Characterisation of a Shallow Gas Anomaly (Paso Anomaly) in the Catcher Field Area, Central North Sea, UK

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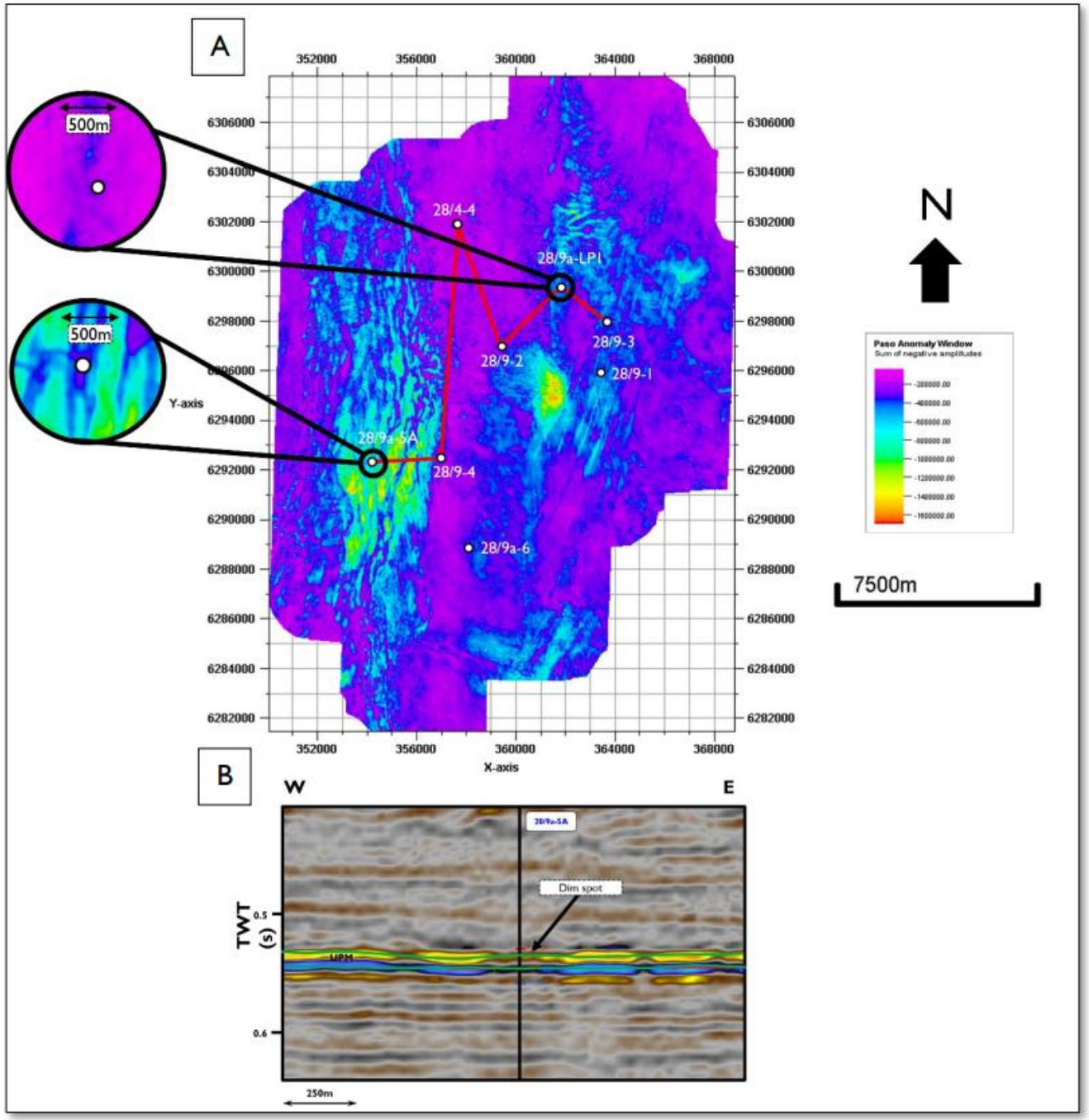
Integrated Petroleum Geoscience MSc Project

In association with:

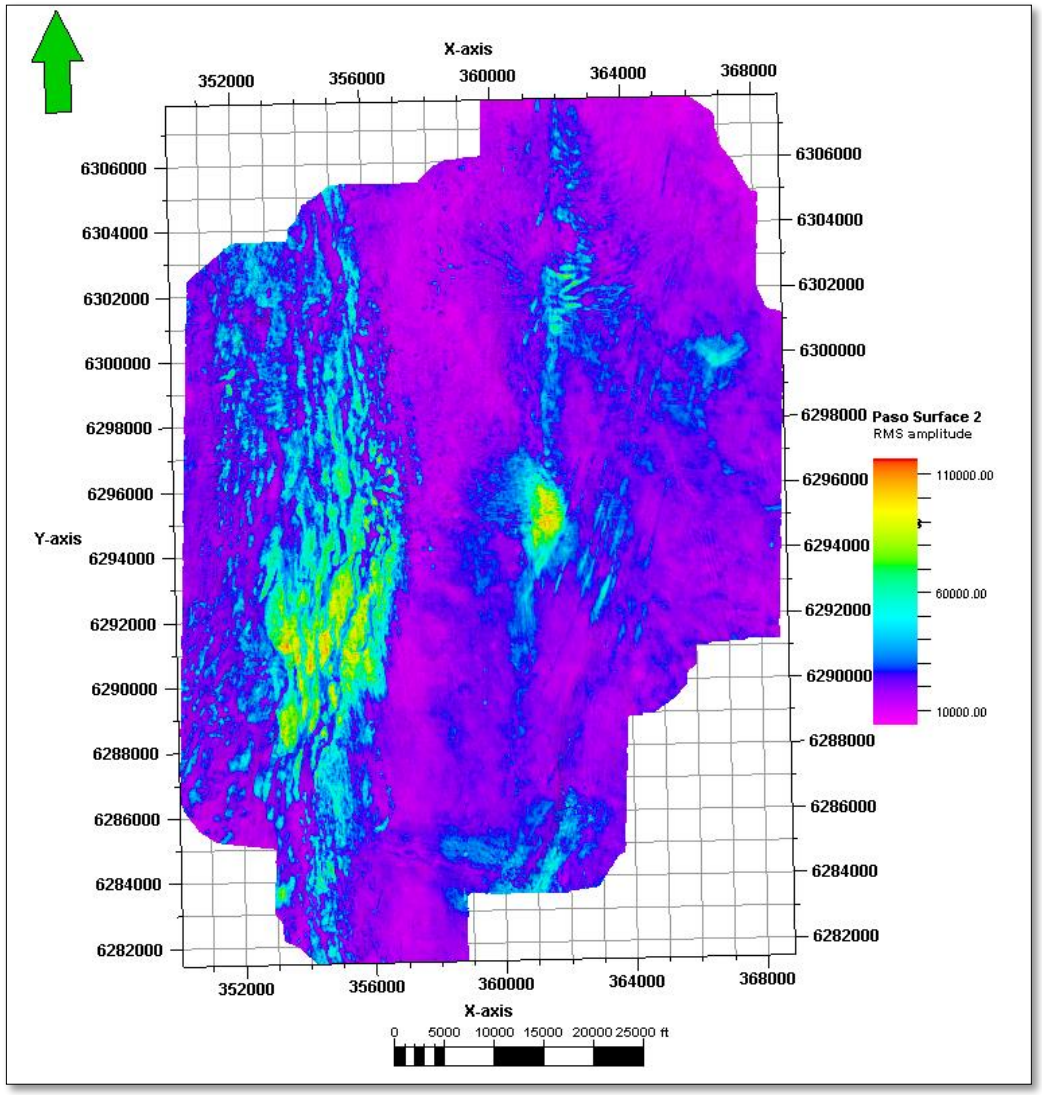
Contents

Overview

- The Paso Anomaly is located in the overburden of the Catcher Field Area, Central North Sea at a depth of ~550m TVDss
- It is a high-amplitude soft reflector thought to be representative of shallow gas and has been historically been avoided during drilling
- There is uncertainty whether the anomaly is truly representative of gas, and if so, how it was generated
- Furthermore, there is has been no interpretation of depositional environment, meaning production potential is unknown



Previous Understanding

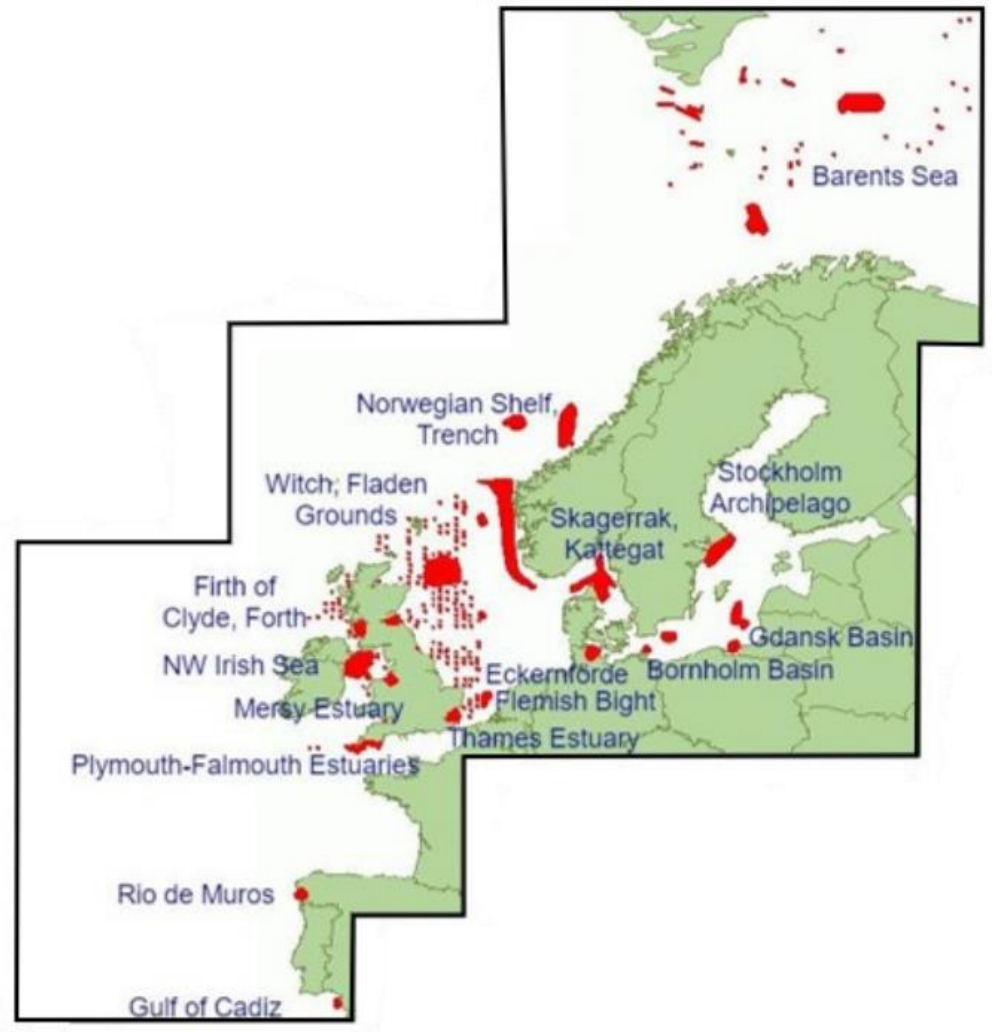


- 2 anomalously high features trending S-N or vice versa seen over an **RMS** amplitude extraction
- No understanding of depositional environments
- No understanding of play elements

Motivation for study – Aviat success

- **With shallow gas being historically regarded as drilling hazards, improvements in technology have led many operators to reconsider them as economic prospects for commercial and fuel gas purposes (e.g. Aviat and Netherlands shallow gas fields)**

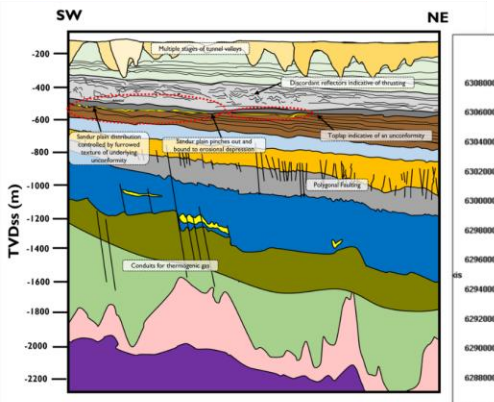
- **With the FPSO currently using produced gas for fuel, and forecasts demonstrating that Catcher may go gas deficient in the near future, there is an increasing need to evaluate owned resources as potential reserves of fuel gas**



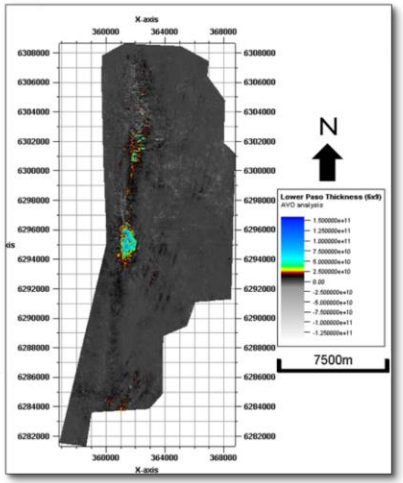
Modified after Fleischer et al., (2003).

Methodology

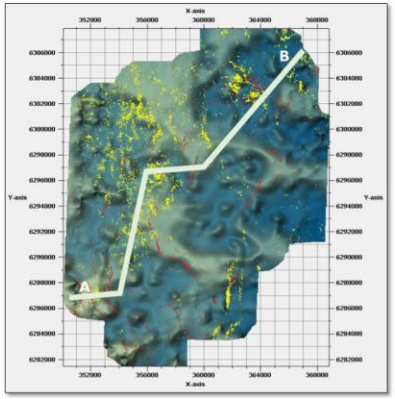
Understanding the stratigraphic context and distribution of the Paso Anomaly

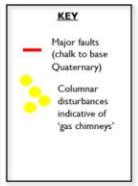


Determination of gas

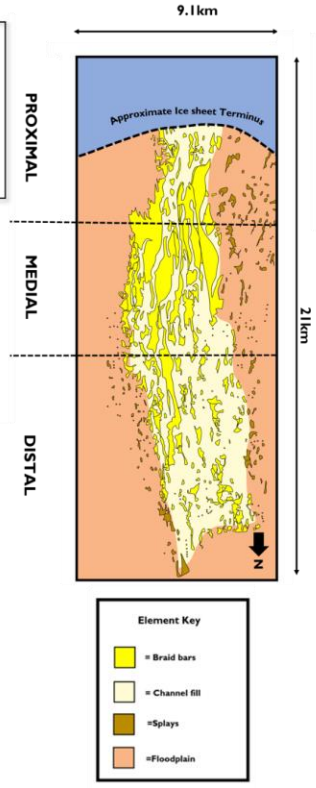


Why is gas present in the shallow subsurface?

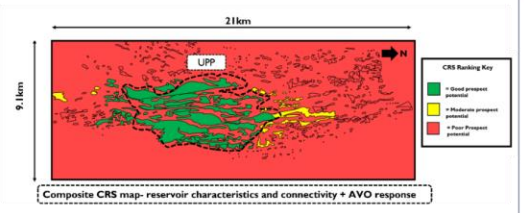


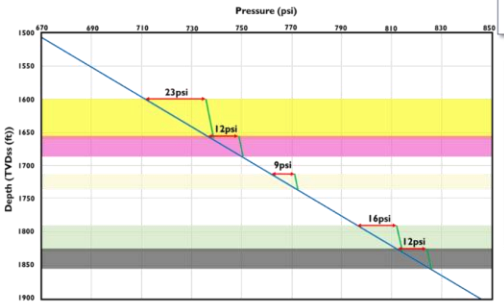


GDE mapping

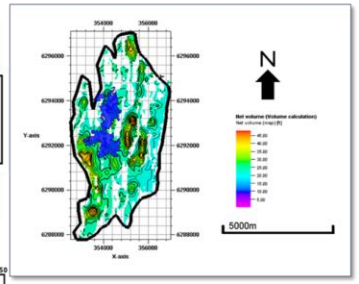


Reservoir, sealing and trapping mechanisms

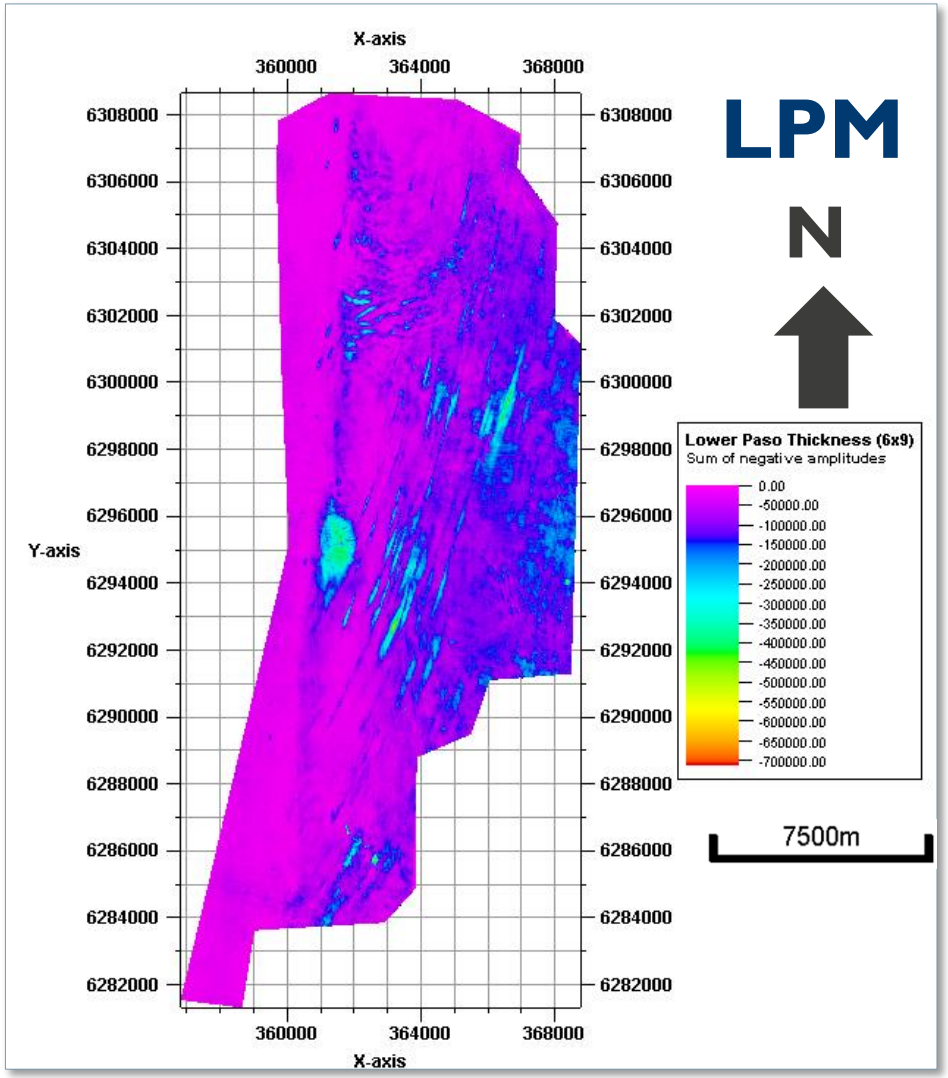


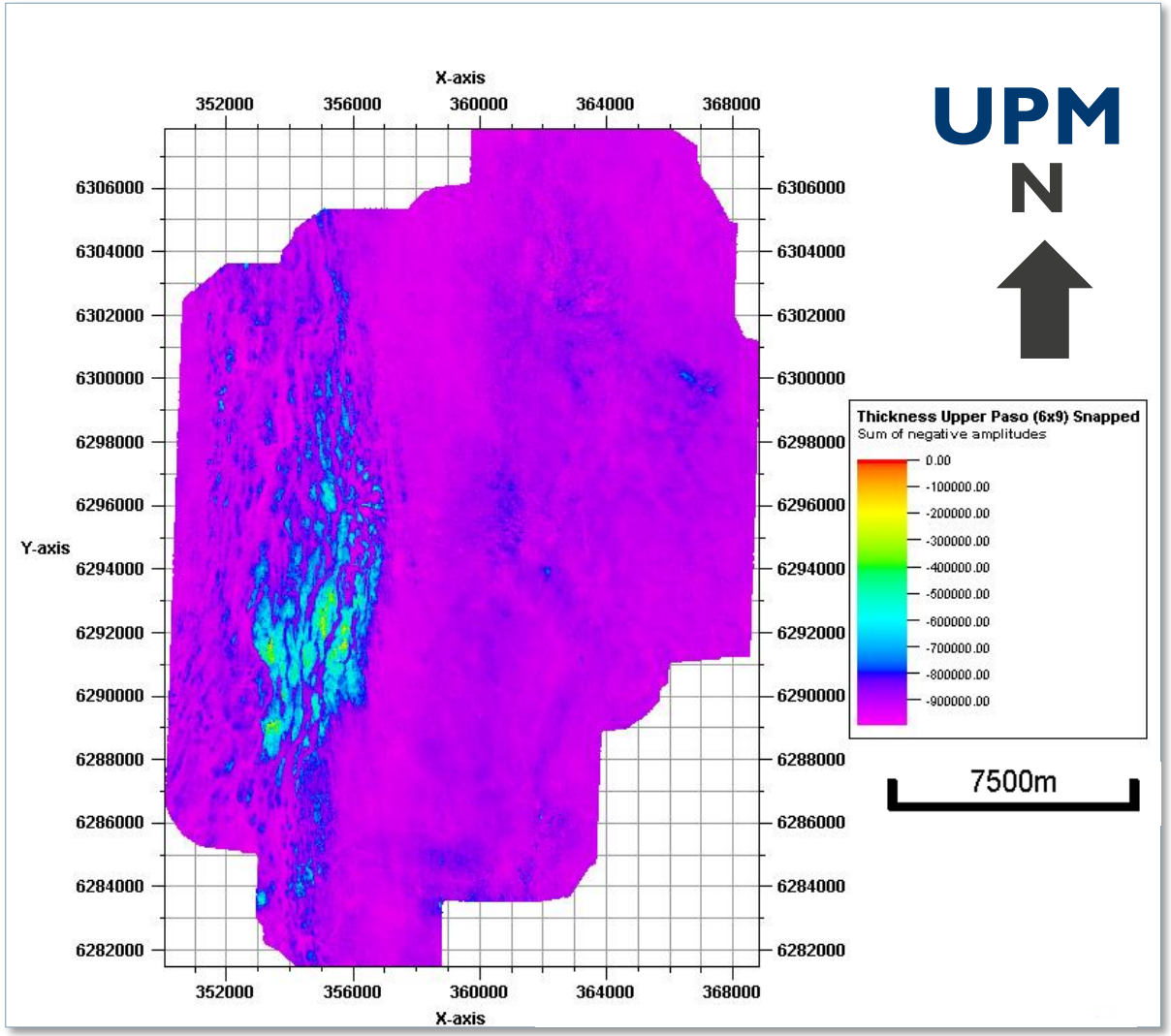


Commercial feasibility



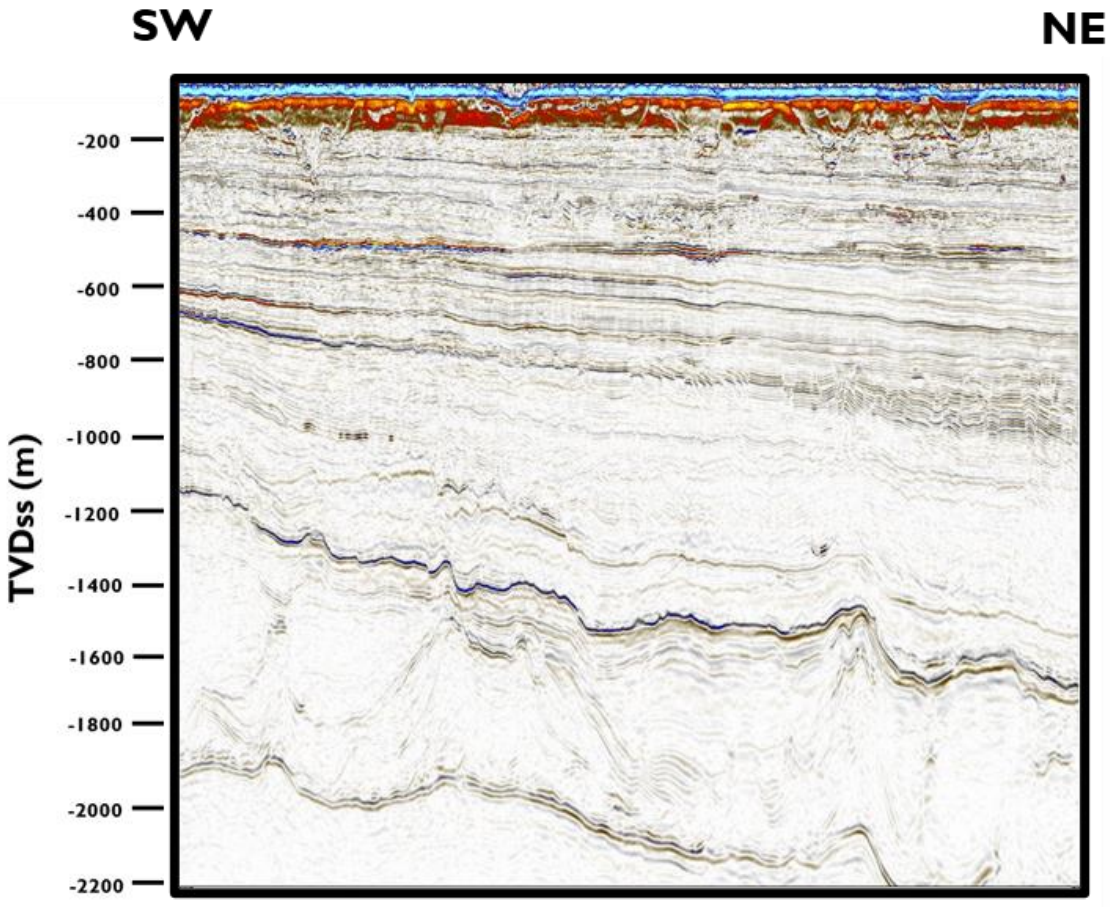
New Understanding- Upper and Lower Paso Mbrs

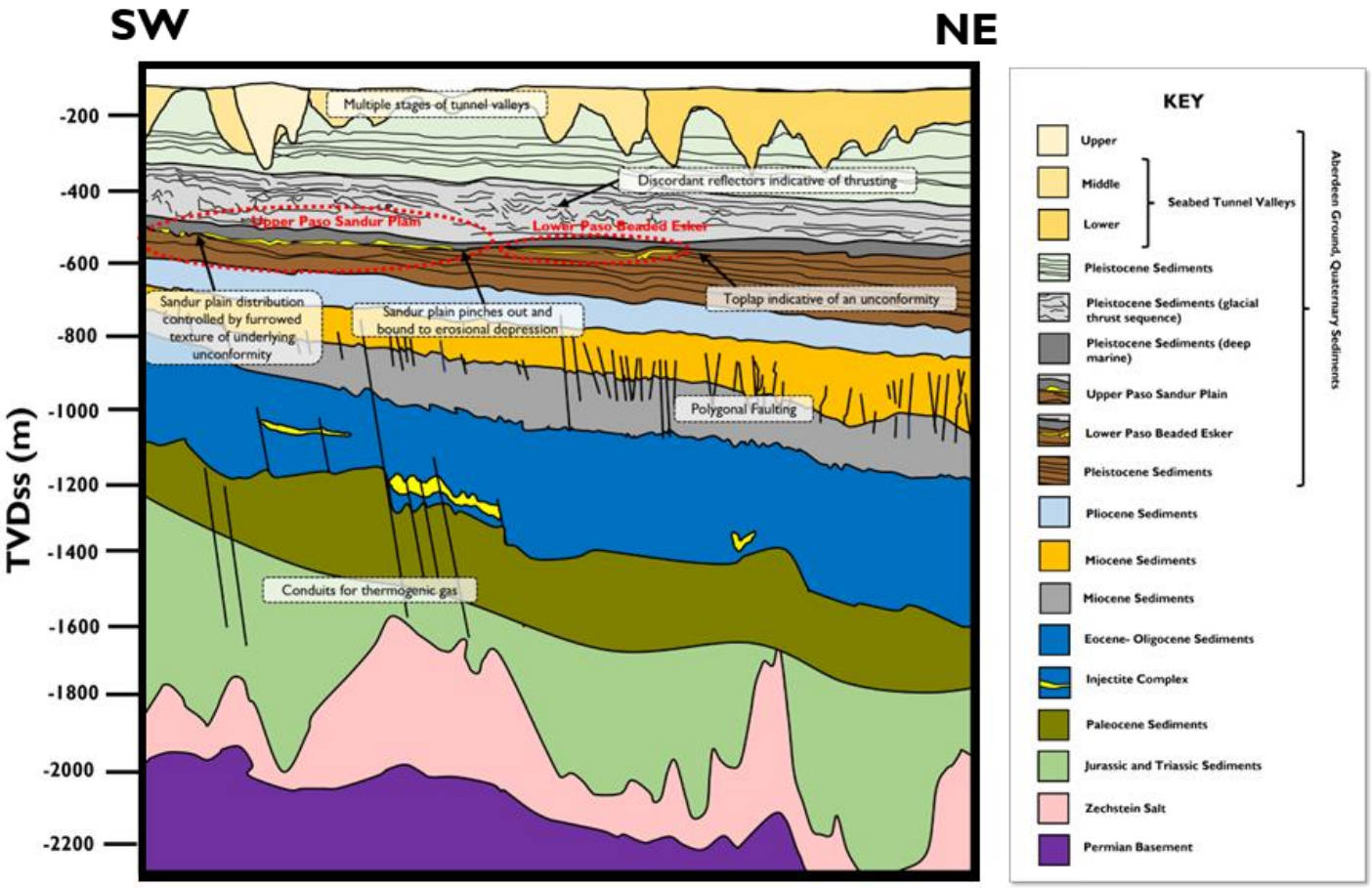




- **2 anomalies viewed in an SNA extraction at two stratigraphic levels, associated with an Upper Paso Member (UPM) and a Lower Paso Member (LPM)**

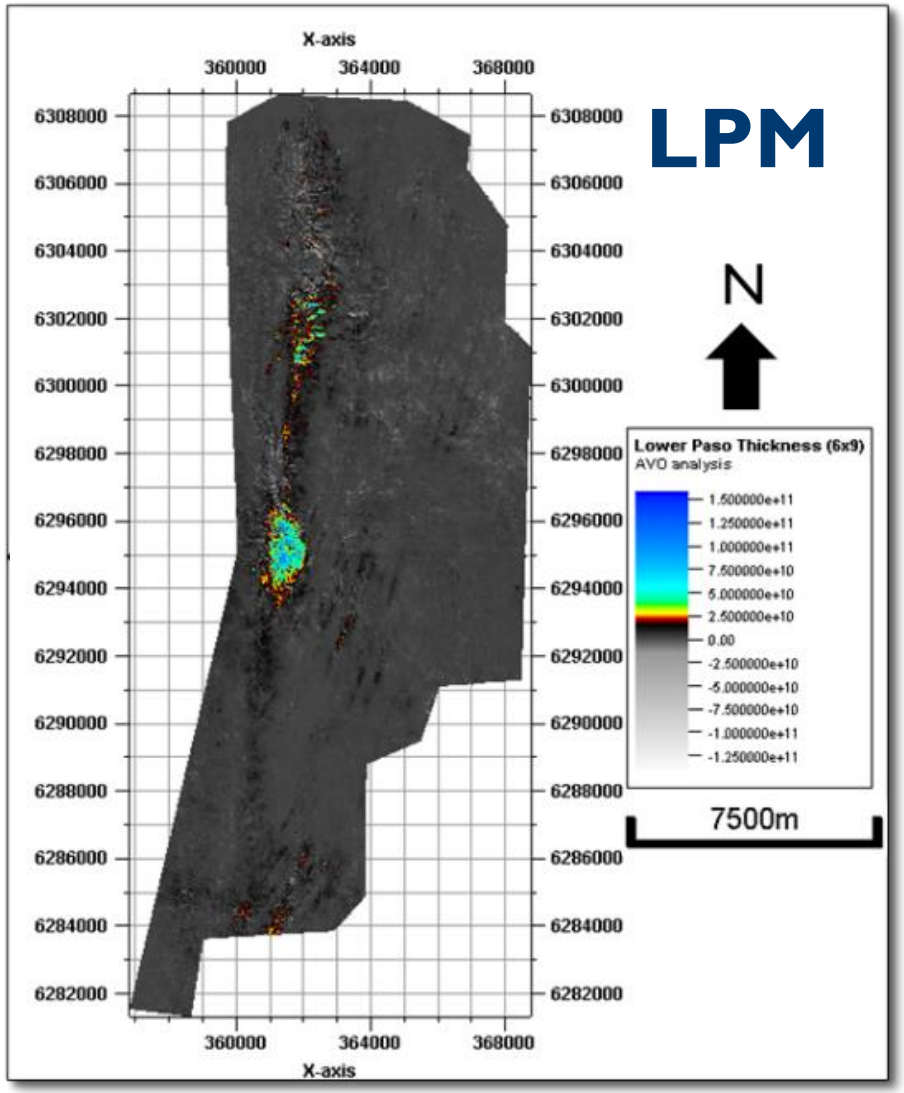
New Understanding- Upper and Lower Paso Mbrs

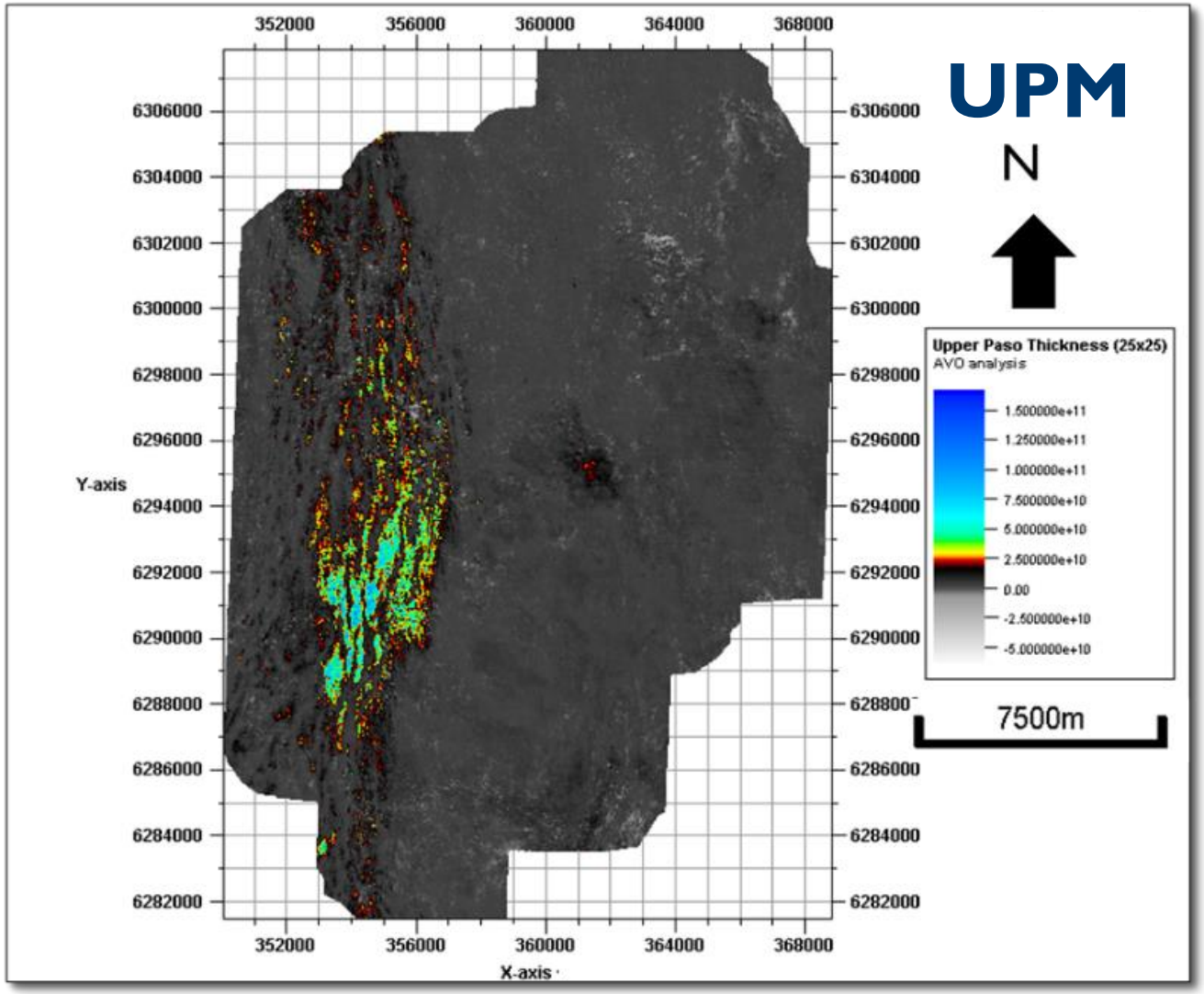




Contents

AVO Analysis

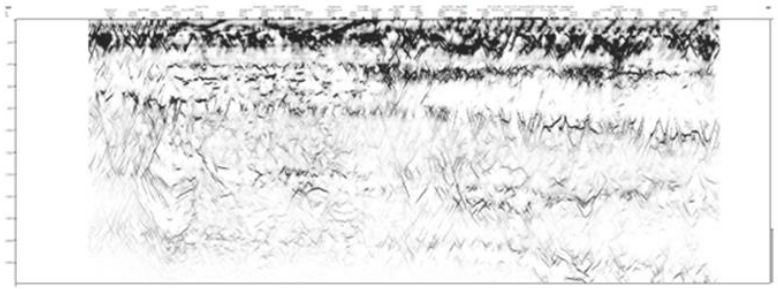




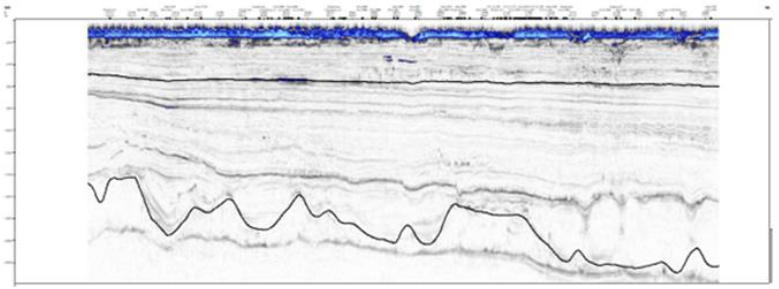
- **Both UPM and LPM show high negative amplitudes on a product volume cube, indicating a class III AVO response suggestive of a gas-filled sand**

Assessing Gas Origin- Thermogenic

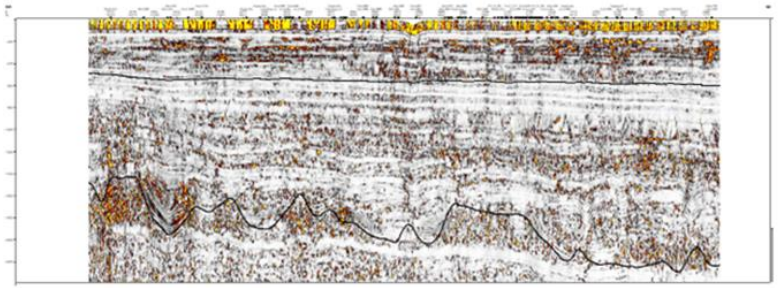
Fault Volume



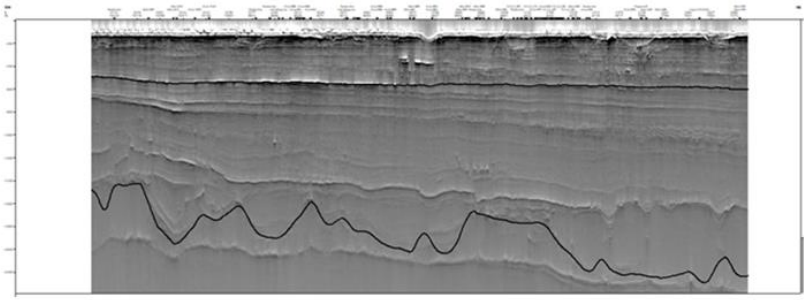
Sweetness



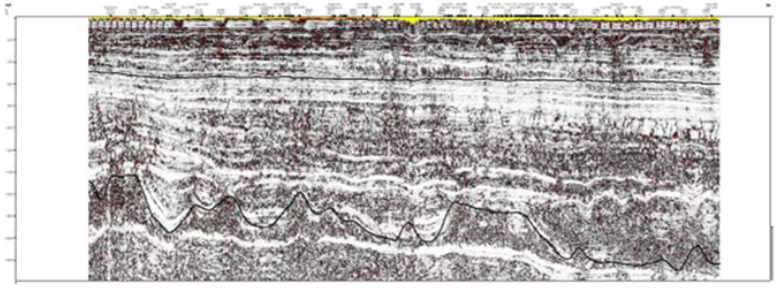
Variance



Outcrop

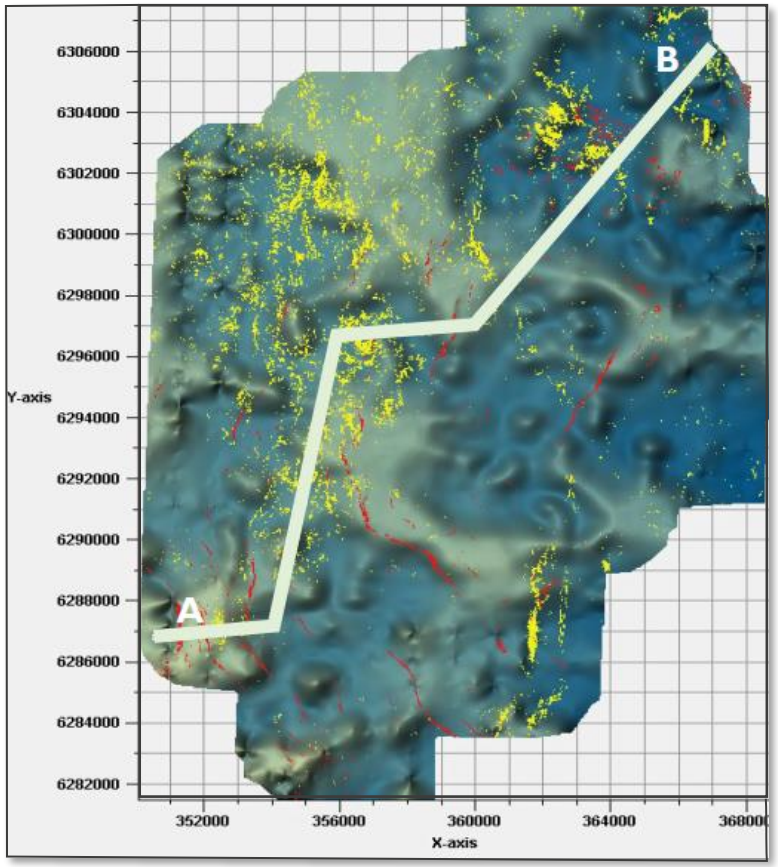


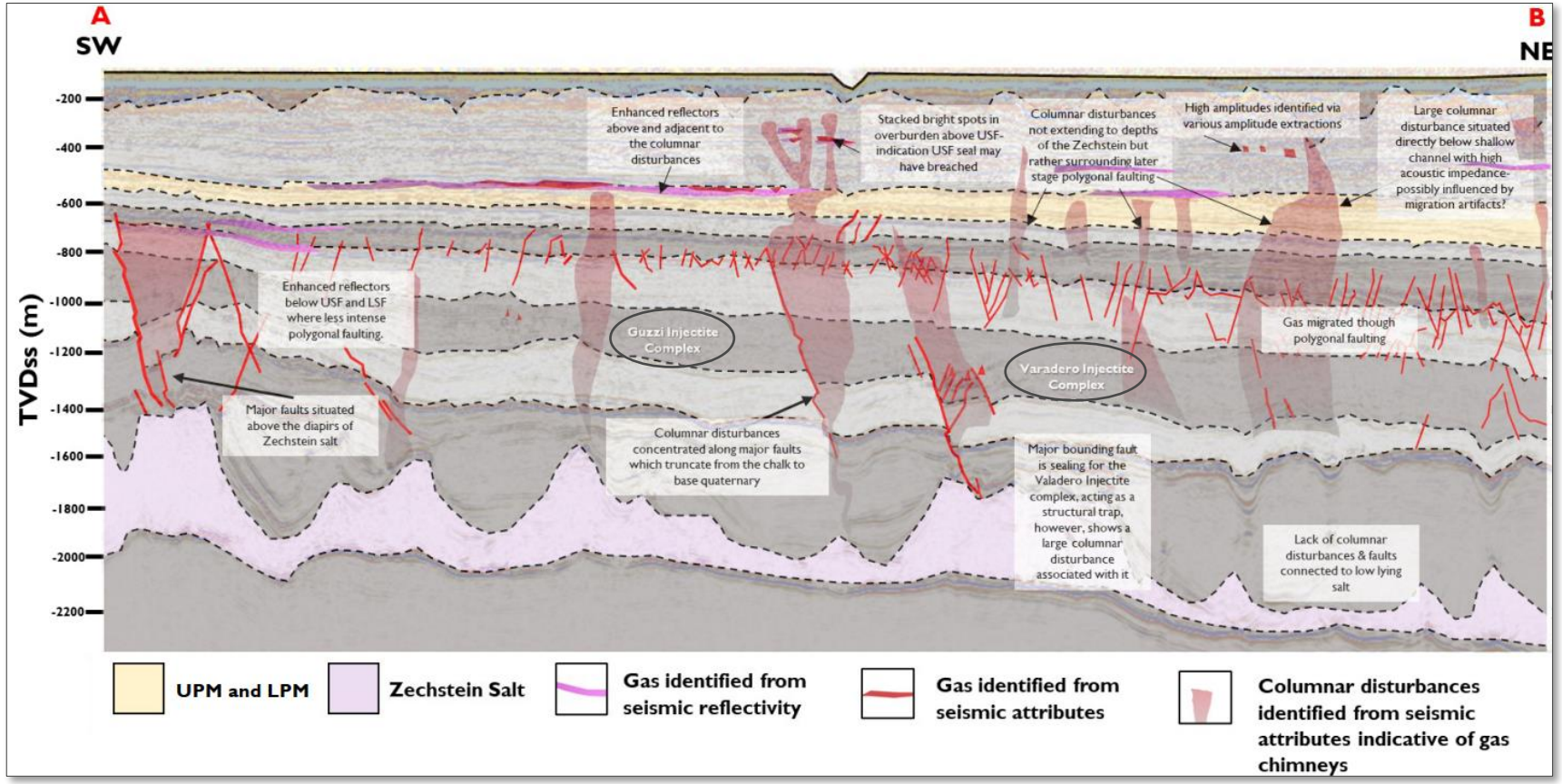
Chaos

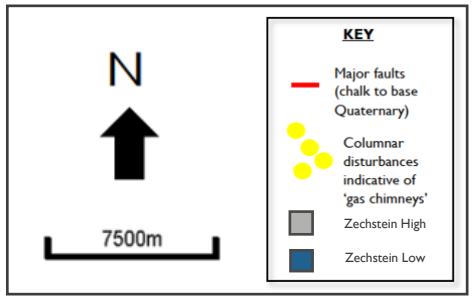


Amplitude Extractions

Assessing Gas Origin- Thermogenic

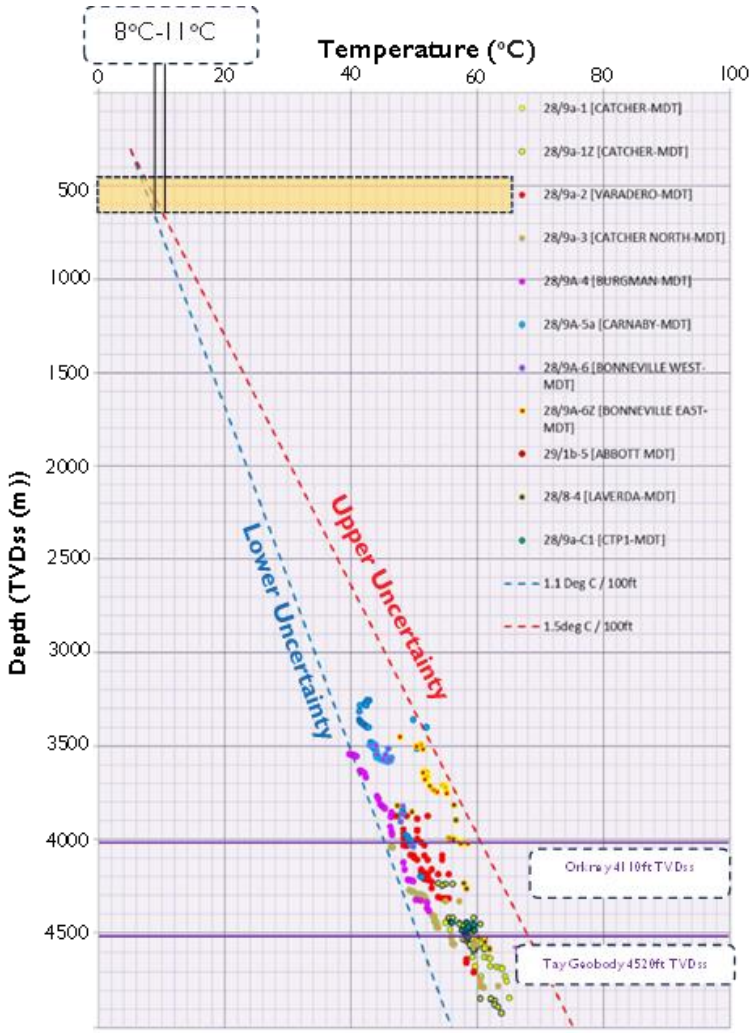






Assessing Gas Origin- Biogenic

	Upper Paso Member			Lower Paso Member		
Well	**Lithology**	**Total gas % EMA**	**Gas Composition (ppm)**	**Lithology**	**Total gas % EMA**	**Gas Composition (ppm)**
28/9a-5a	Mudstone	0.05	NA	Not Present	Not Present	Not Present
28/9-4	Mudstone	1.5	Methane (15500)	Not Present	Not Present	Not Present
28/4-4	Siltstone	0.7	Methane (8000)	Not Present	Not Present	Not Present
28/9-2	Mudstone	0.5	Methane (7000)	Not Present	Not Present	Not Present
28/9a-LP1	Siltstone	0.2	Methane (2000), CO_2 (110)	Siltstone	0.5	Methane (6000), CO_2 (1000)
28/9-3	Siltstone	0.3	Methane (2000)	Siltstone	0.4	Methane (3000)



Contents

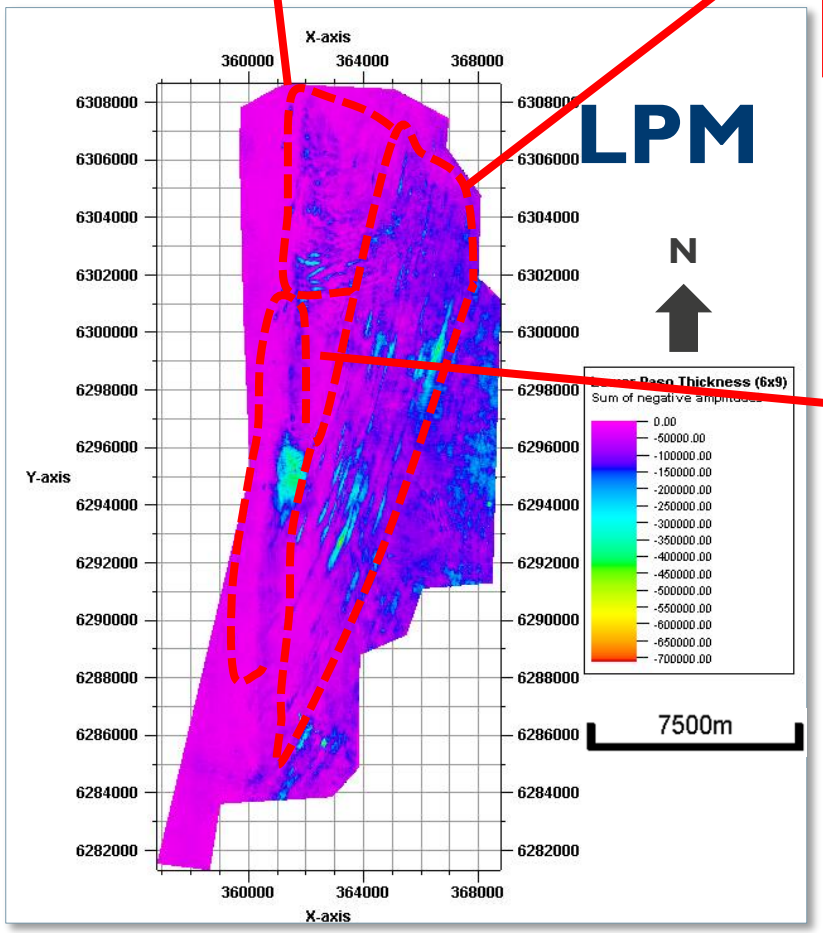
GDE interpretation

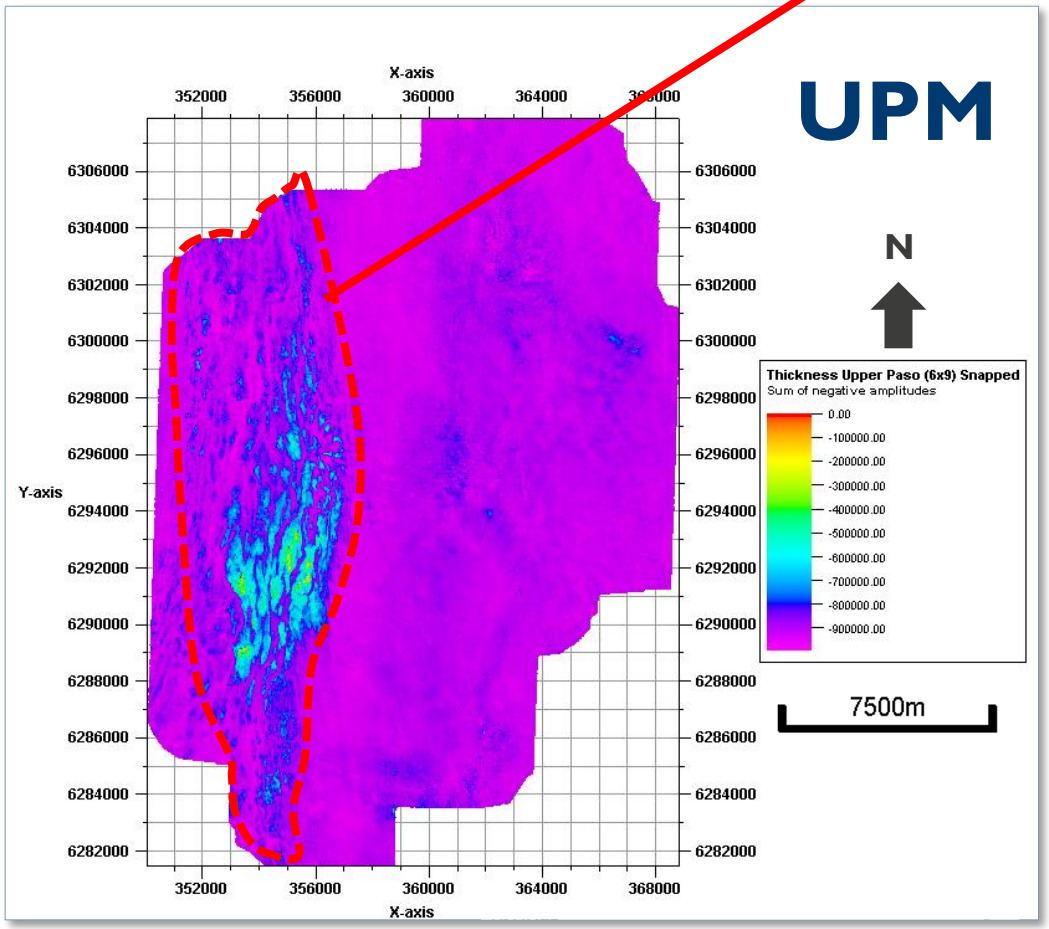
De Geer Moraine

Mega Scale Glacial Lineation's (MSGLs)

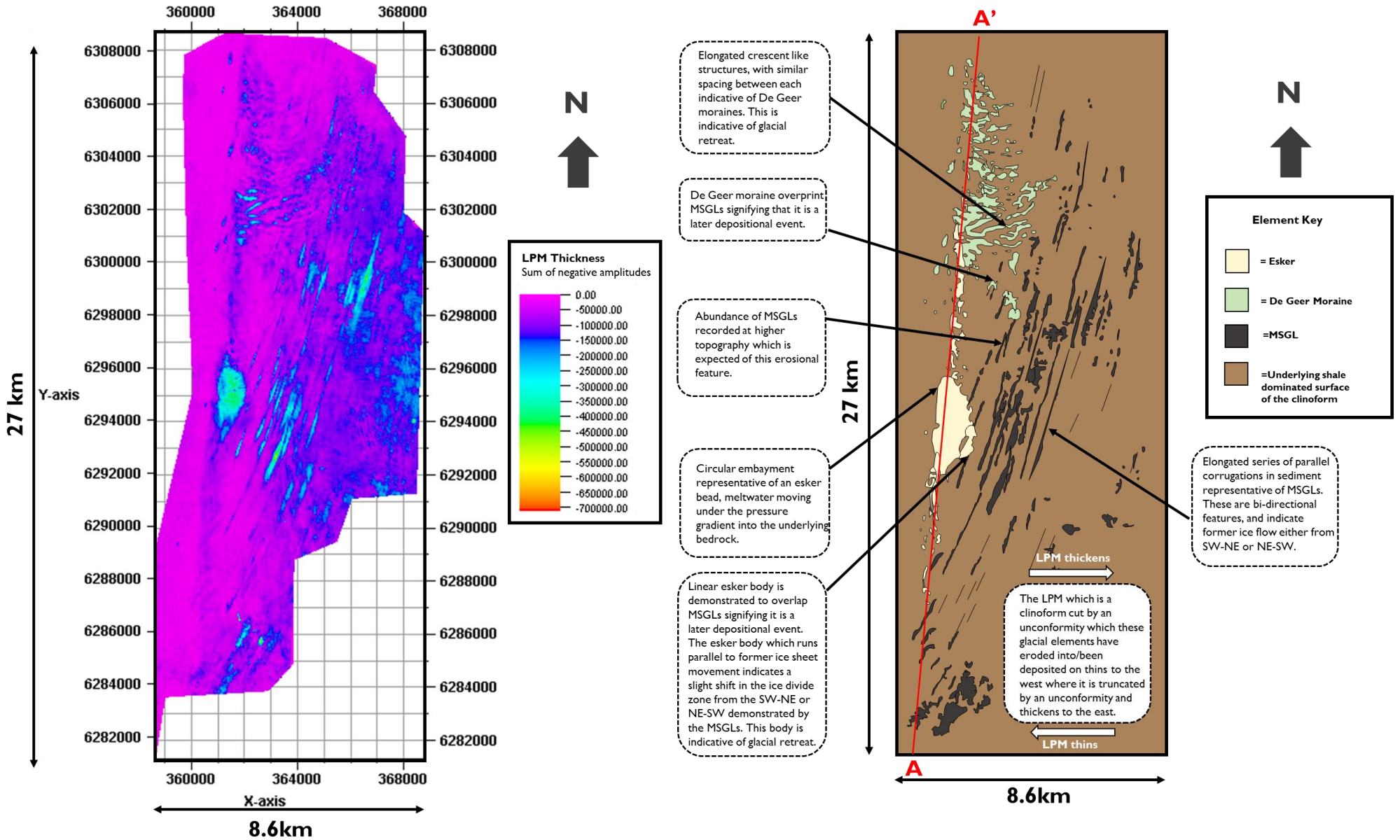
Beaded Esker

Sandur Plain

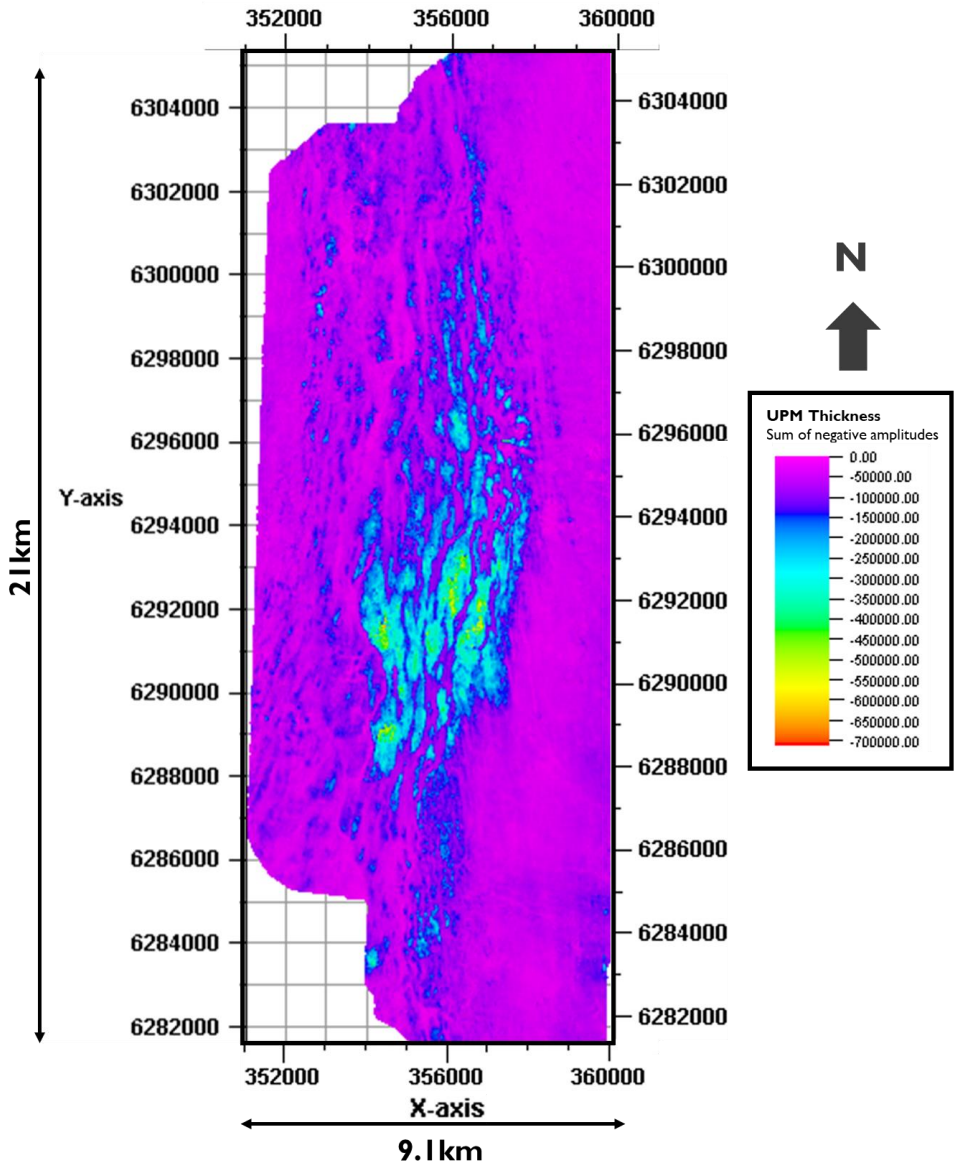


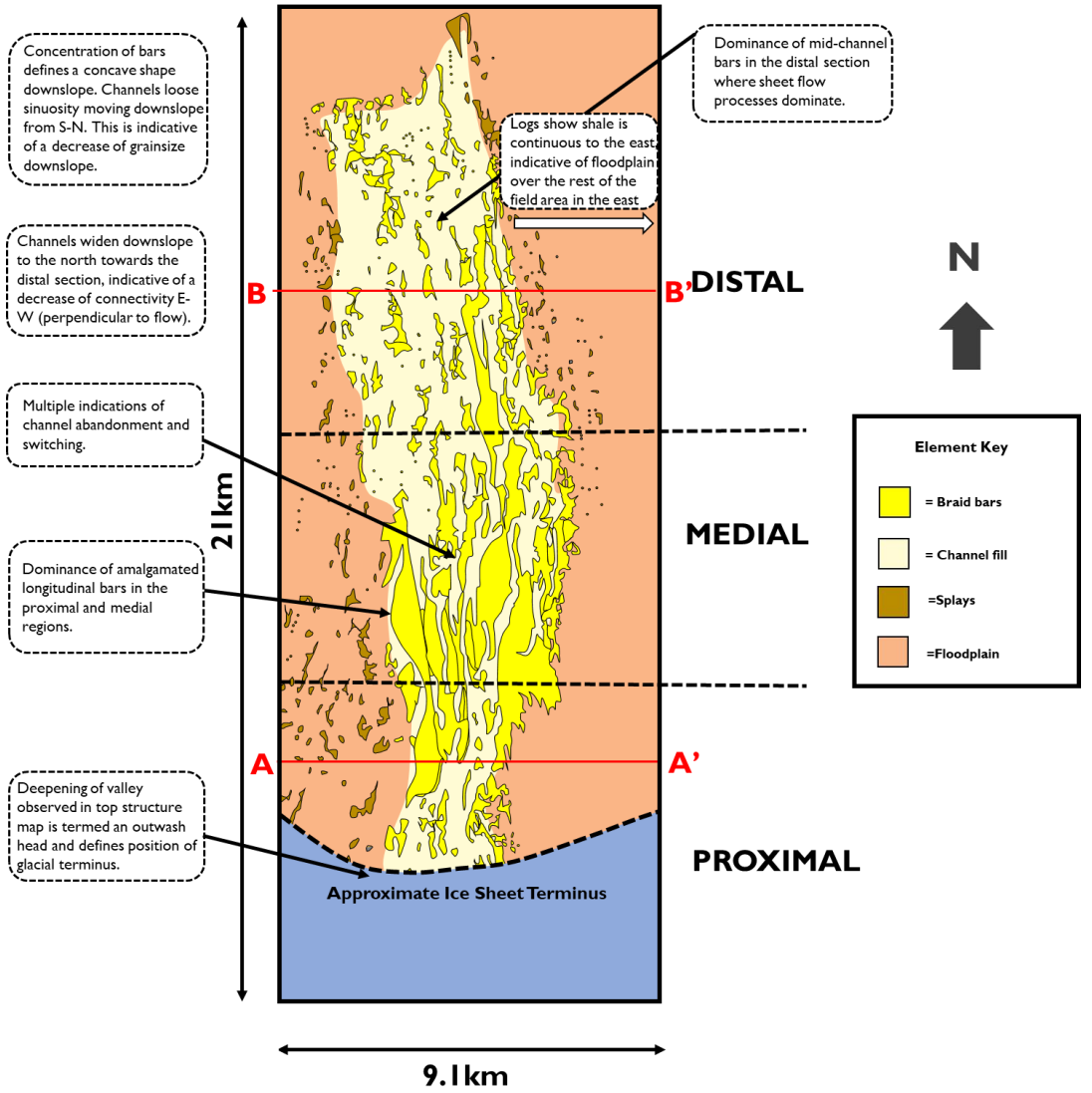


LPM GDE interpretation

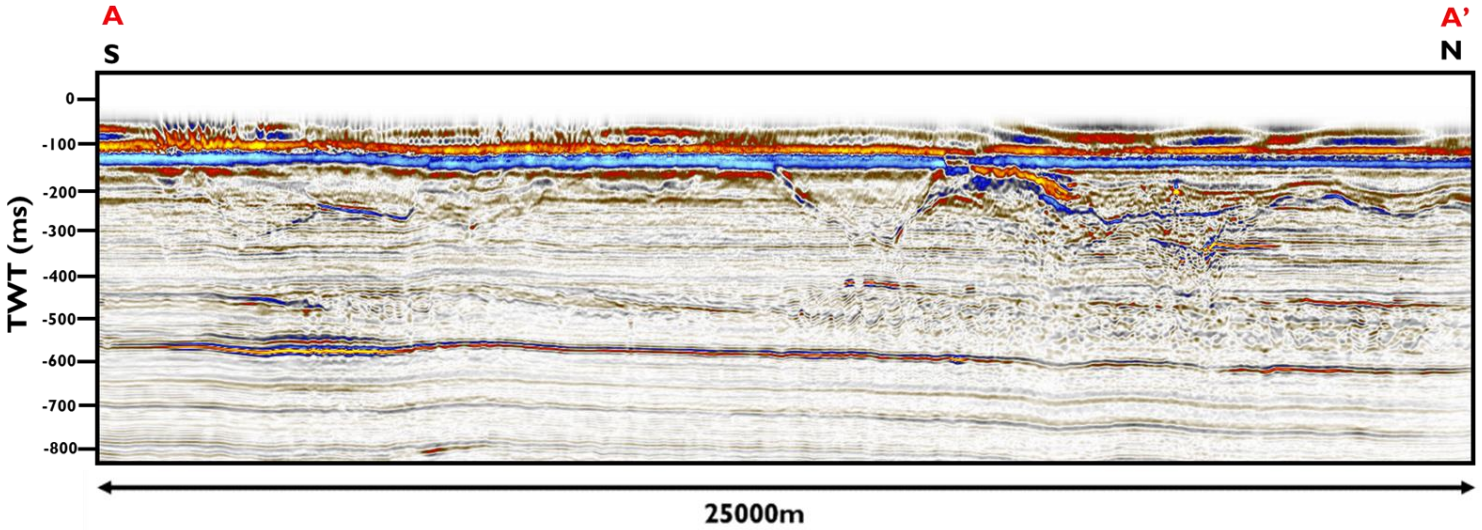


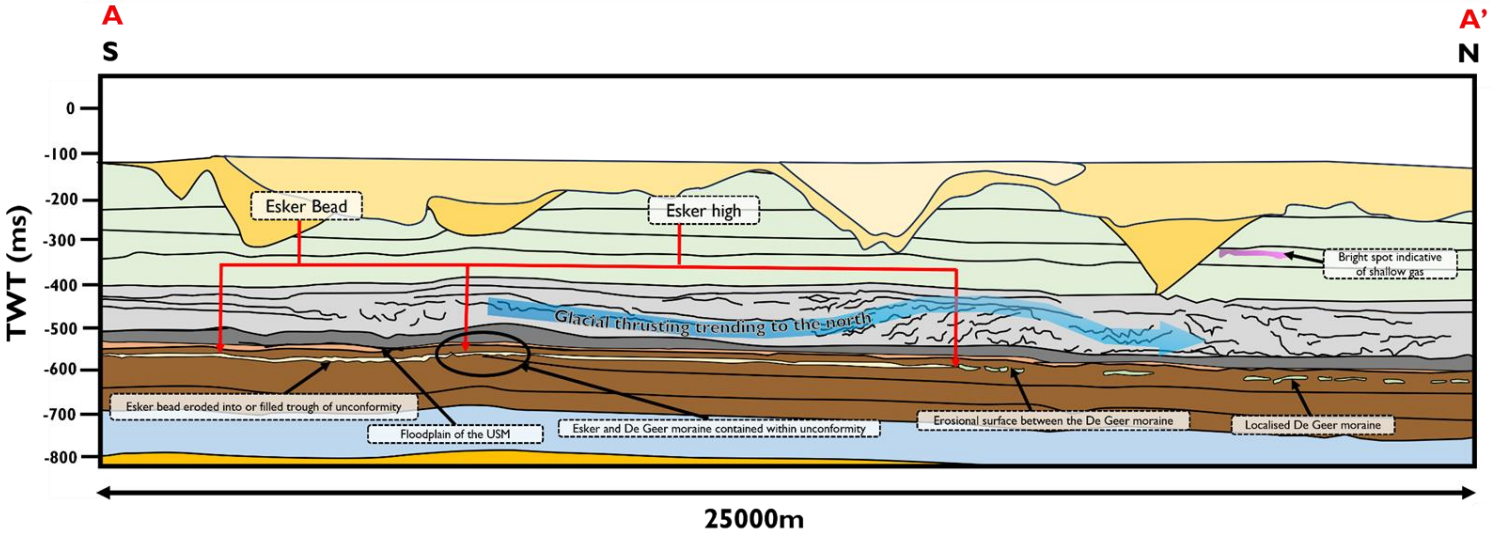
UPM GDE interpretation

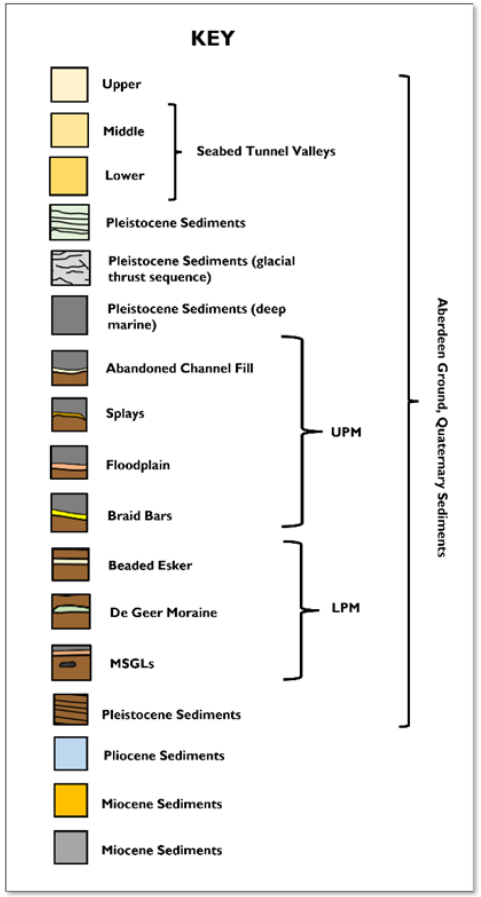


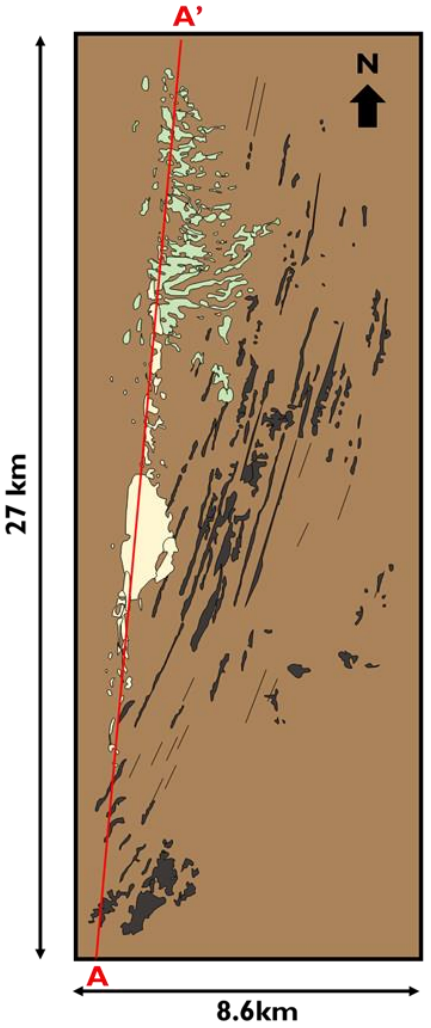


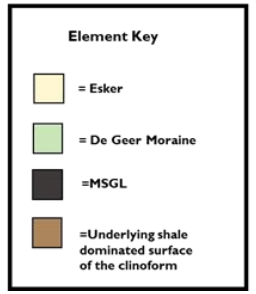
LPM GDE interpretation



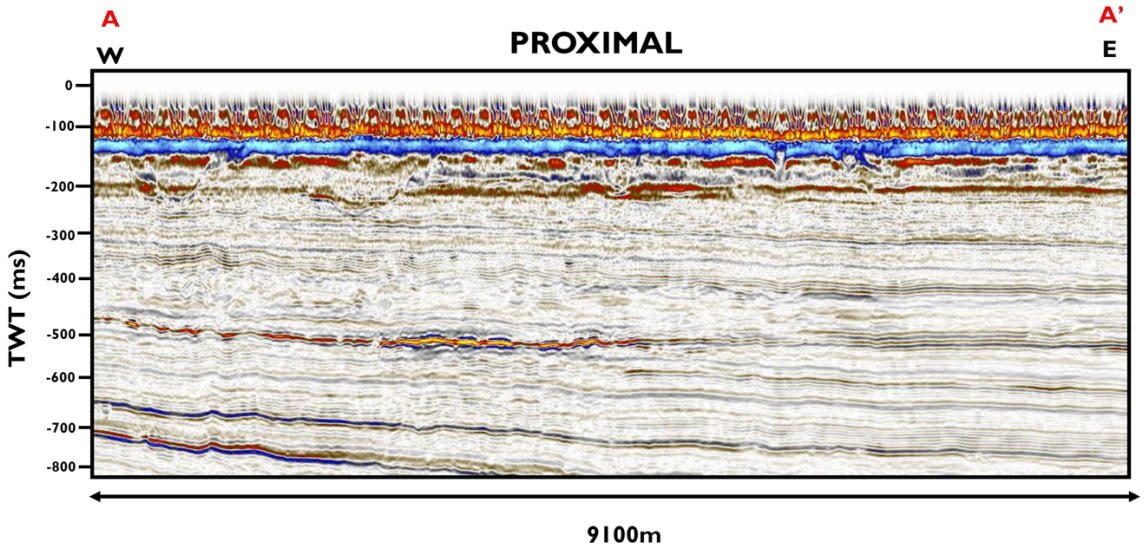


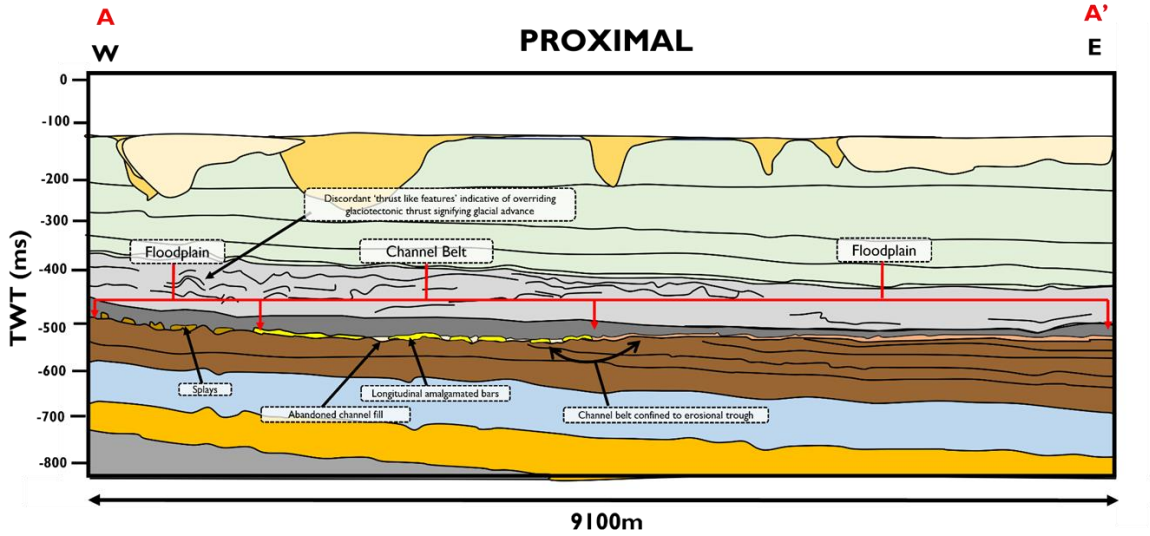


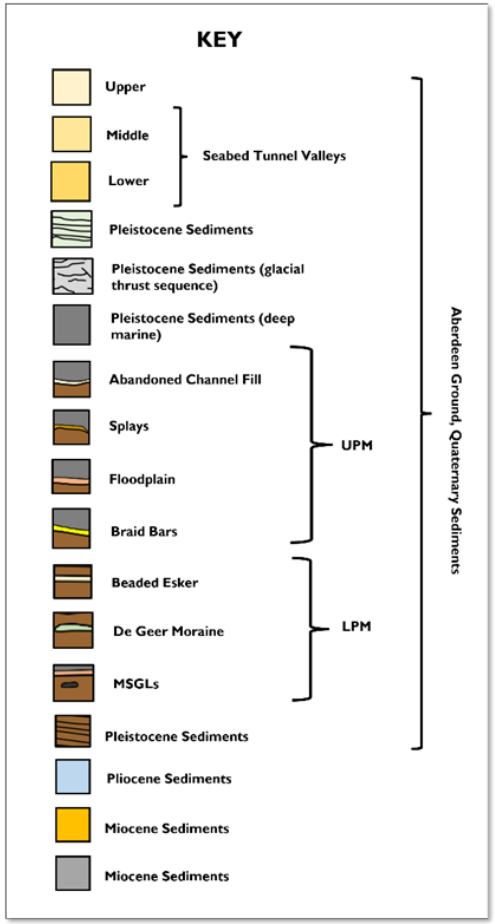


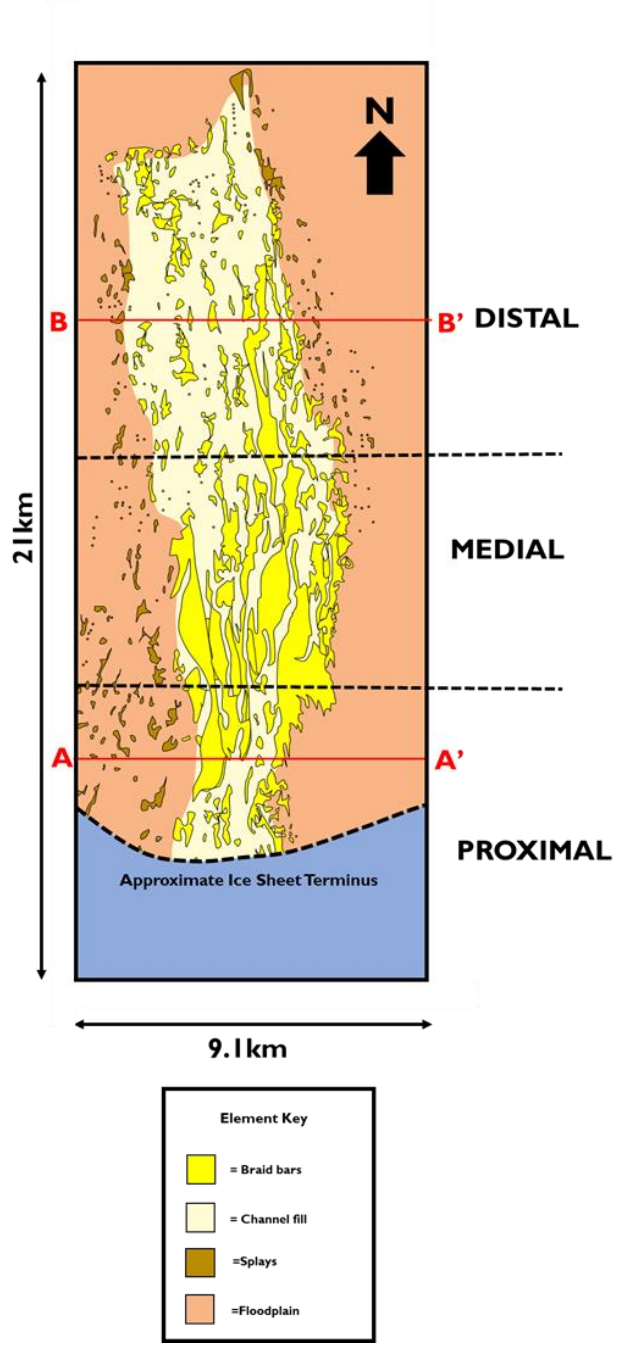


UPM GDE interpretation- Proximal

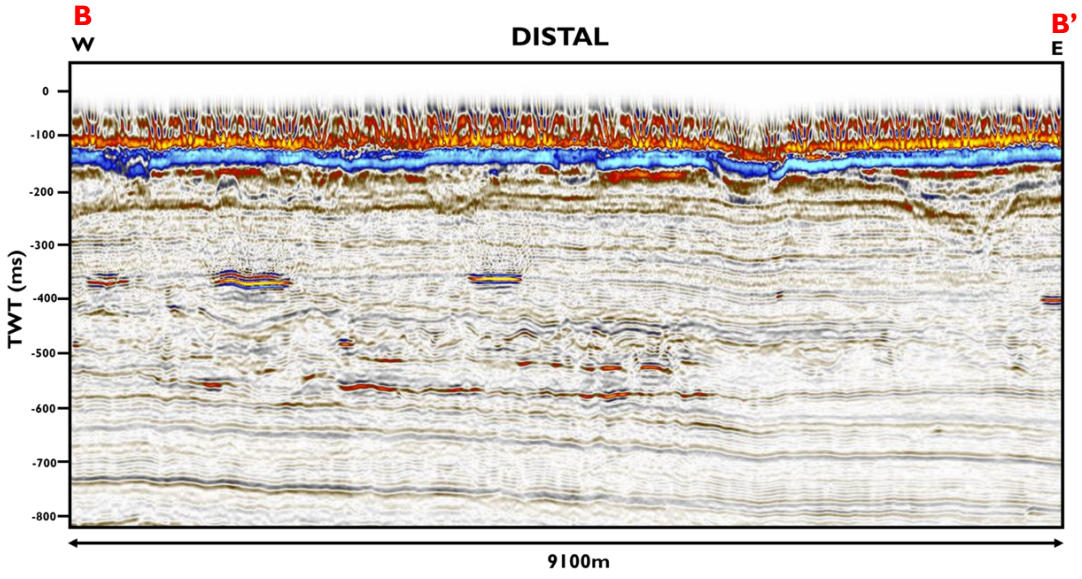


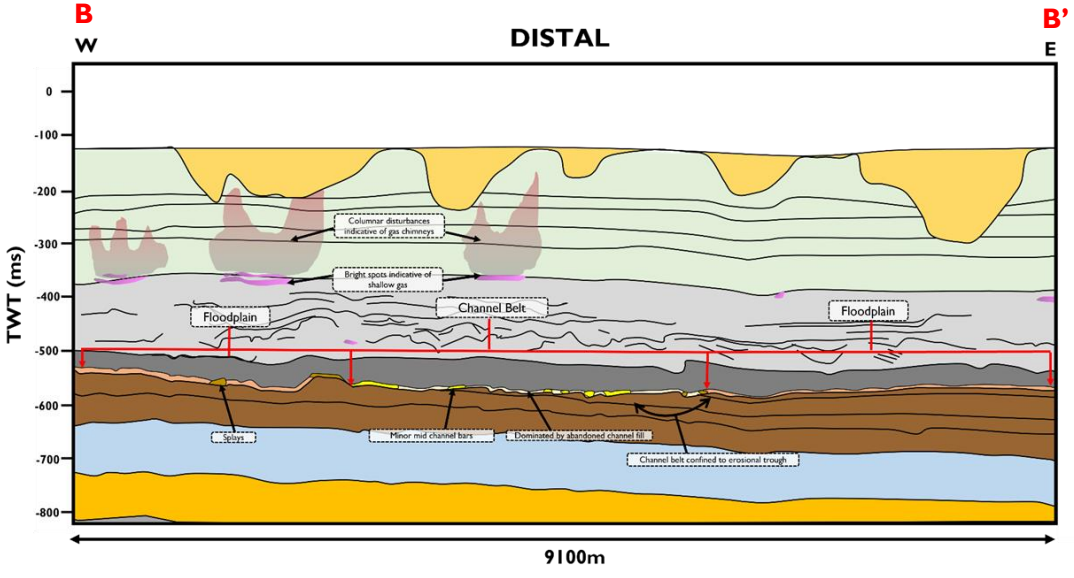


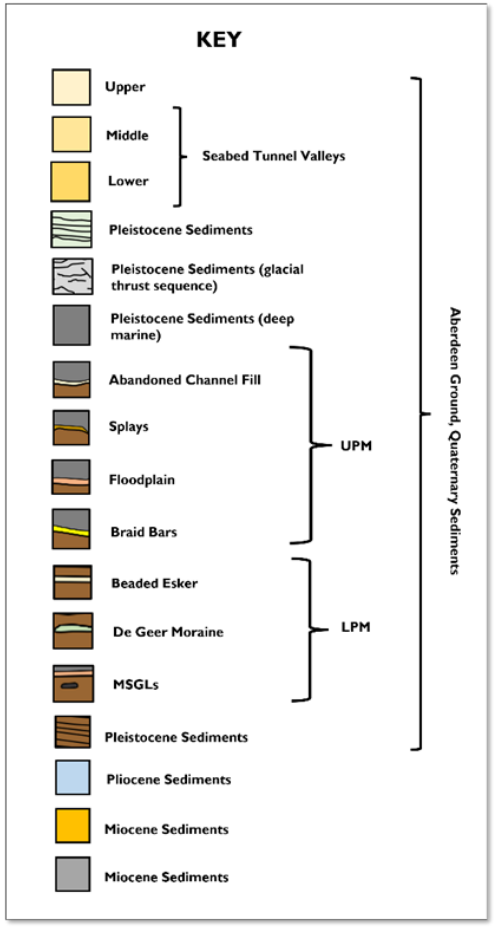


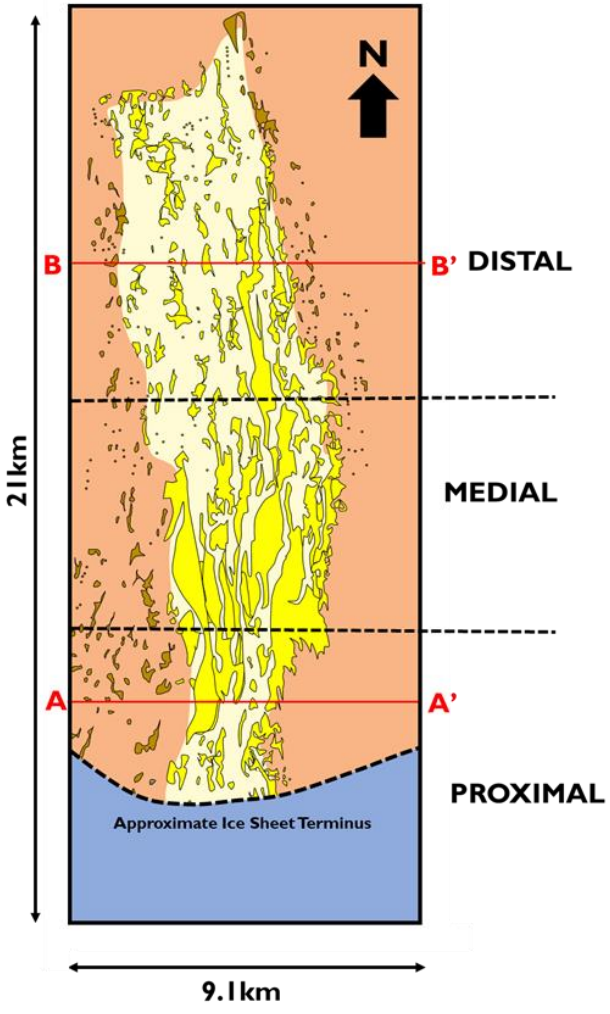


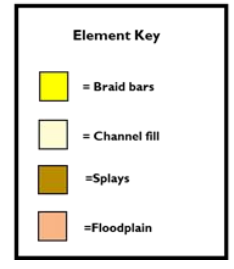
UPM GDE interpretation- Distal



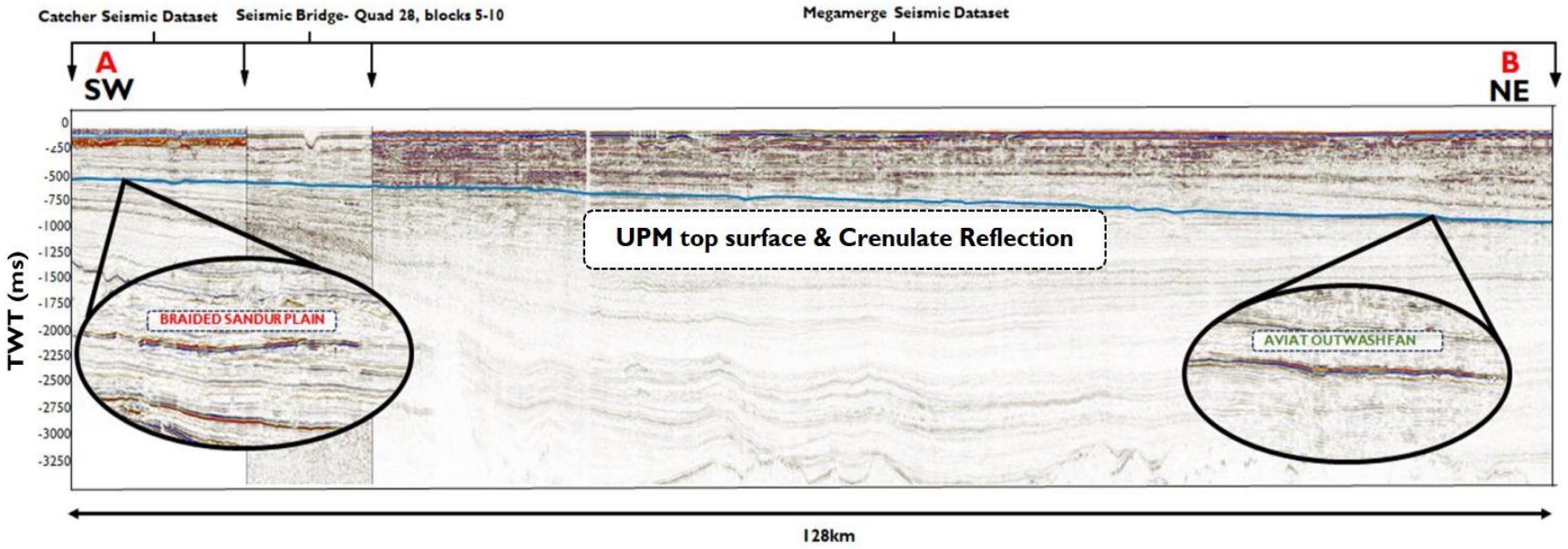


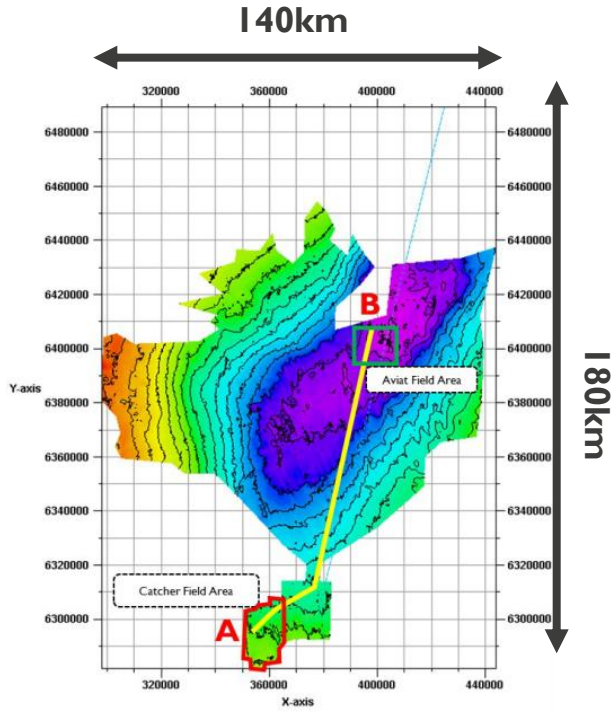






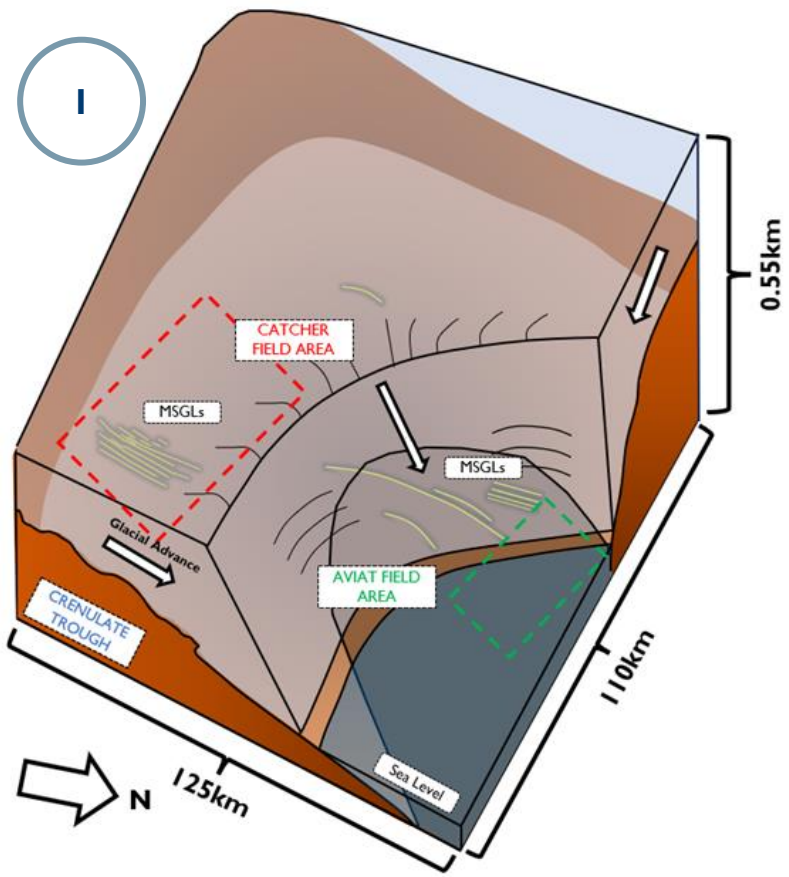
Regional Context



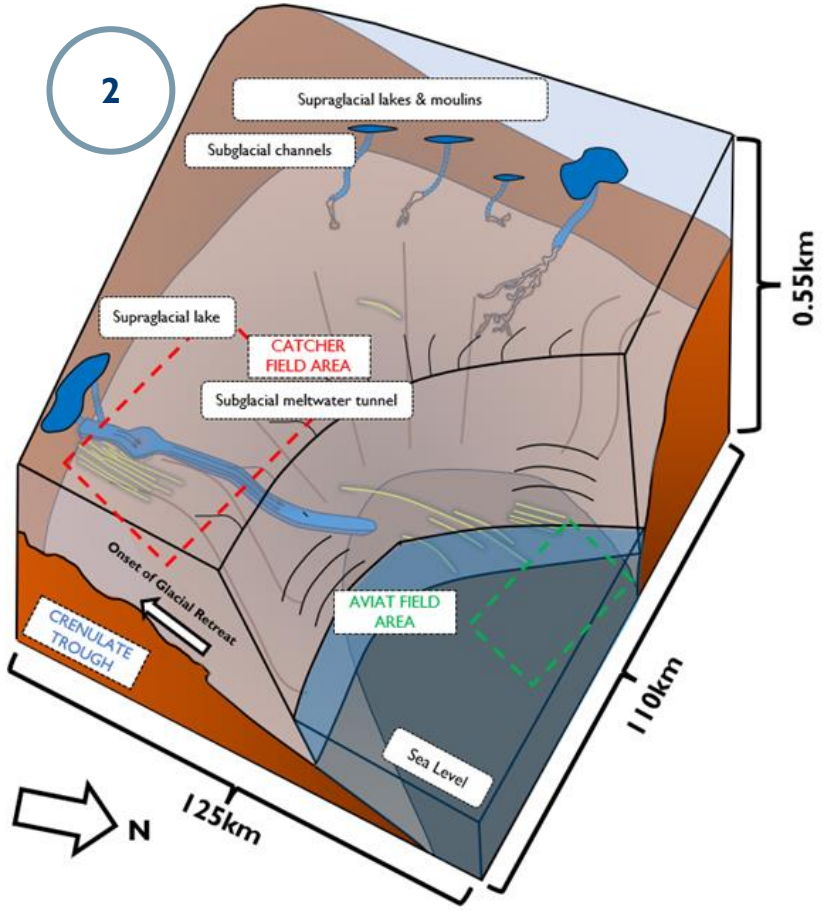


Regional Context

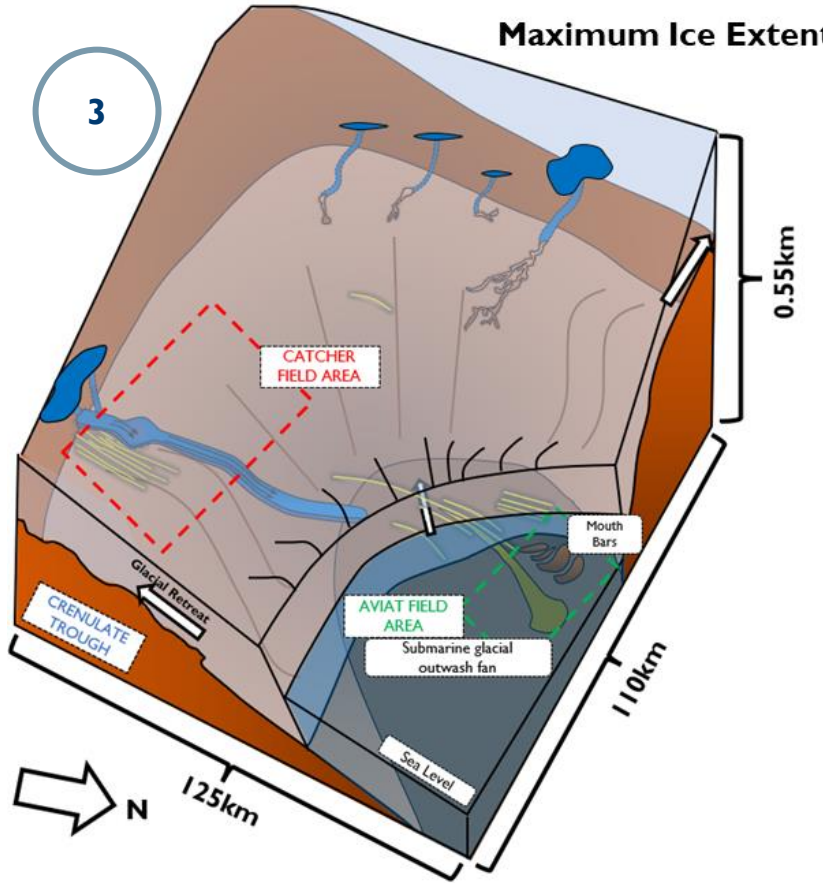
Evolution of the Lower Pleistocene ice stream depositional system responsible for the deposition of UPM, LPM and the Aviat subaqueous glacial outwash fan.



1) Glacial advance (stadial), ice stream advancing from the shoreline towards the Crenulate Trough in a NE direction indicated by the trend of the MSGLs. The ice stream has now advanced into the Crenulate Trough however it is still land terminating.



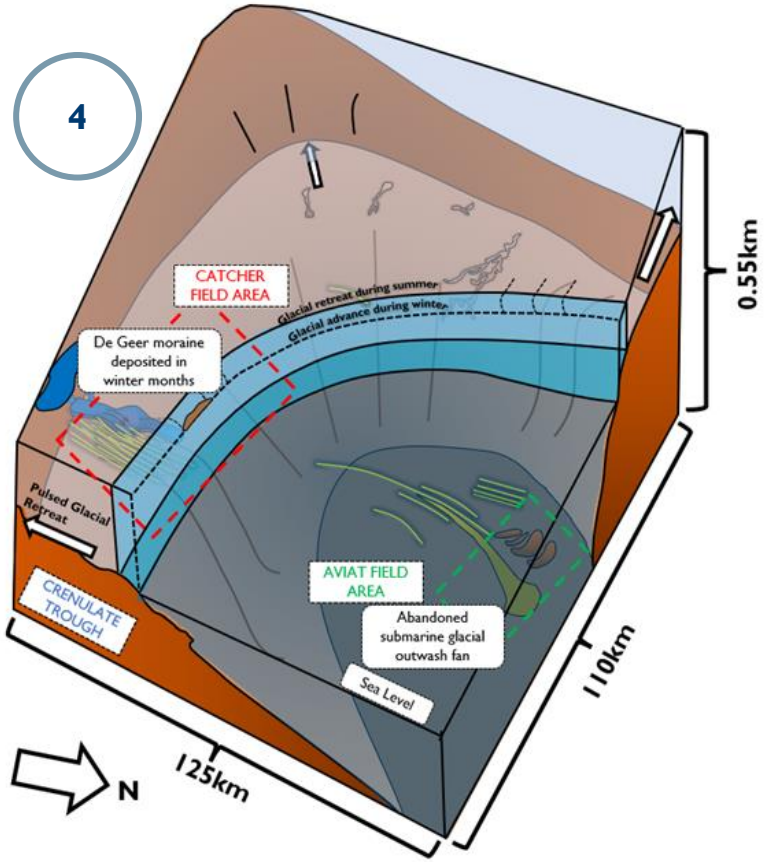
2) Further advance of the ice sheet until its terminus reaches sea level and it begins to recede. Supraglacial melt on the ice stream exploits crevasses and moulins and flows as meltwater to the base of the ice sheet, forming subglacial channels and meltwater tunnels.

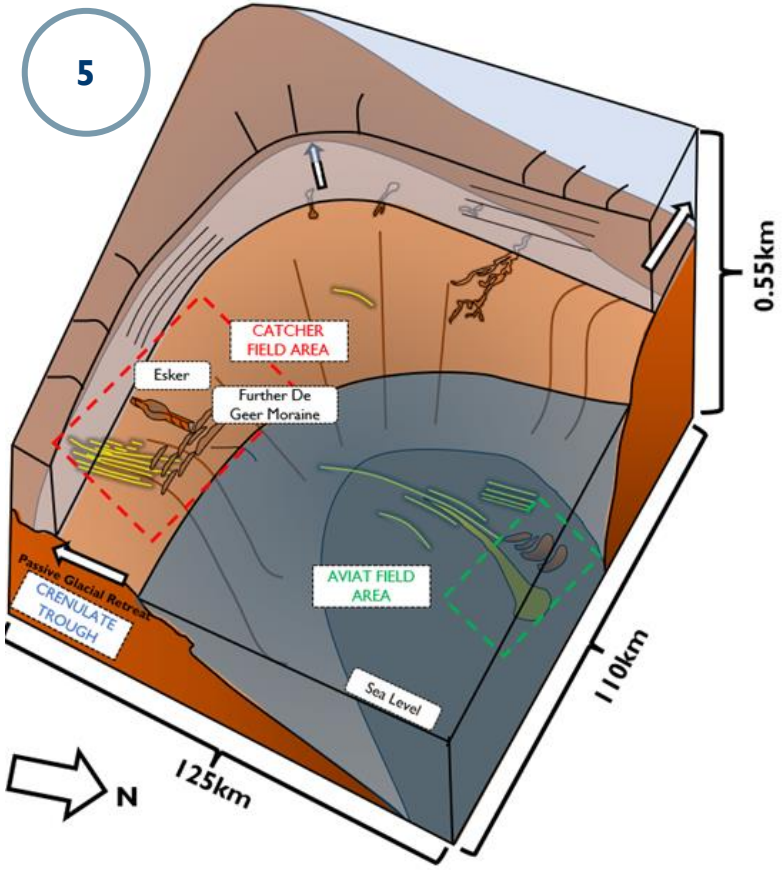


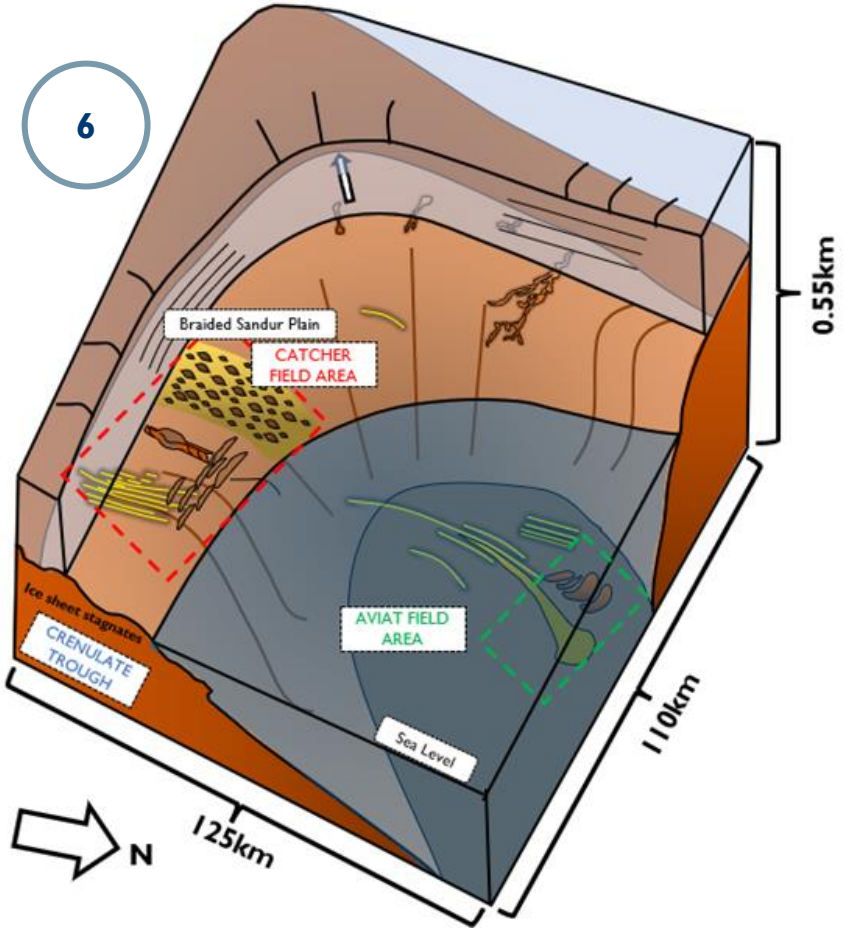
3) Sediment is expelled at the snout of the ice sheet, forming both mouth bars and a subaqueous glacial outwash fan.

Regional Context

Evolution of the Lower Pleistocene ice stream depositional system responsible for the deposition of UPM, LPM and the Aviat subaqueous glacial outwash fan.





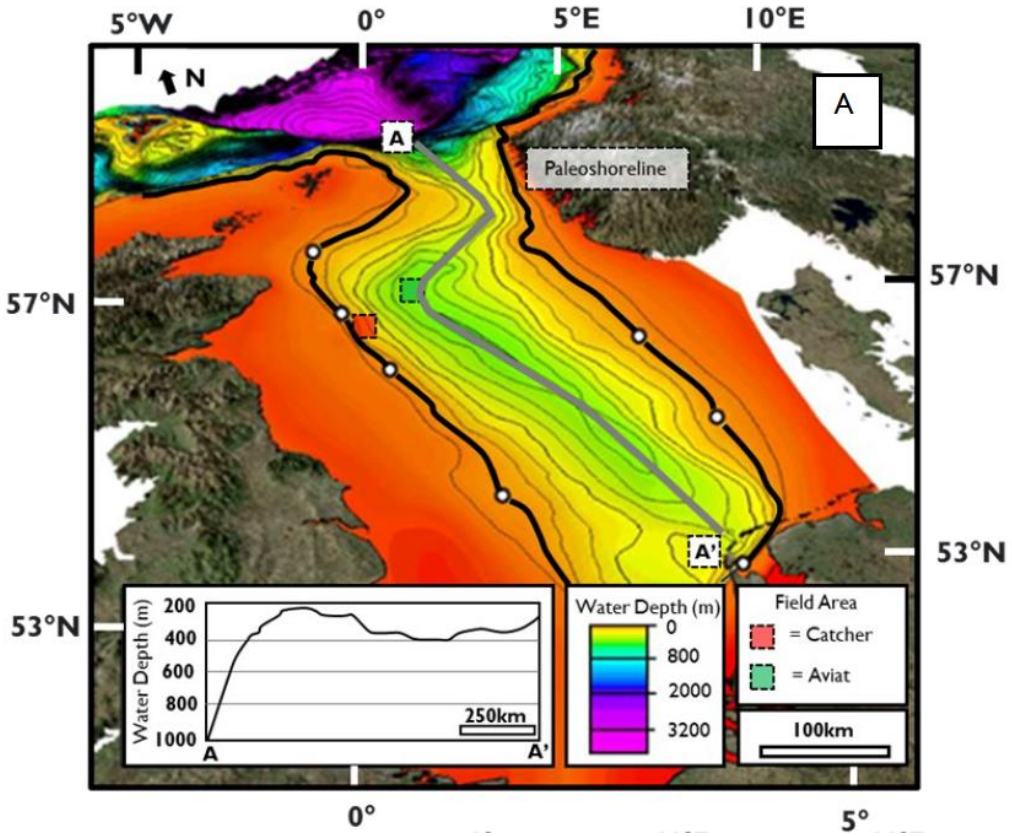


4) The ice stream retreats (inter-stadial) to the Catcher Field Area, switches off, and undergoes a pulsed retreat, with small advances during the winter forming De Geer moraines.

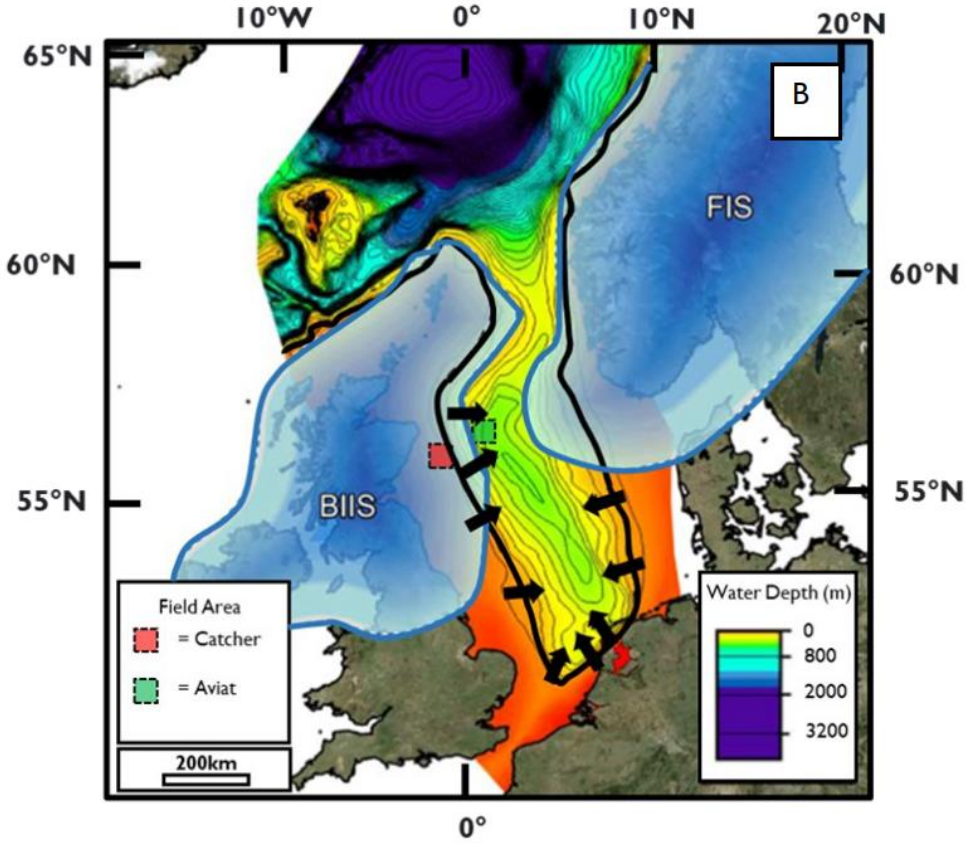
5) The ice sheet undergoes a passive retreat to the slopes of the Catcher Field Area, forming an esker.

6) The ice sheet stagnates and forms a braided sandur plain at its terminus.

Wider Glacial Context



A: Lower Pleistocene bathymetry, shown as depth below modern sea level. The black line denotes the position of the Lower Pleistocene coastline.



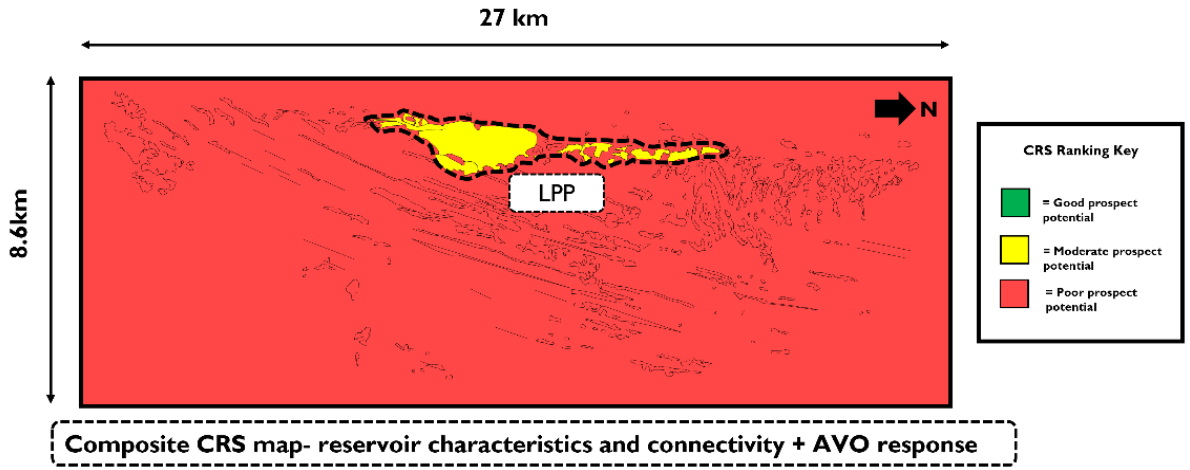
B: Hypothetical geometries of the BISS and FIS during the Lower Pleistocene (2.53Ma ago) The black arrows indicate freshwater inputs.

(Modified after Rea et al., (2018)).

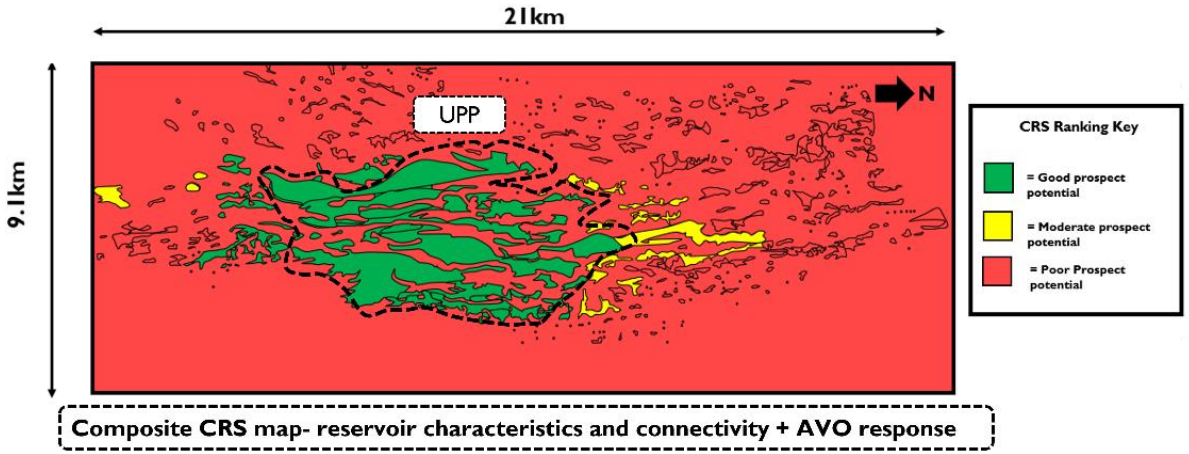
Contents

Prospectivity & Volumetrics

LPM- Composite CRS



UPM- Composite CRS



- **The UPP showed promise, however, volumetrics at this time are considered marginal**
- **Base case economics were undertaken considering fuel gas forecasts, future developments, and existing infrastructure. A hypothetical field development plan was made, however is beyond the scope of this presentation**

Contents

Conclusions

- **AVO analysis on the Paso Anomaly demonstrated a class III response, indicative of gas. The gas was interpreted to be biogenically altered thermogenic gas which has migrated from depth due to crestal faulting associated with Zechstein diapirism**

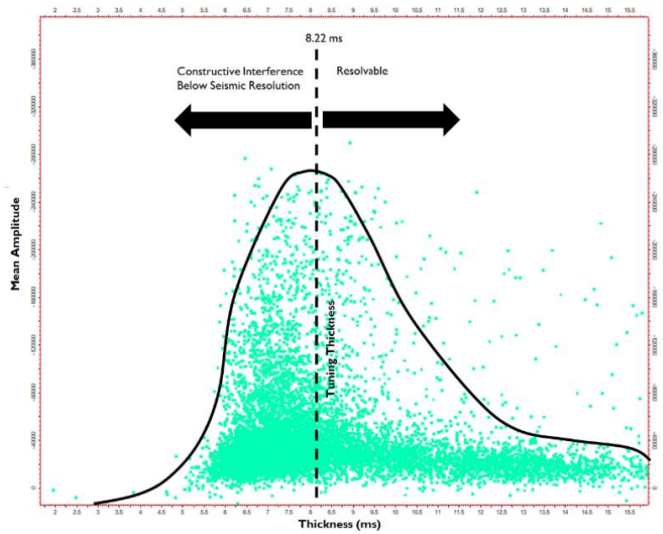
- **The Paso Anomaly was found to correlate to the Aviat Shallow Gas Field, with both fields inferred to be part of the same depositional system and strongly suggesting a Lower Pleistocene age. The anomaly was interpreted to be a result of a glacial retreat over advance sequence of an ice stream, trending SW-NE, on the edge of the BIIS**

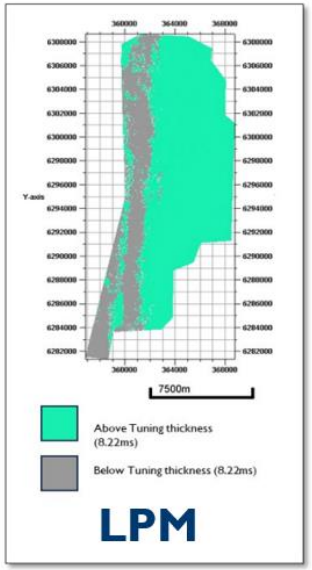
- **Volumetric analysis has indicated marginal volumes within the UPP and a proposed development plan demonstrated potential to be economic**

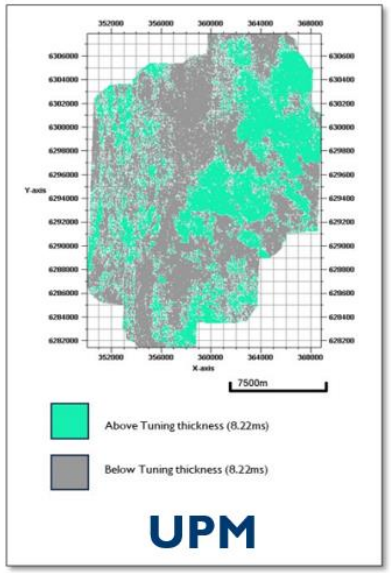
Future Work

- **Three of the biggest uncertainties throughout this project were the reservoir parameters which were based off analogues the potential for a fizz gas effect lowering gas saturations and the reservoirs close to tuning thickness. These all ultimately placed a big uncertainty on GIIP**

- **Any future production well drilled near the anomaly, should use the opportunity to drill through the Paso Anomaly and run a full suite of LWD and collect core plugs to measure gas saturation. This would offset the cost required to drill a dedicated UPM appraisal well**







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- **Francis Buckley** an independent consultant and author within Pleistocene geophysics and morphology

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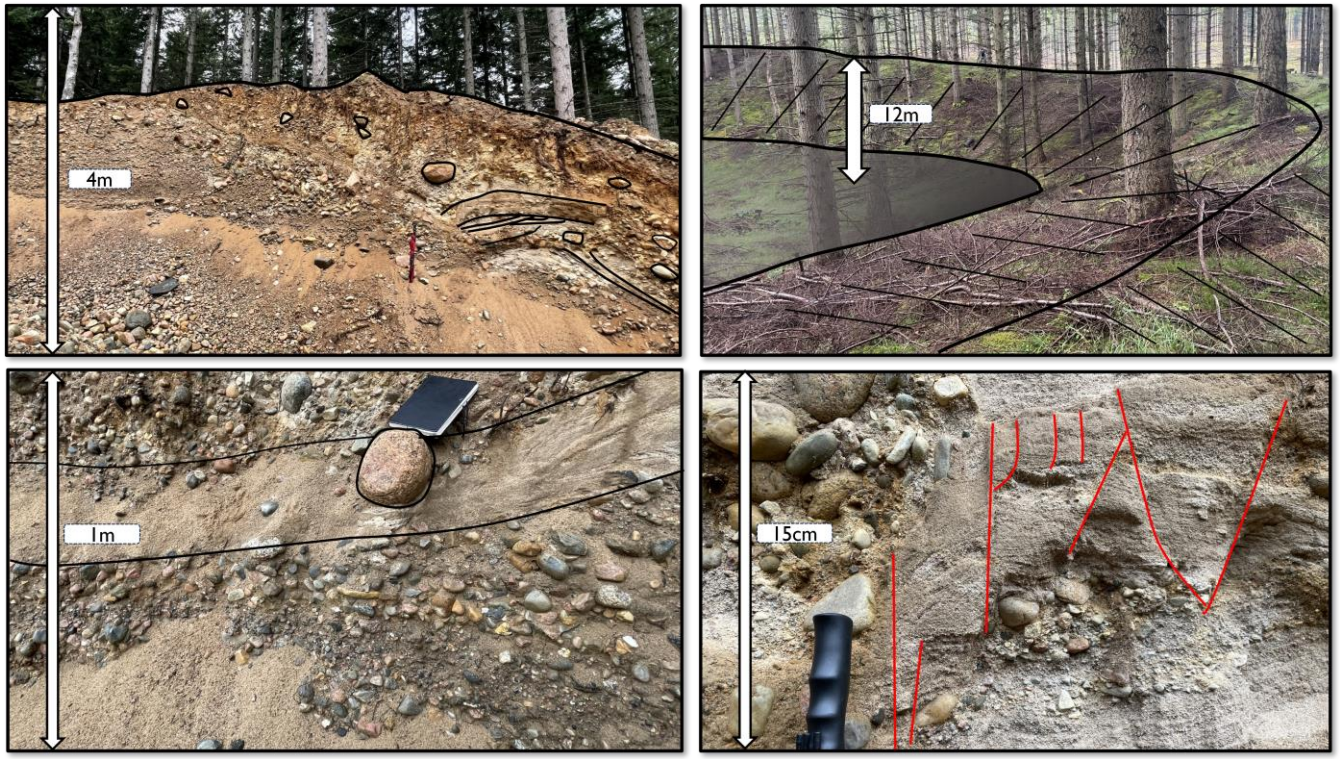
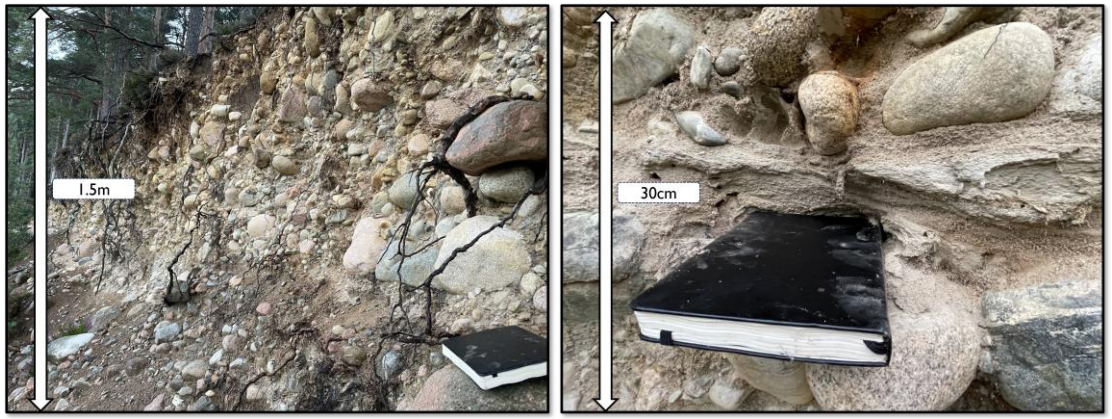
A chance to see some outcrop analogues in the field!



Eskers and their deposits in Cambus O'May Esker Complex, Deeside, Aberdeenshire



Sandur plain in the Muir of Dinnet, Deeside, Aberdeenshire

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