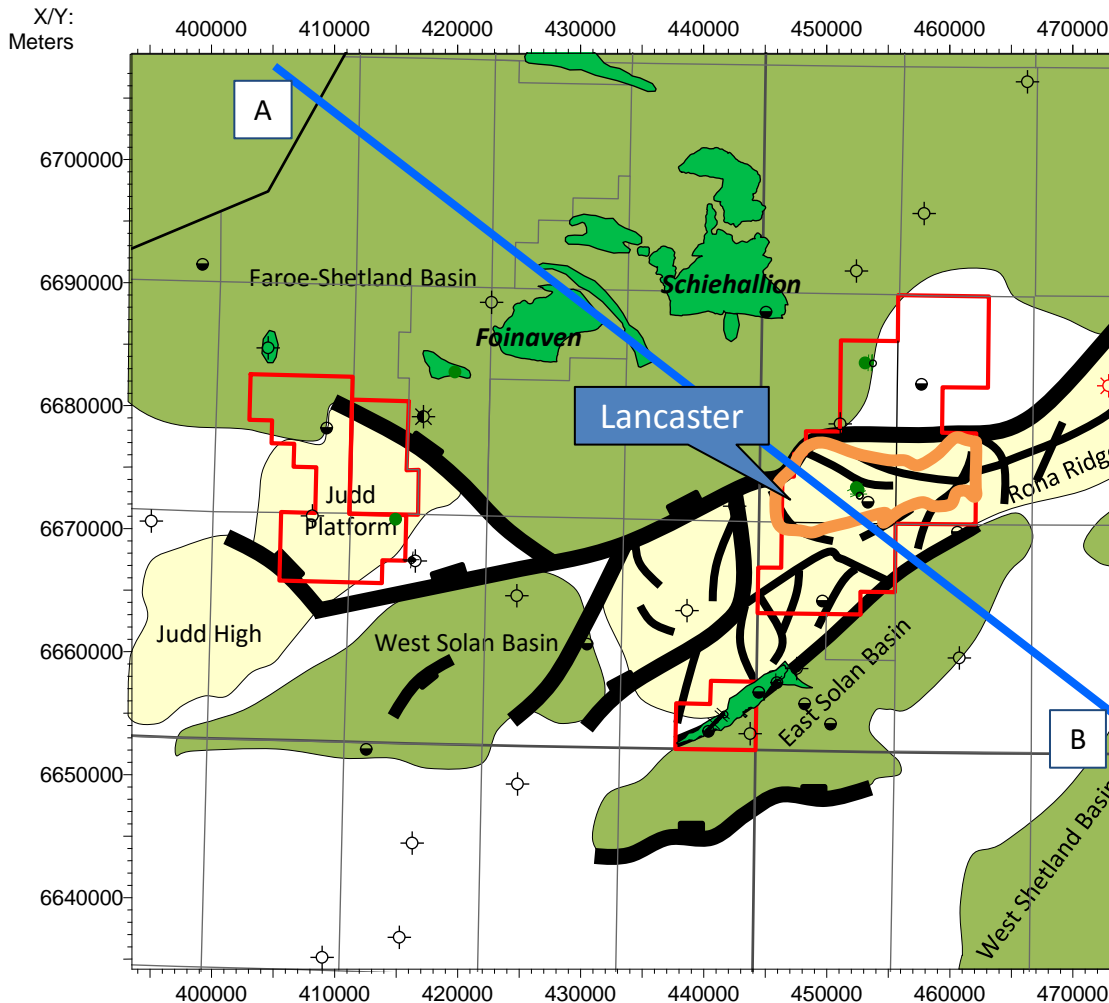




# West of Shetland Geological Setting



Lancaster is located West of Shetland in a proven petroleum basin. Oil is demonstrated in basement throughout the region and several large oil and gas fields are present including Clair, Foinaven and Schiehallion



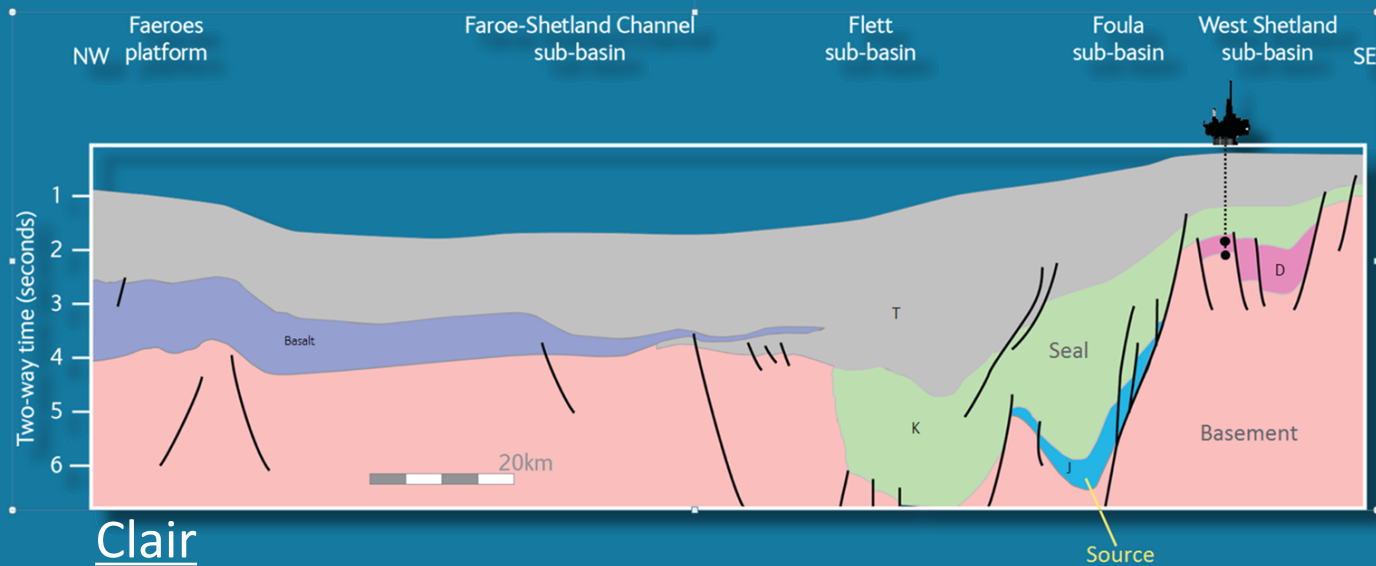
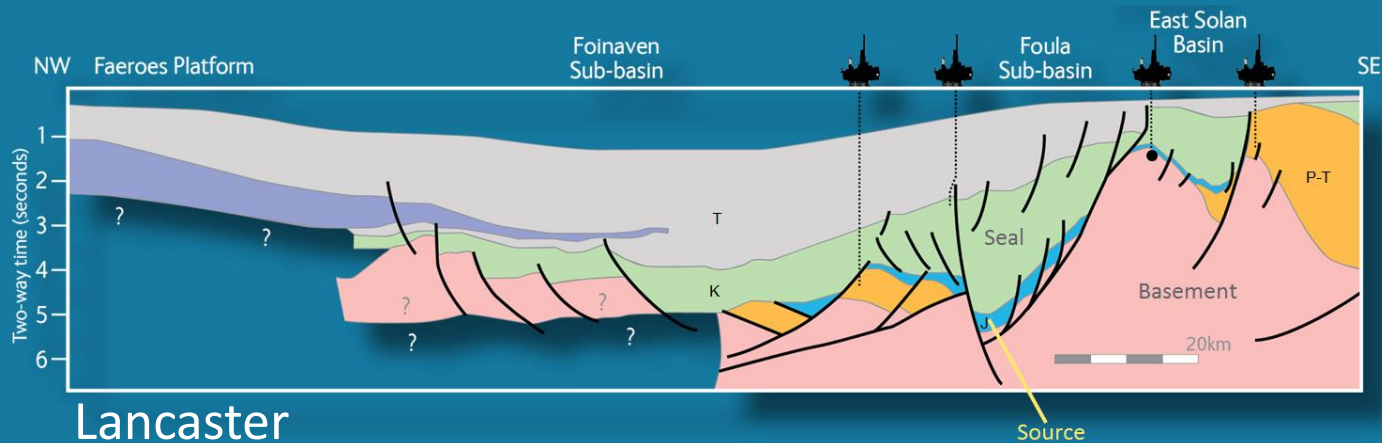
# Lancaster Area Geological Setting

- Lancaster is located on the southwestern limb of the Rona Ridge updip of the Faroe-Shetland Basin and to the south east of the Foinaven and Schiehallion Fields
- Water depths at Lancaster are relatively shallow at ~150 metres



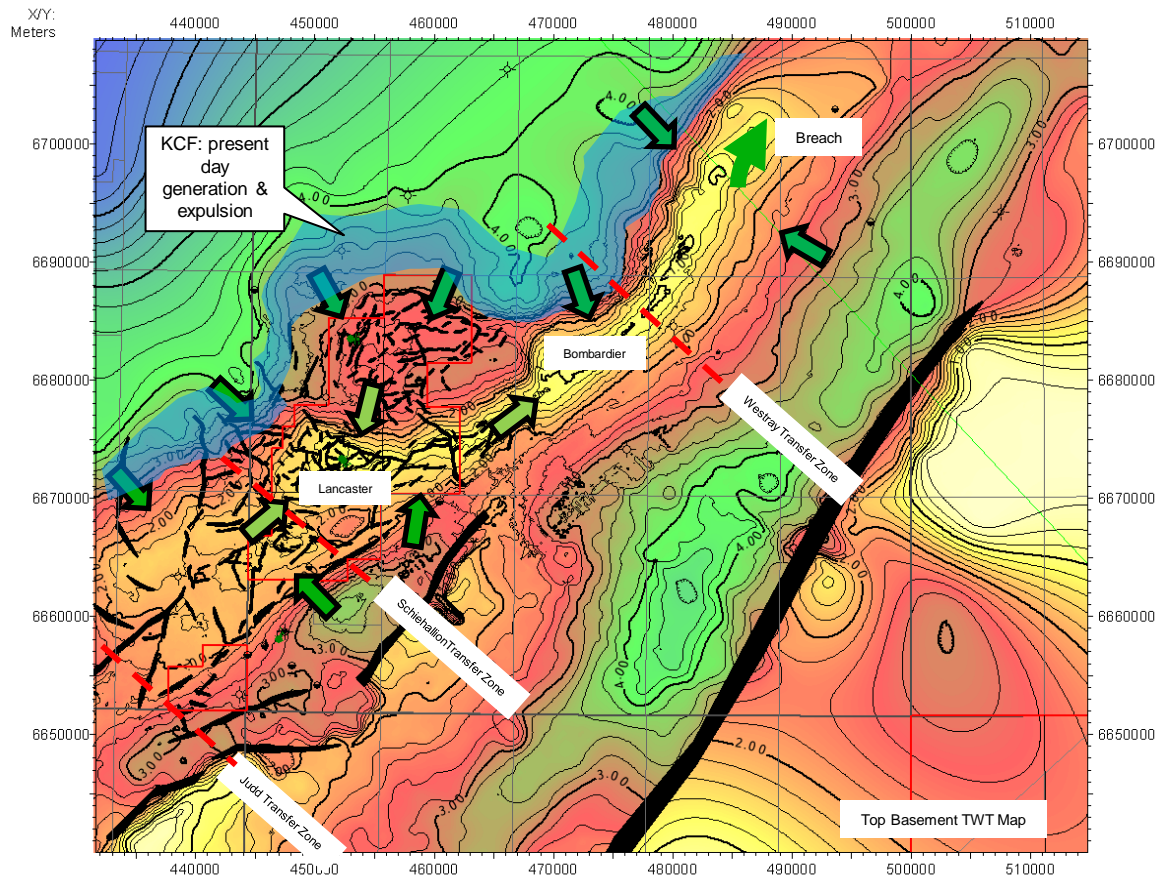
# Geological Cross-section

- Similarities between tectonic setting and basement age at Lancaster and Clair
- Differences include thick Devonian sandstone present on Clair is absent from Lancaster



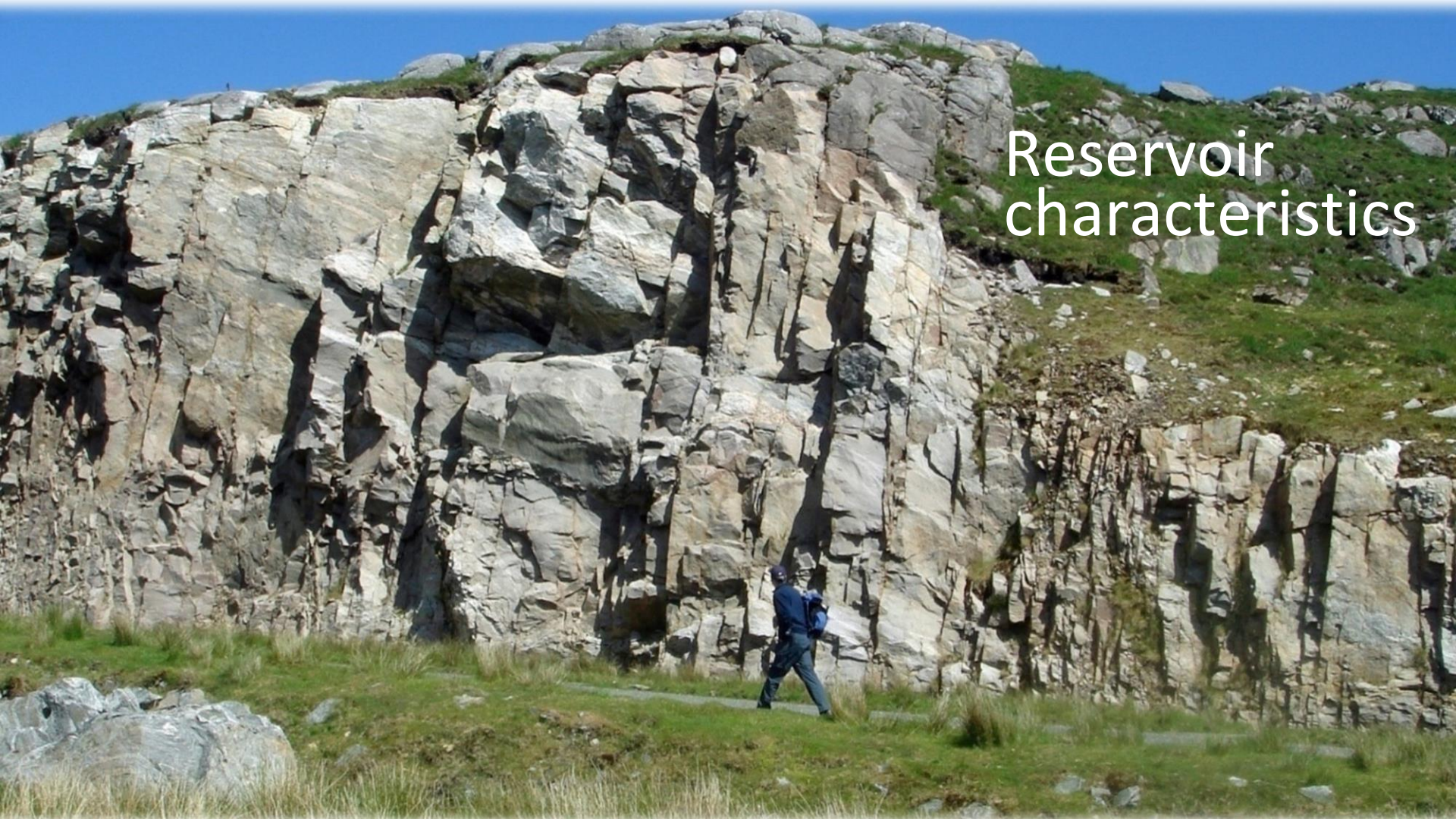
# Regional Basement Structure, Kitchens and Charge

- KCF onlapping onto the basement ridge is in the oil window today

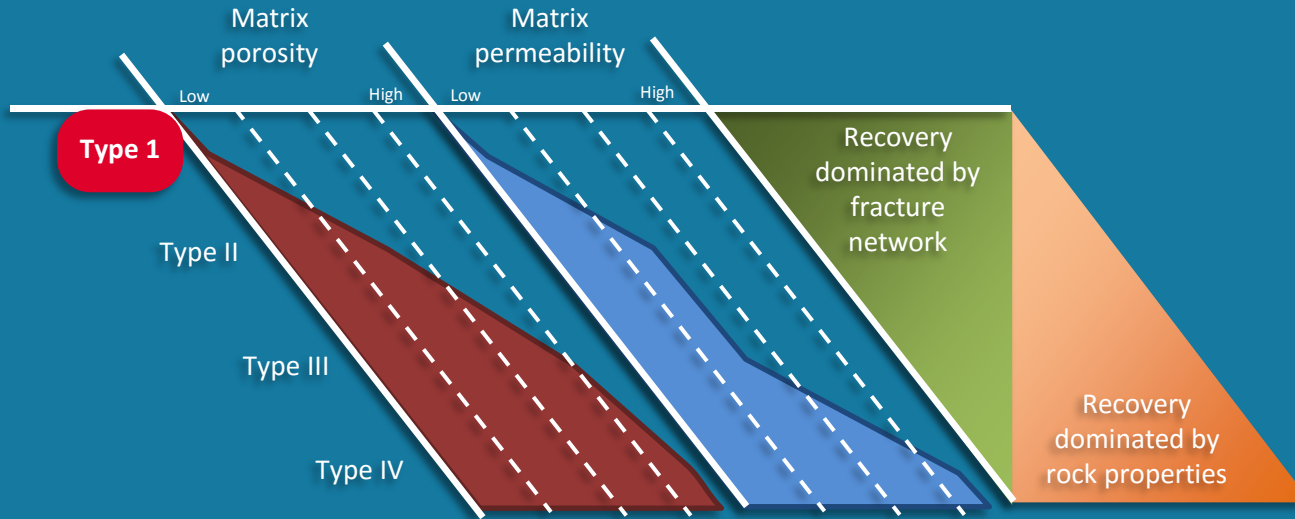




# Reservoir characteristics



# Fractured Basement characteristics



*Definitions of Naturally Fractured Reservoirs, after Nelson 2001*

- Oil storage and mobility entirely depends on the fracture network



# Lithology

## Tonalite (2.3-2.4 Ba )

- Plutonic rock, quartz rich (>20%) with plagioclase and minor alkali feldspar (<10%). Tonalites are most commonly related to island arcs or orogenic magnetism and are associated with granodiorite / granite intrusions
- Tonalite comprises 80-95% of GRV based on current well data



## Dolerite (2.3 Ba)

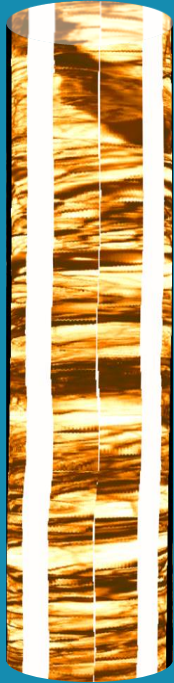
- A dark intrusive rock consisting of pyroxene, feldspar and magnetic iron, locally grades to basalt. Possibly related to Scourian Dyke complex or as differential segregation of initial melt
- Dolerite comprises 5-20% of GRV based on current well data



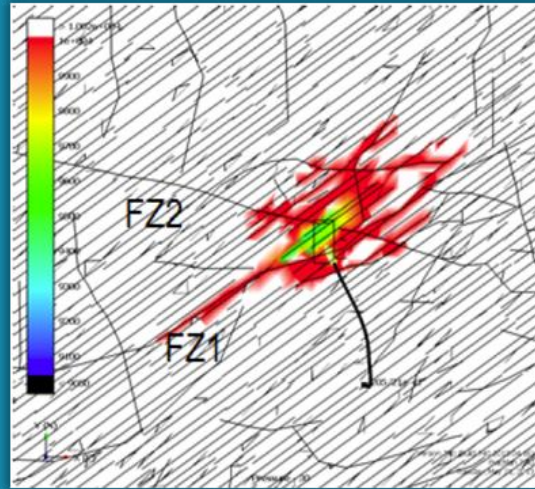
# Fracture characteristics at different scales of measurement



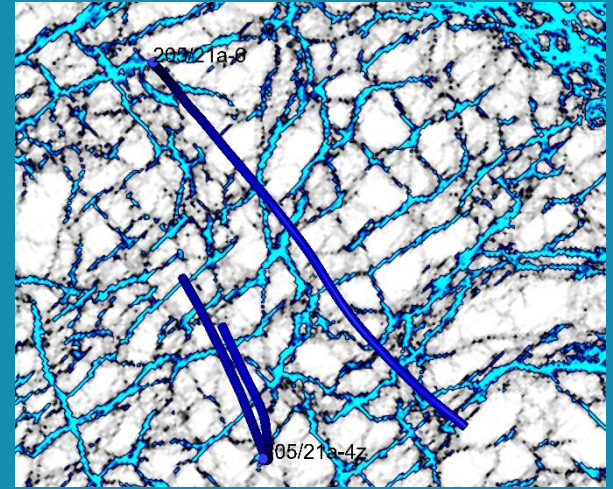
Core plug



Borehole



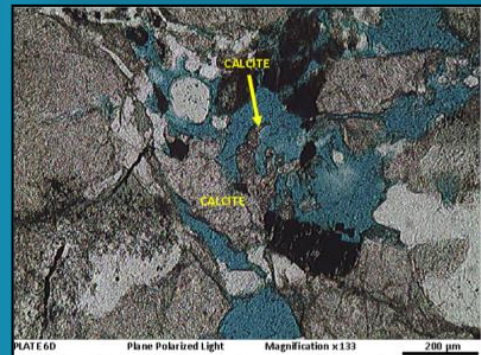
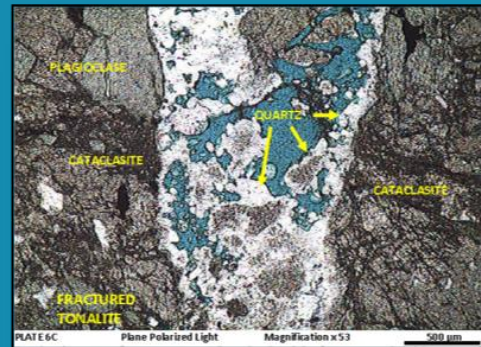
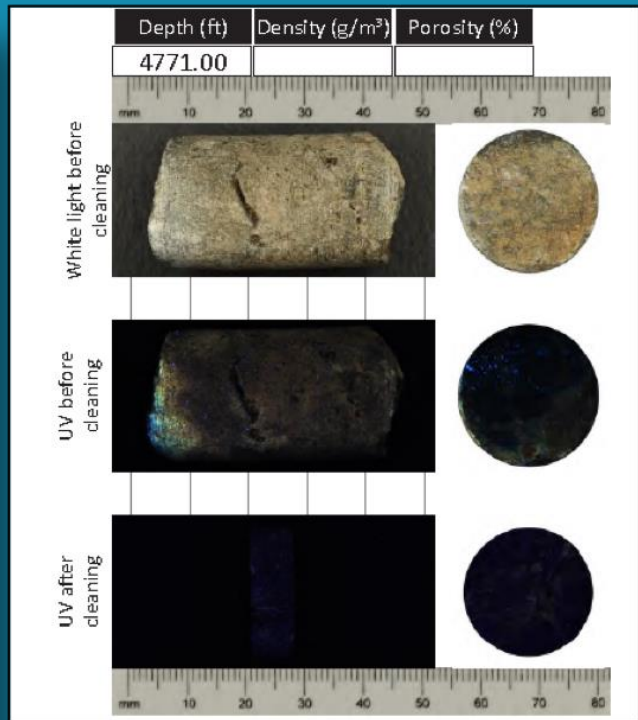
Dynamic well test



3D seismic survey

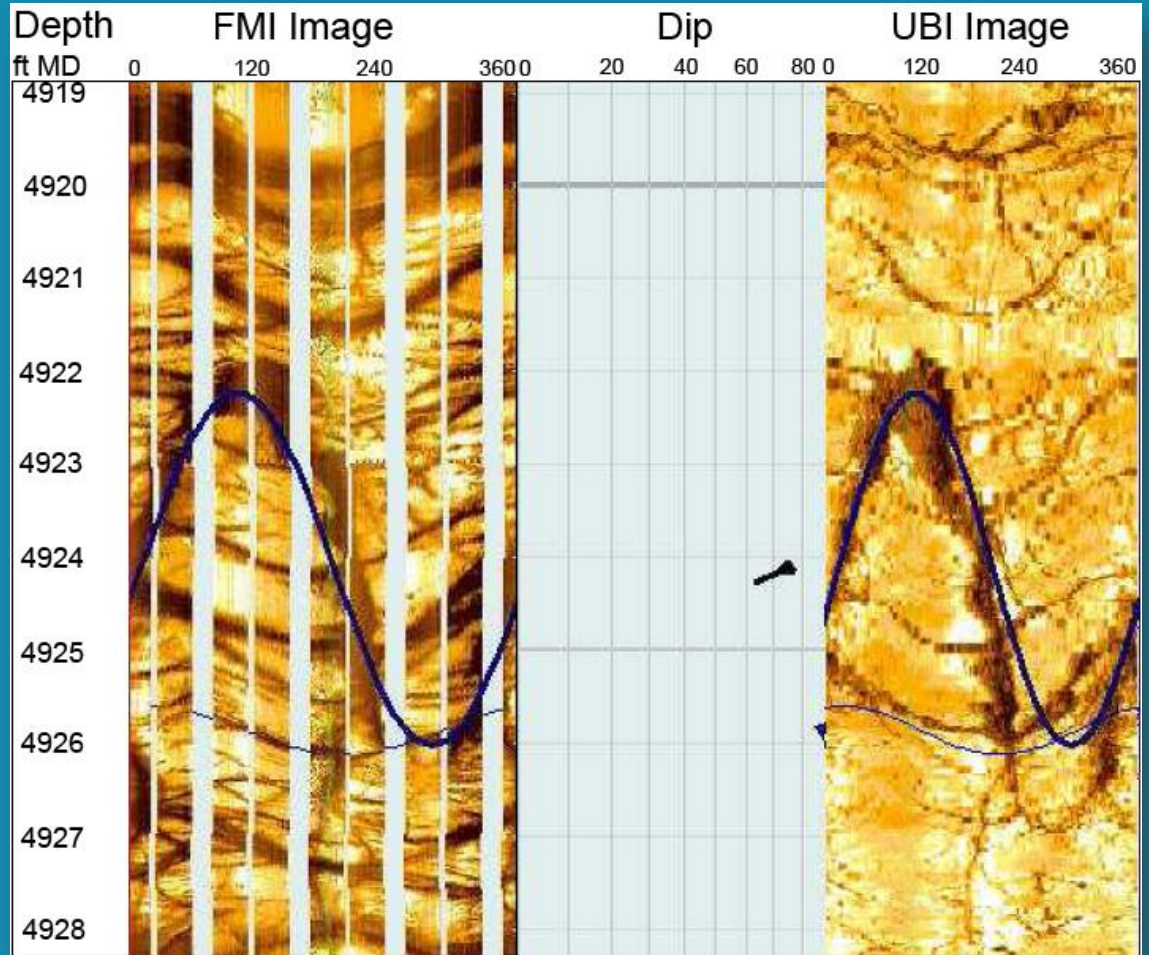


# Micro fractures



# Joints

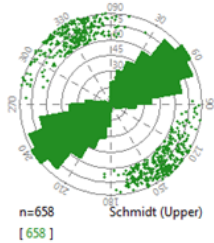
Example of a single joint picked  
from electrical and acoustic image logs



# Joint Types

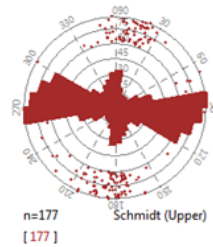
## Fractured Basement

Regional Joints



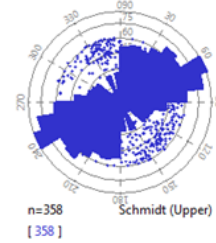
Mean dip/strike: 76° NESW

Cross Joints >60°



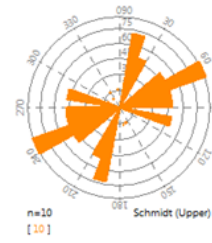
Mean dip/strike: 74.5° EW and a secondary trend NS

Cross Joints >20°, <60°



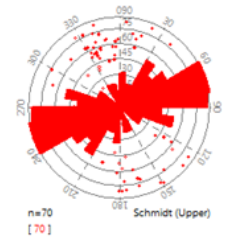
Mean dip/strike: 47.9° NESW

Cross Joints <20°



Mean dip/strike: 14.7° NESW and a minor trend NWSE

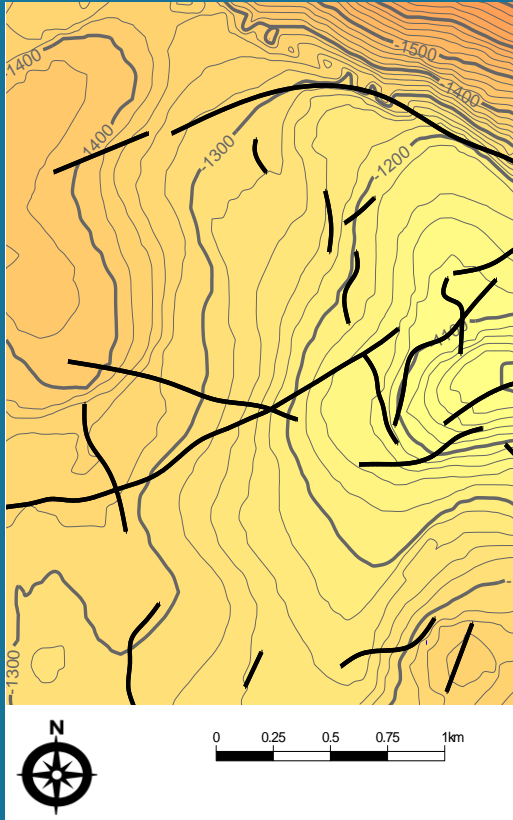
Large Aperture Fractures



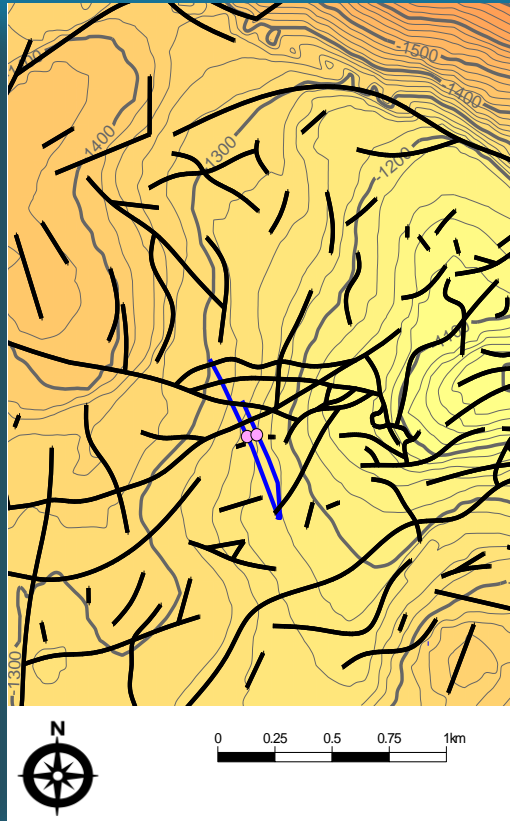
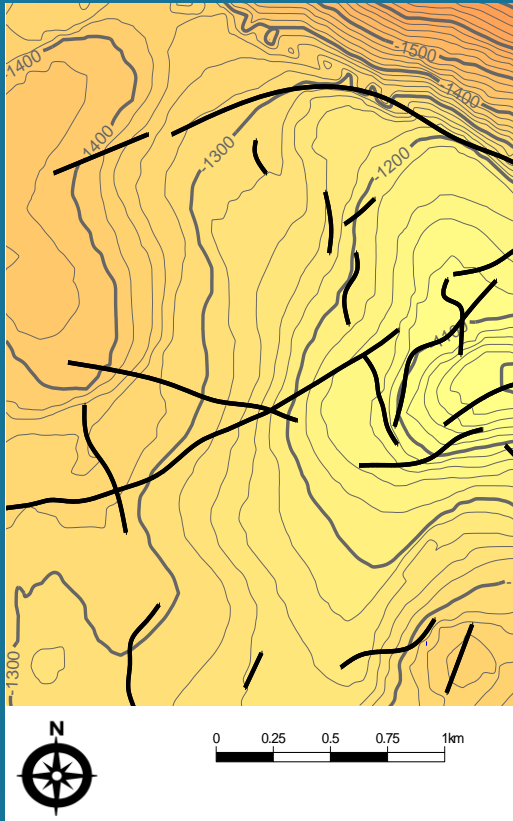
Mean dip/strike: 61.9° NESW



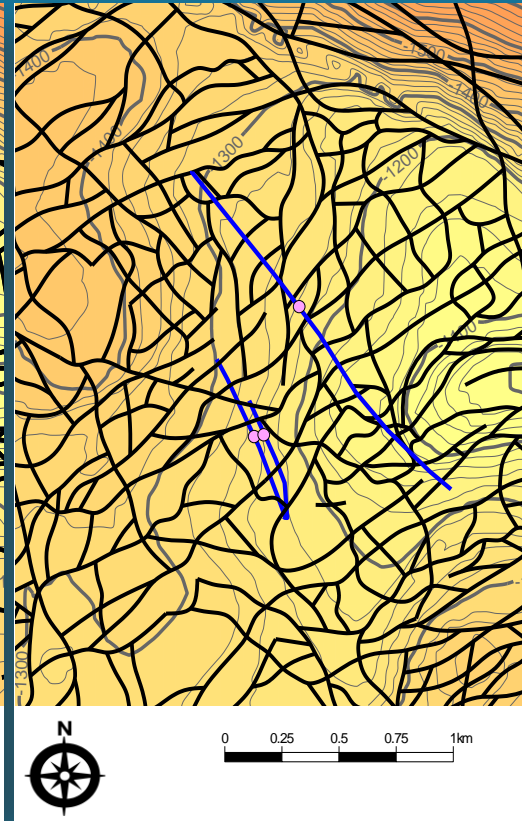
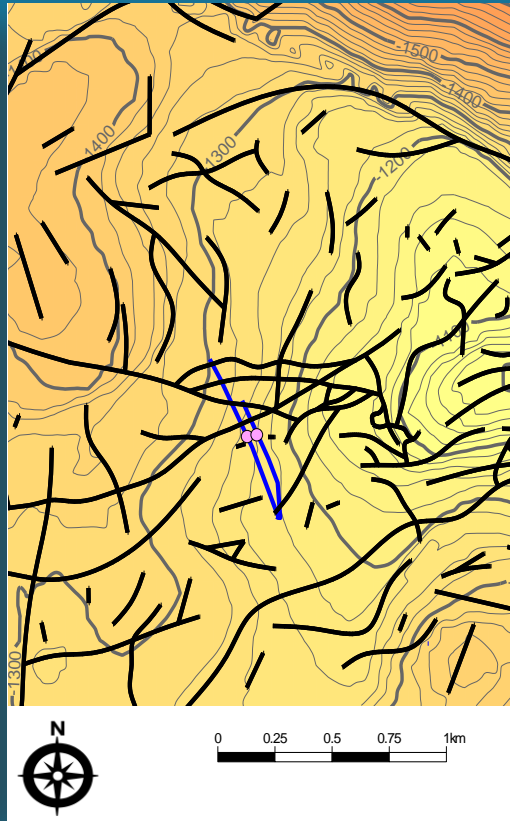
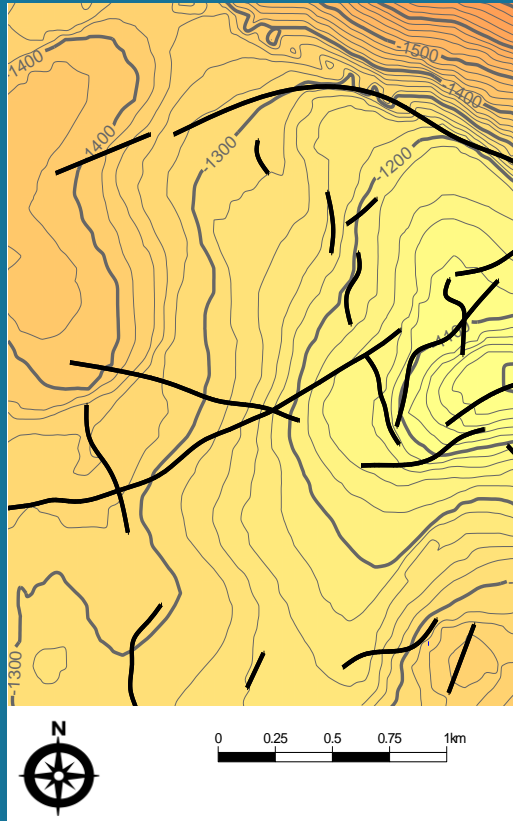
# Fault map evolution



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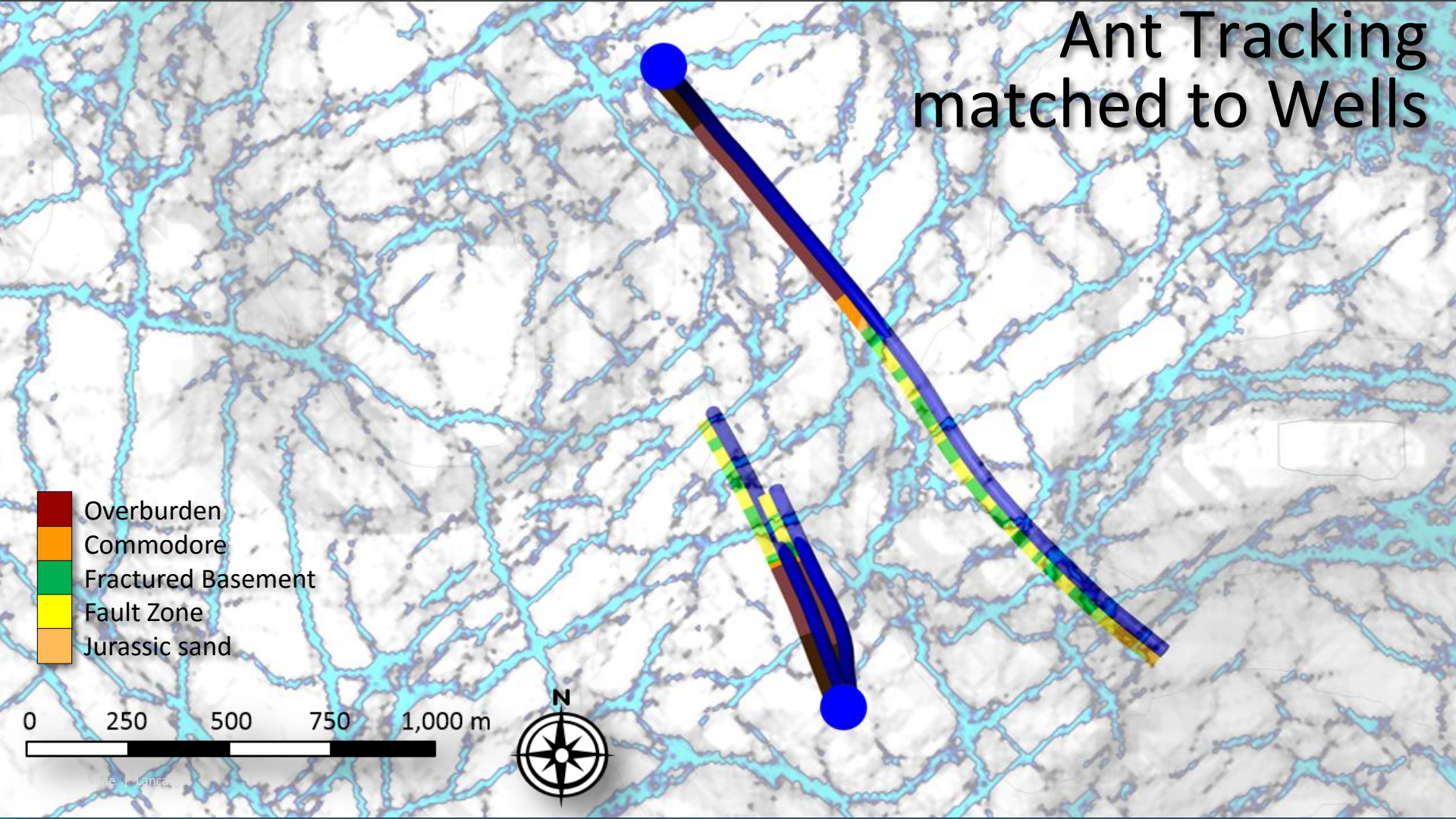


# Fault map evolution

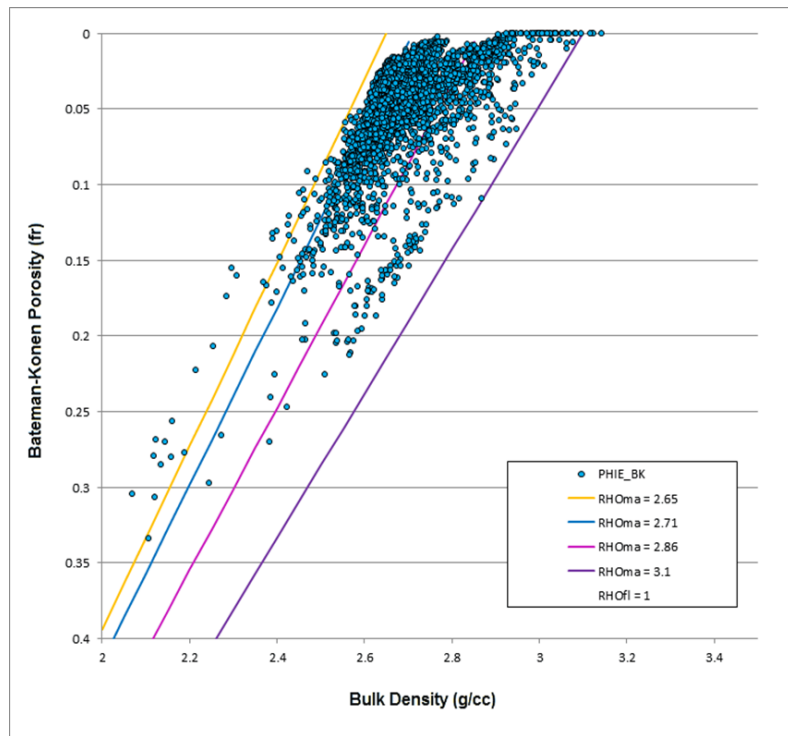




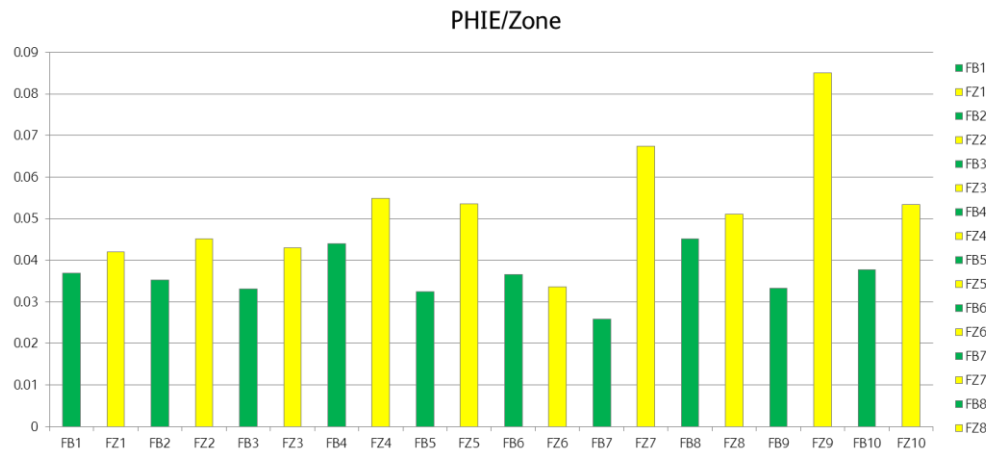
# Ant Tracking matched to Wells



# Basement porosity distribution



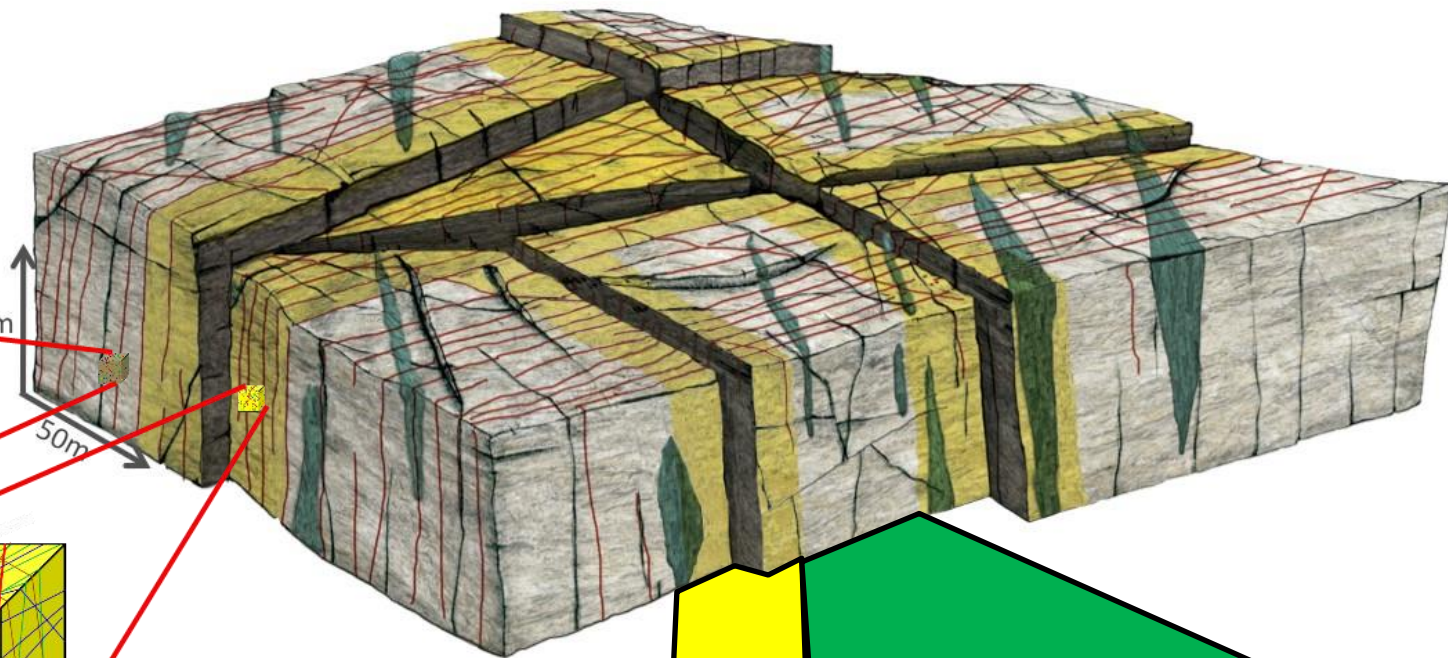
Zone	Thickness md ft		PHIE (frac)
<b>FZ</b>	1419.6	48.85%	0.052
<b>FB</b>	1486.5	51.15%	0.036
<b>All</b>	2906.1	100%	<b>0.043</b>





# Conceptual model

Micro fractures and joints are present throughout the Fractured Basement and Fault Zones



## Fault Zones

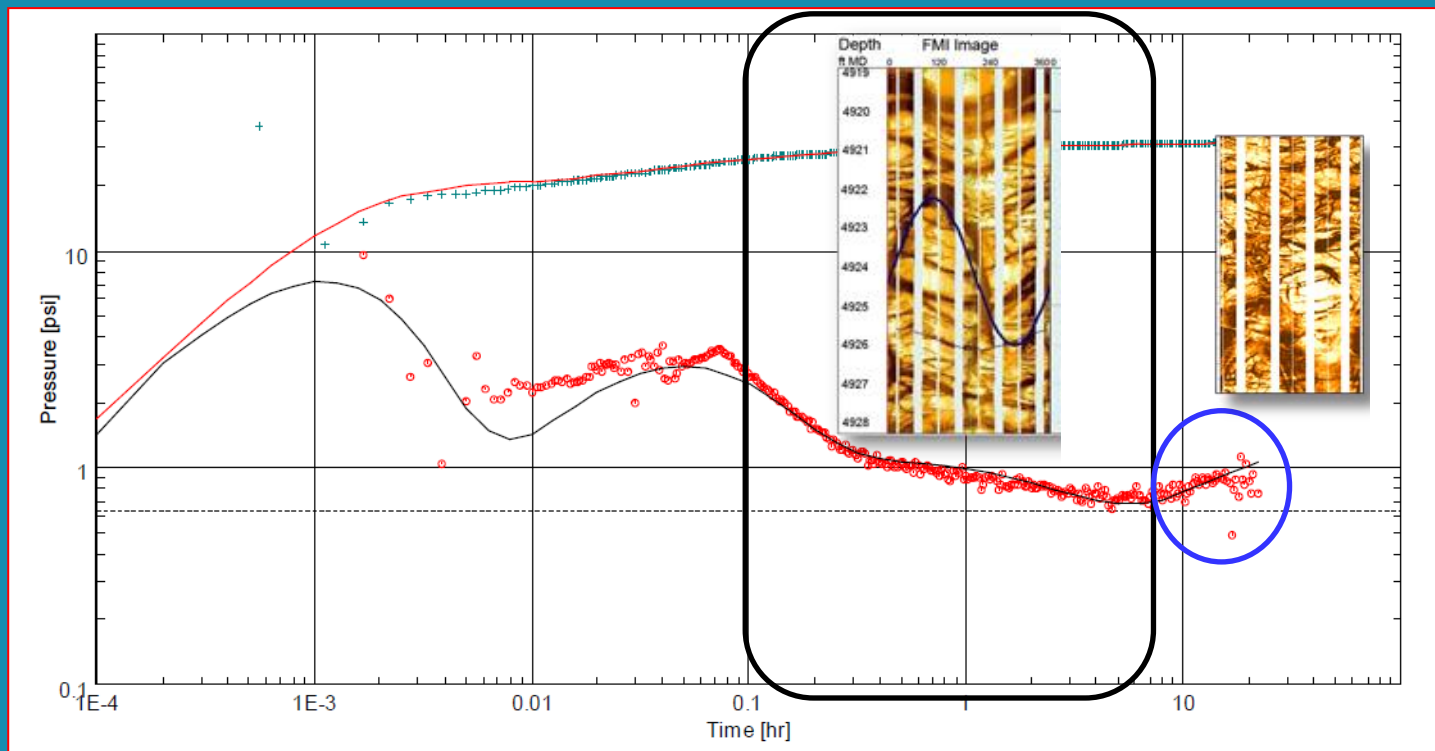
Represent pervasively fractured volumes of rock, that include preferentially enhanced aperture fractures and therefore improved reservoir characteristics. Fault Zones are associated with seismically-resolvable faults

## Fractured Basement

The intervening host rock is pervasively fractured and also contributes to fluid flow



# 205/21a-6 pressure build up analysis



Final PBU Derivative Match

PI = 160 STB/d/psi

Minimum connected volume = 200 MMrb

No barriers





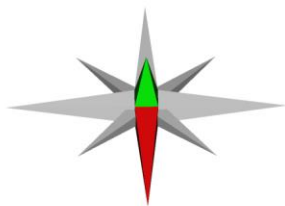
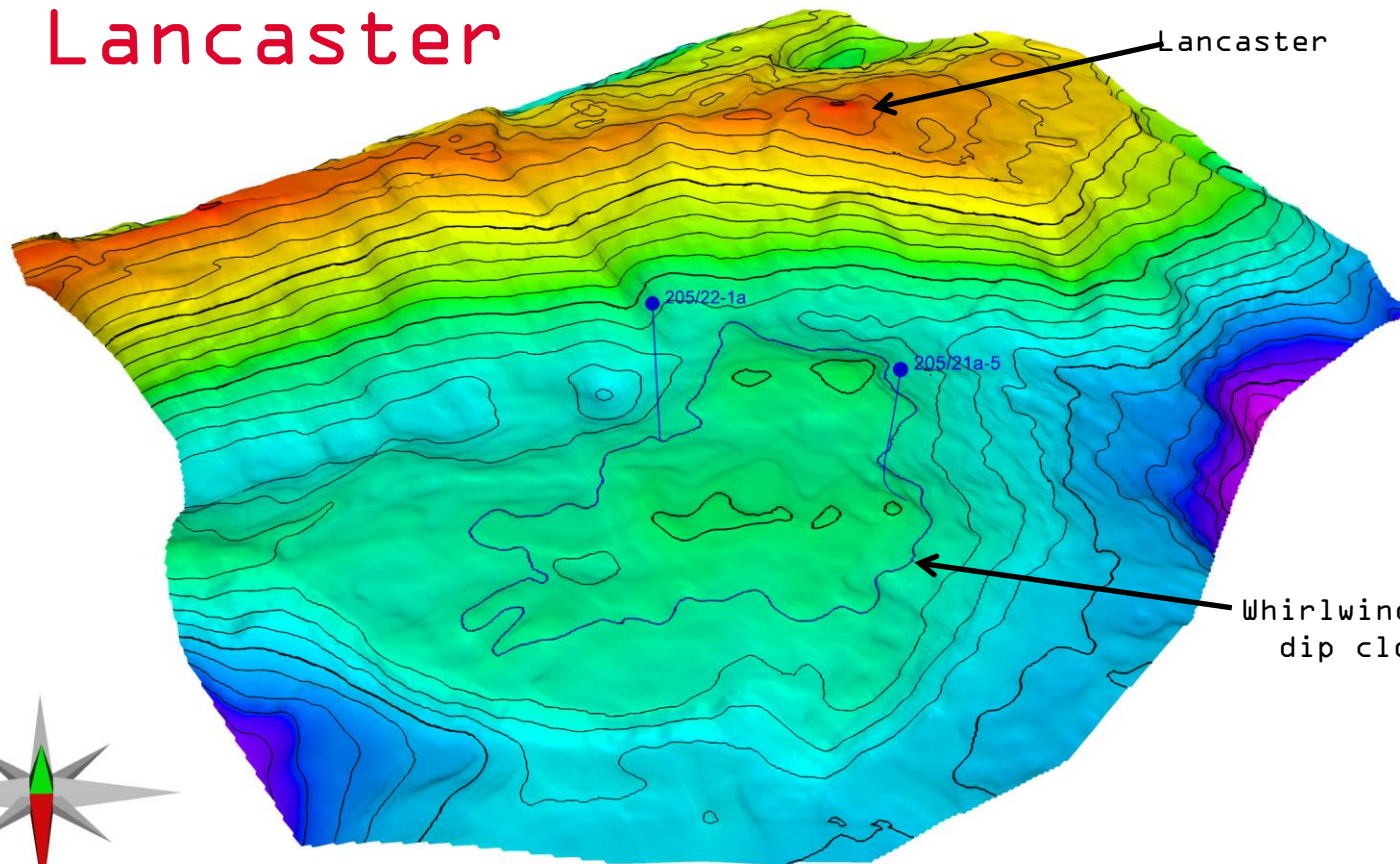


Whirlwind

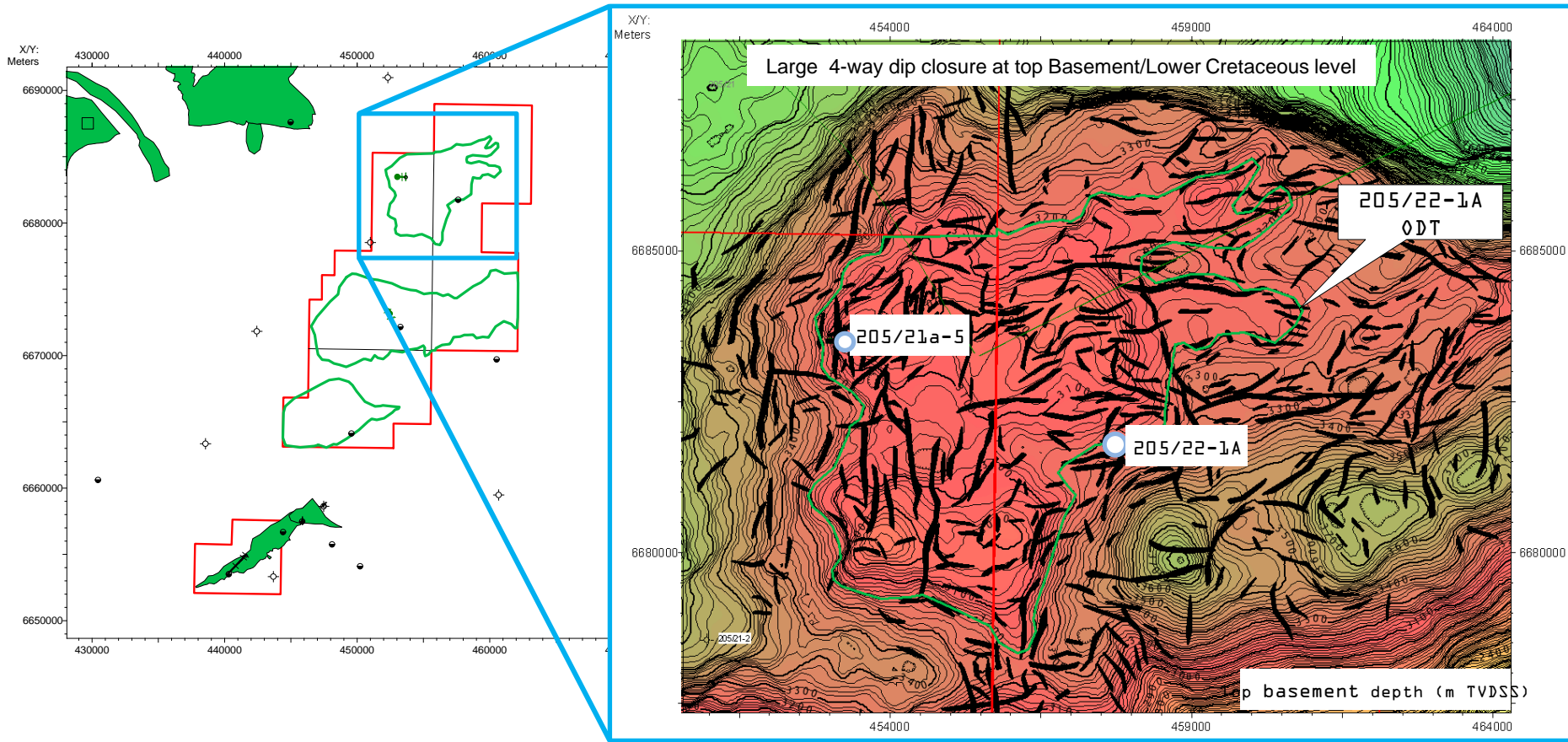


# Whirlwind Location with Respect to Lancaster

Depth (m)

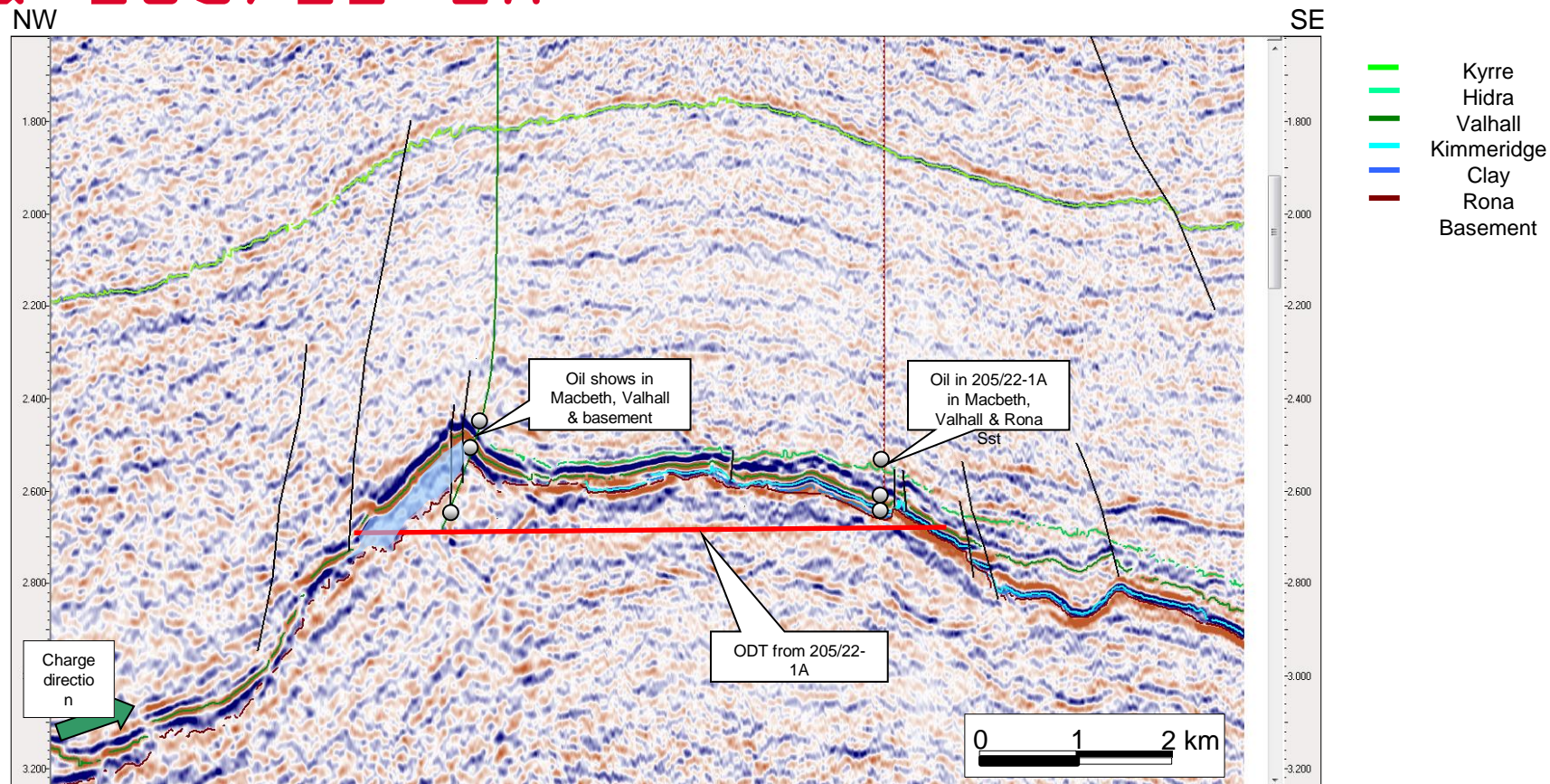


# Whirlwind Location





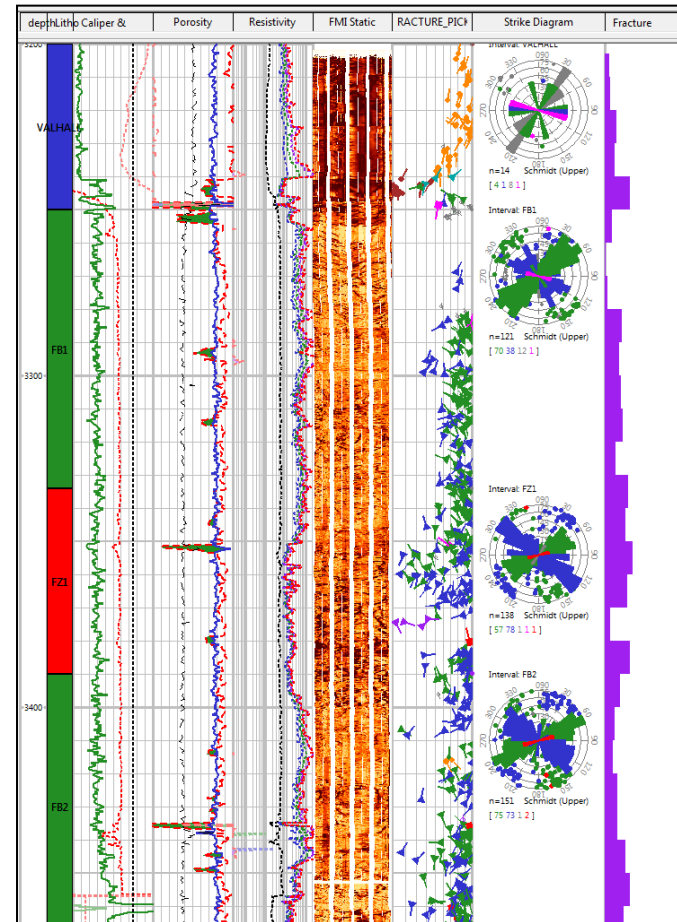
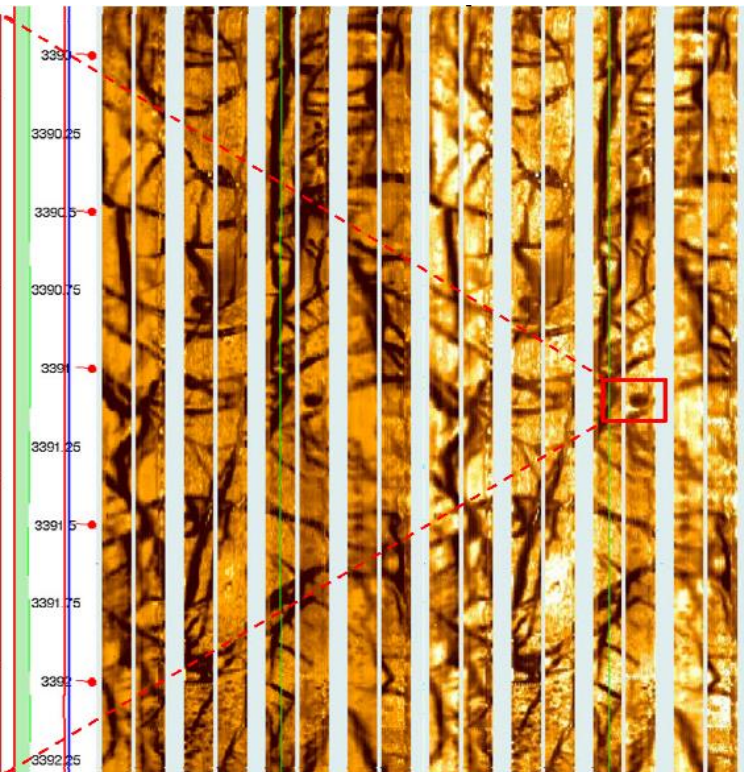
# Seismic Line through 205/21a-5 & 205/22-1A





# Basement Faults and Fractures

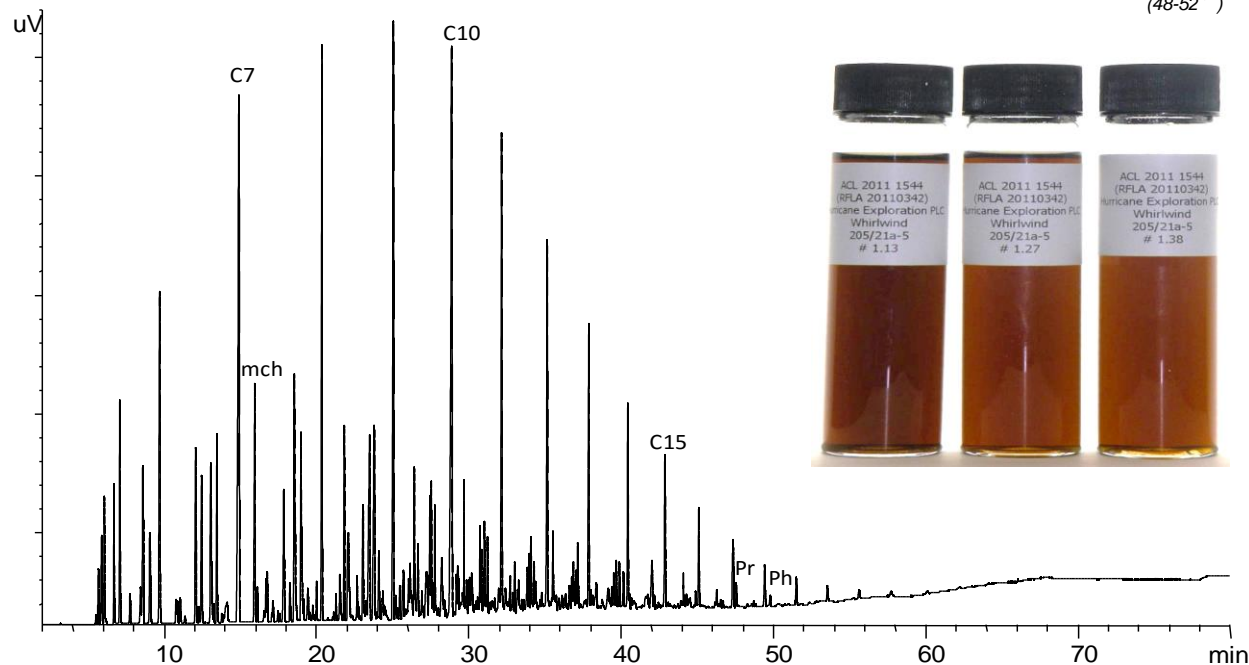
White light before cleaning



# Produced Oil

## Whole oil gas chromatogram (dead oil sample)

*The Whirlwind oil is not biodegraded, and is dominated by light (gasoline-range) hydrocarbons, consistent with its high API gravity (48-52°)*



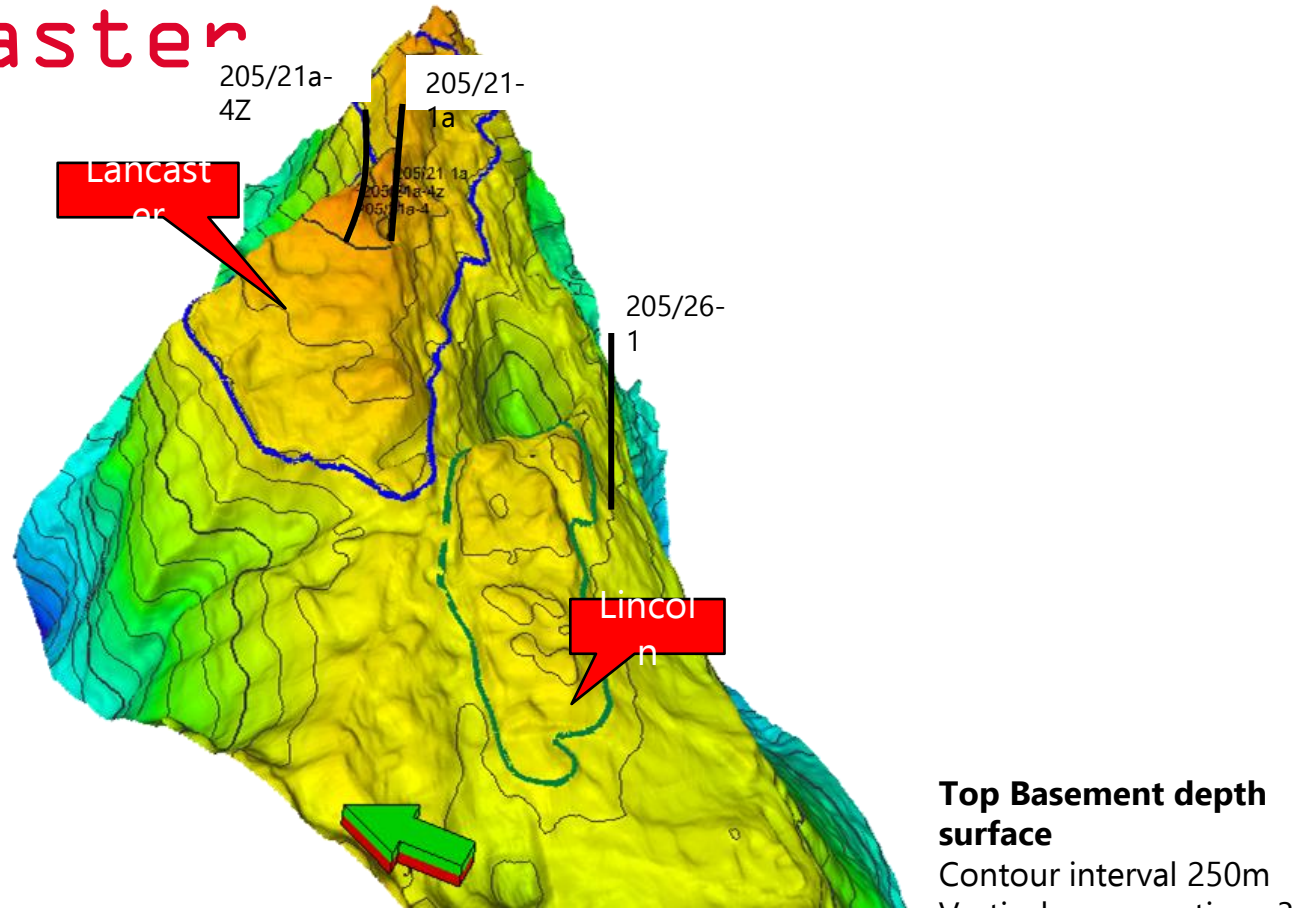




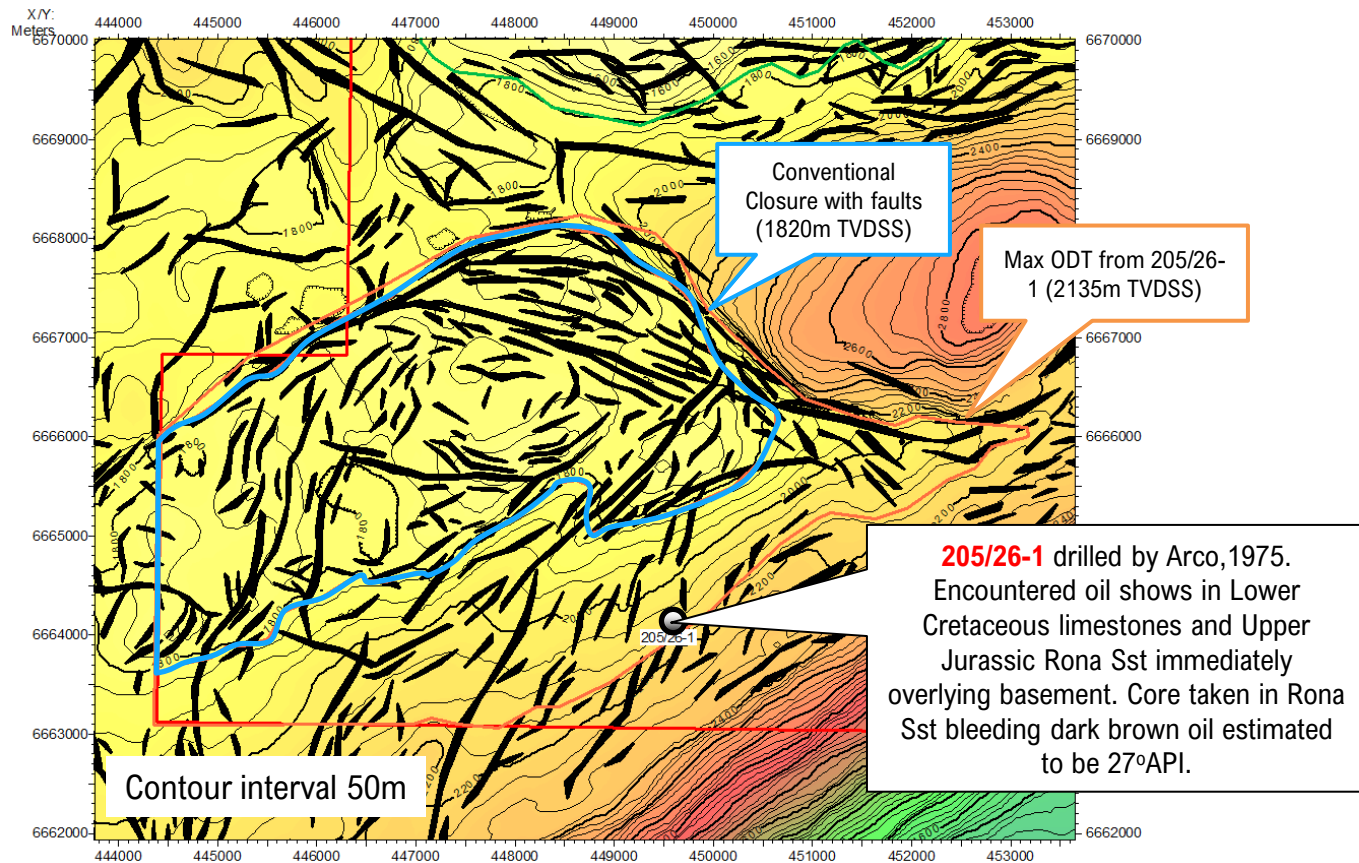
Lincoln



# Lincoln Location Relative to Lancaster

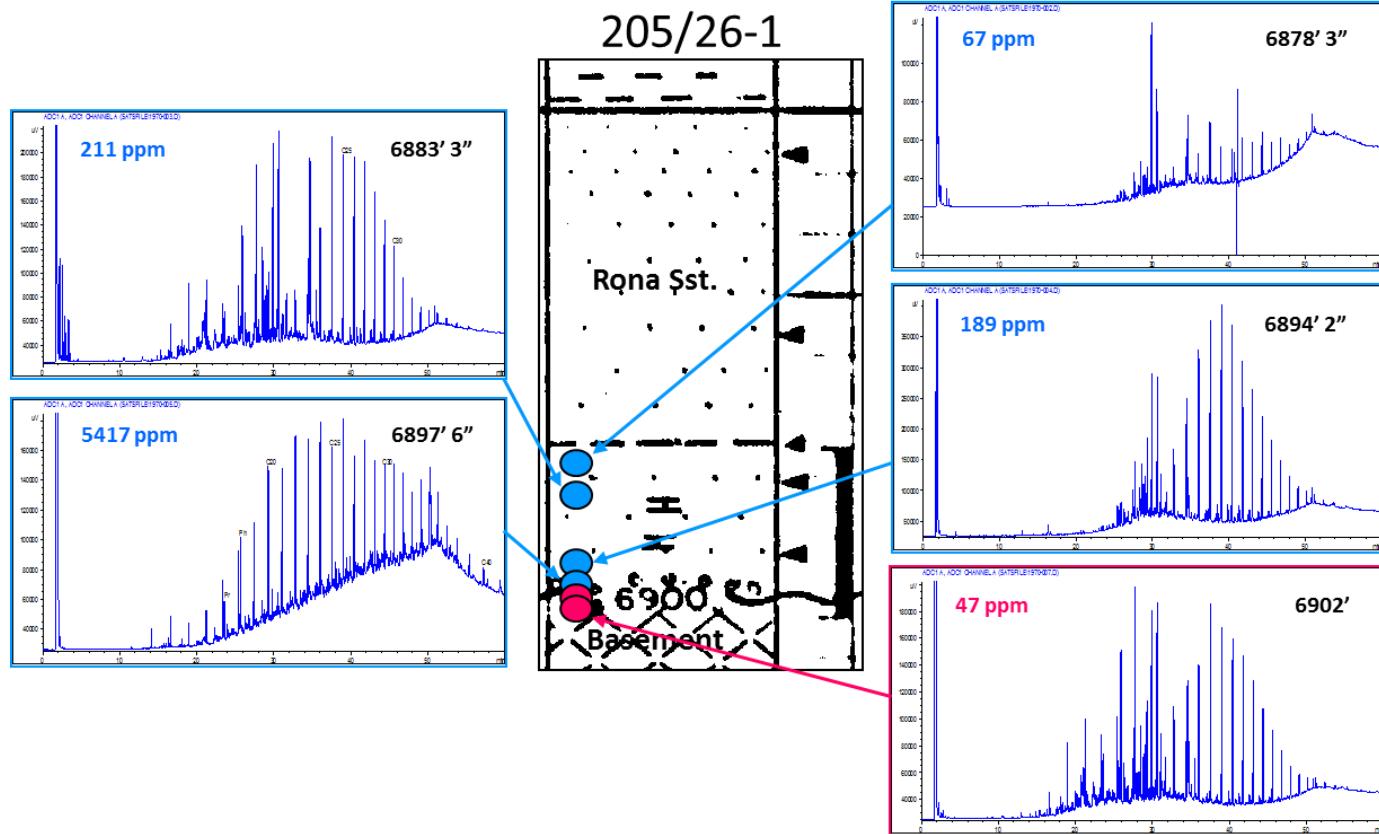


# Lincoln Top Basement Structure & Fault Map



# 205/26-1 Gas Chromatograms

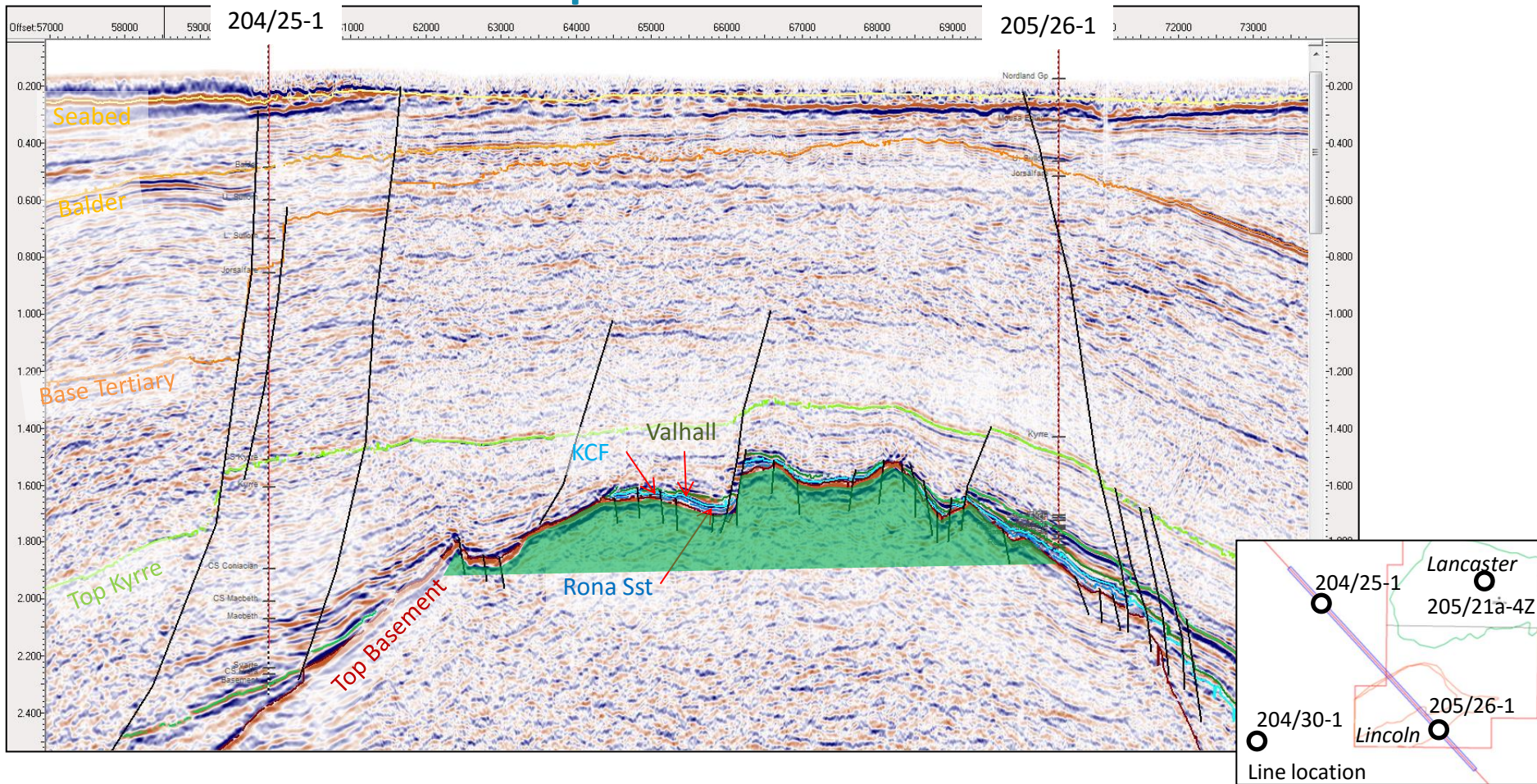
- The presence of n-alkanes indicates fresh undegraded oil. Hump or UCM suggests some biodegradation especially around the base Rona (richest stain)
- Good correlation with oil discovered on Lancaster





## NW

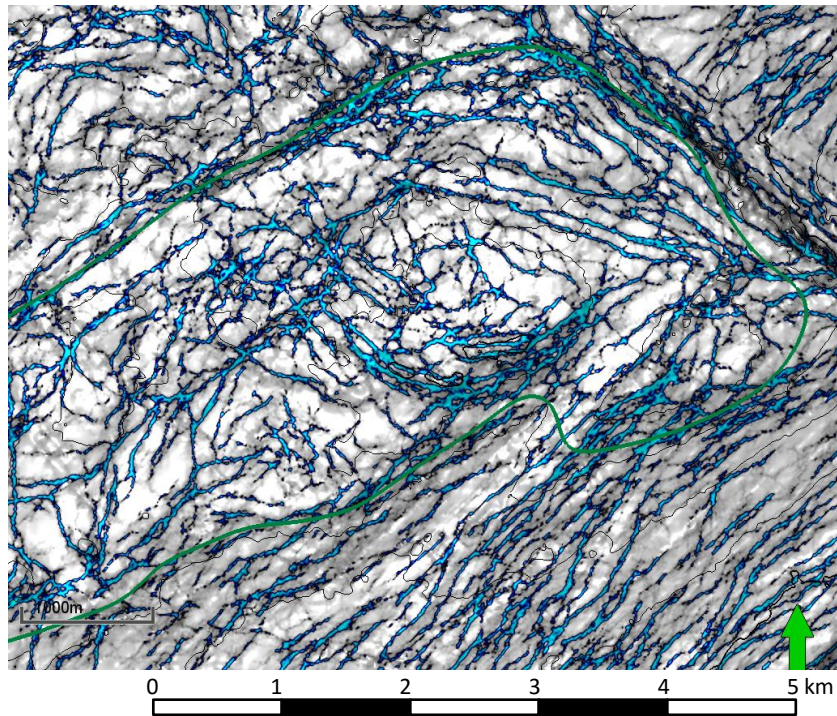
SE



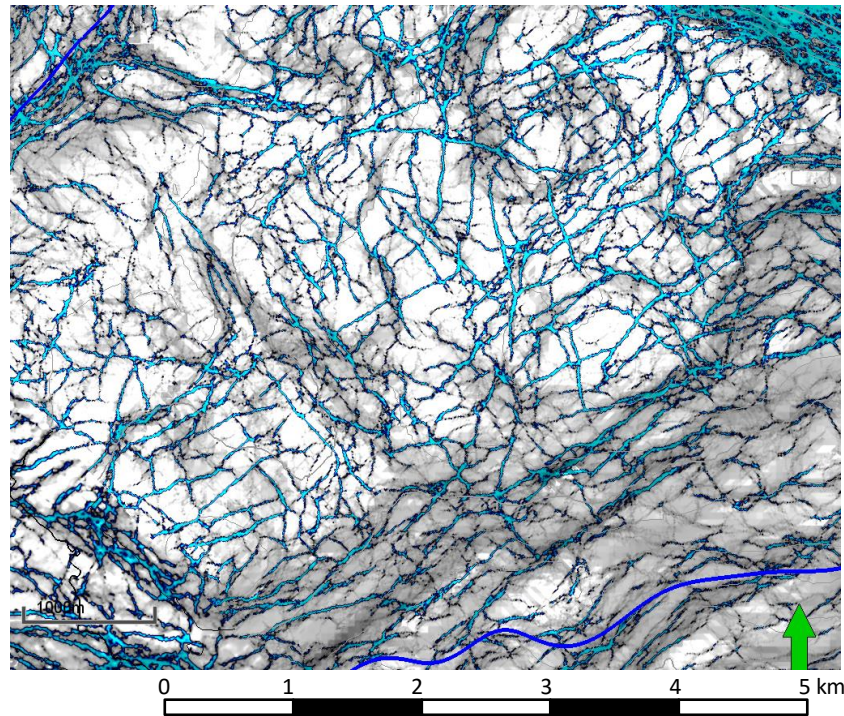


# Lincoln and Lancaster Ant Tracking

Lincoln



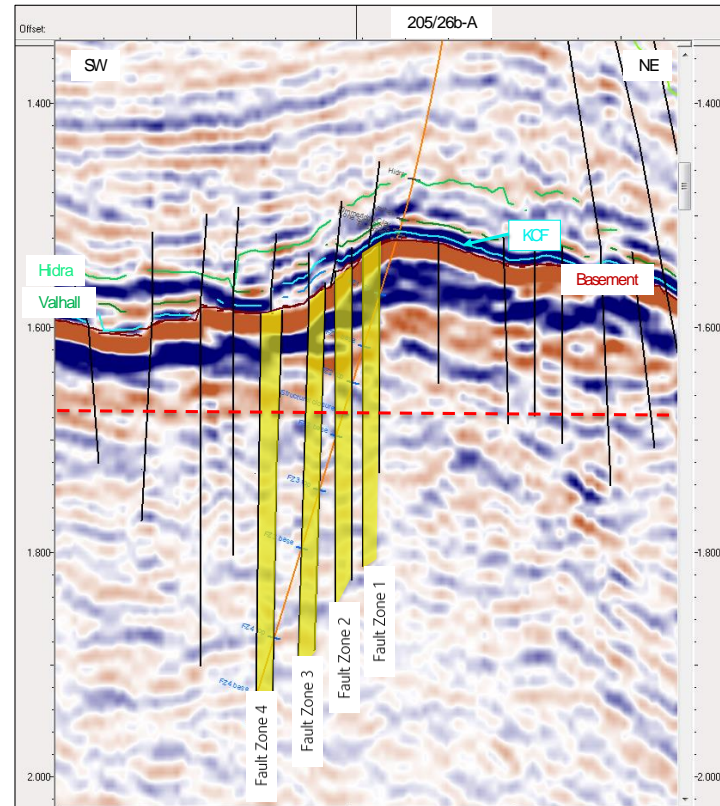
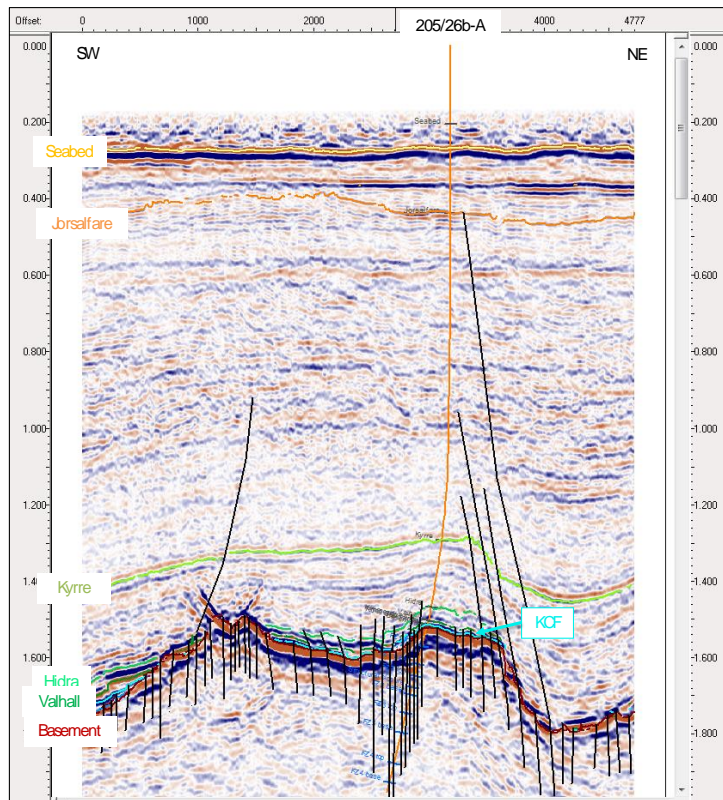
Lancaster



Very similar fault networks, no change in density of faulting



# 205/26b-A Seismic Sections

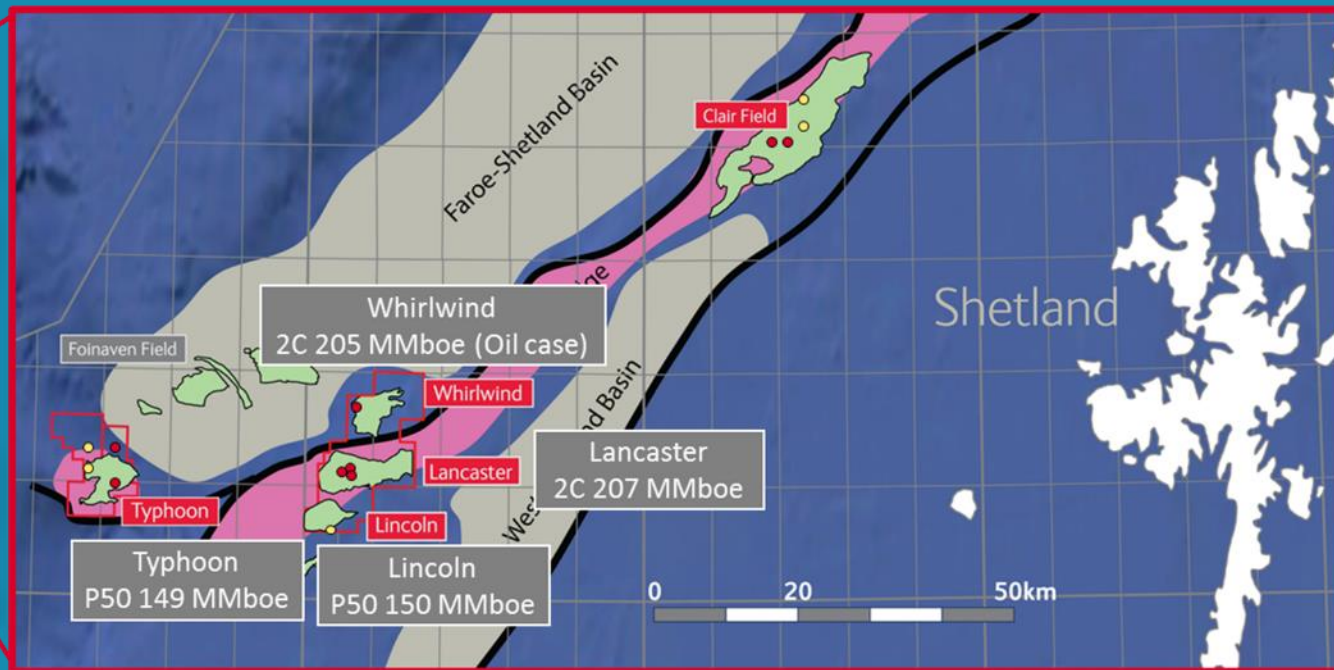
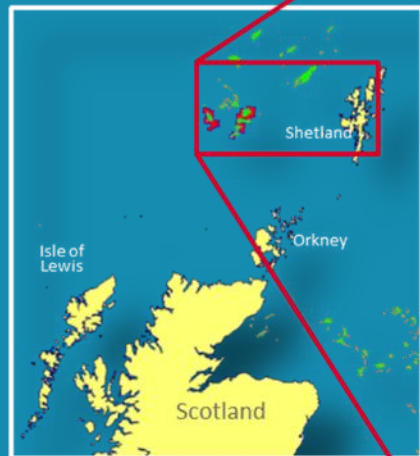




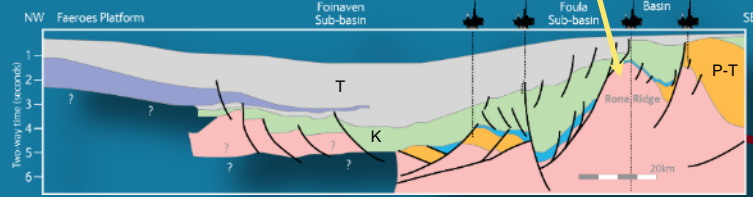
Is there an extensive fractured  
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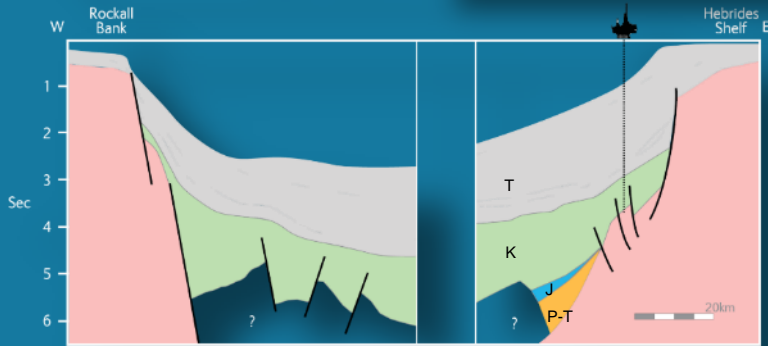




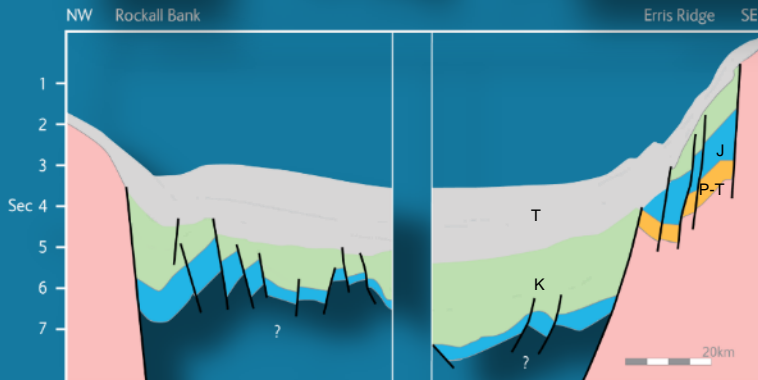
## Lancaster



Rona Ridge

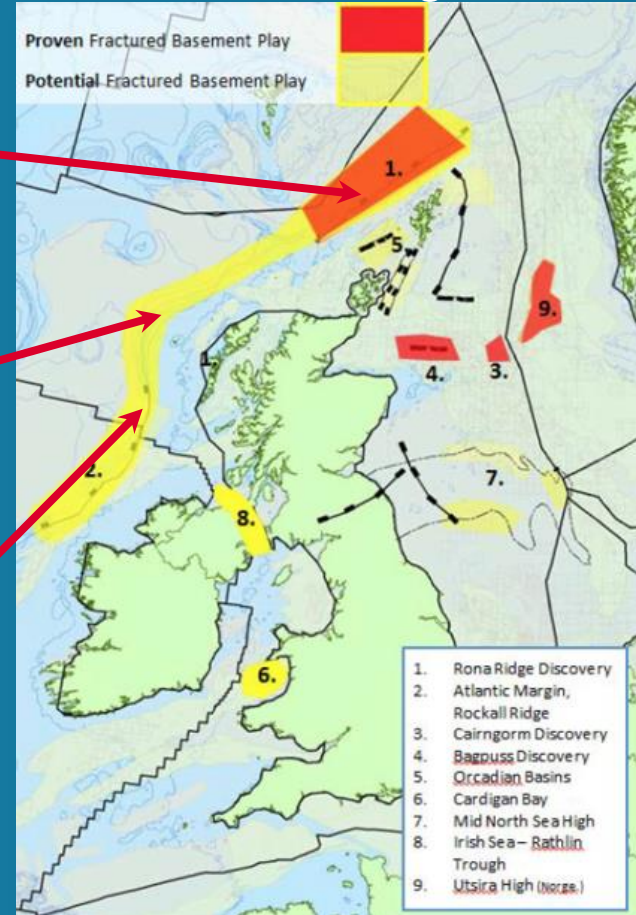


Rockall Ridge  
(north)



Rockall Ridge  
(south)

## Atlantic Margin





# Summary

- The geological setting and reservoir characteristics of the Lancaster are indicative of a working basement play in the West of Shetland
- Further de-risking of the play through long term production is required before the industry accepts this new play type as proven
- UK basement potential is currently unquantified however its resource potential is of strategic significance and potentially a game changer for the UK oil industry



Hurricane