

Iceberg ploughmarks illuminated by shallow gas:

- Analysis of shallow gas in the Ekofisk Area

Haavik, Eidissen & Landrø, EAGE 2014



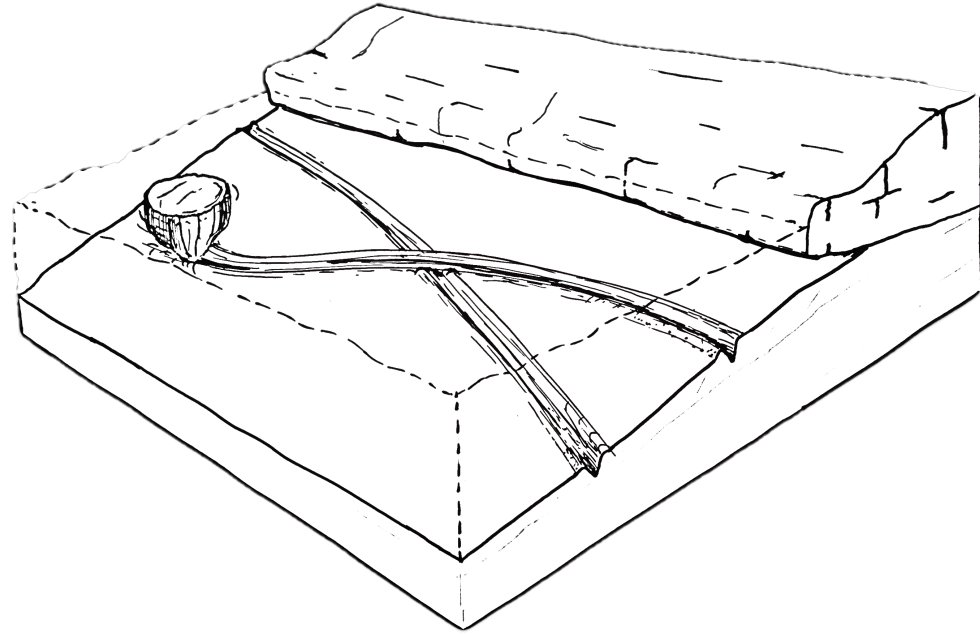
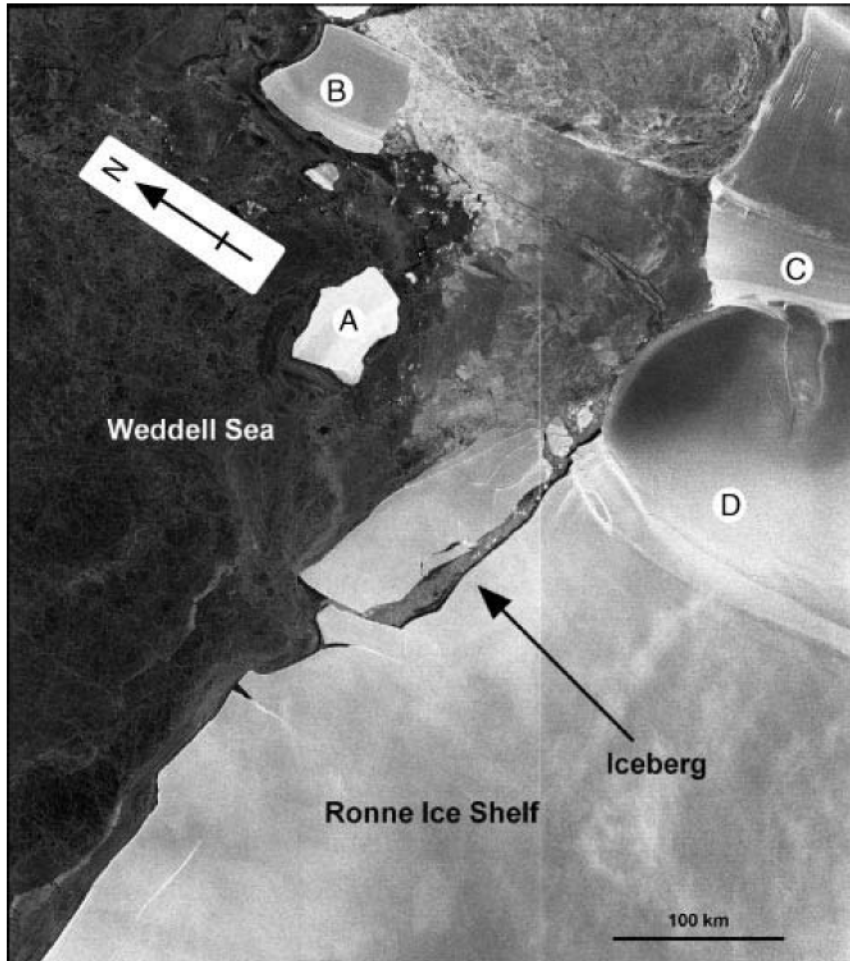
ROSE Meeting 2014



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Iceberg Ploughmarks



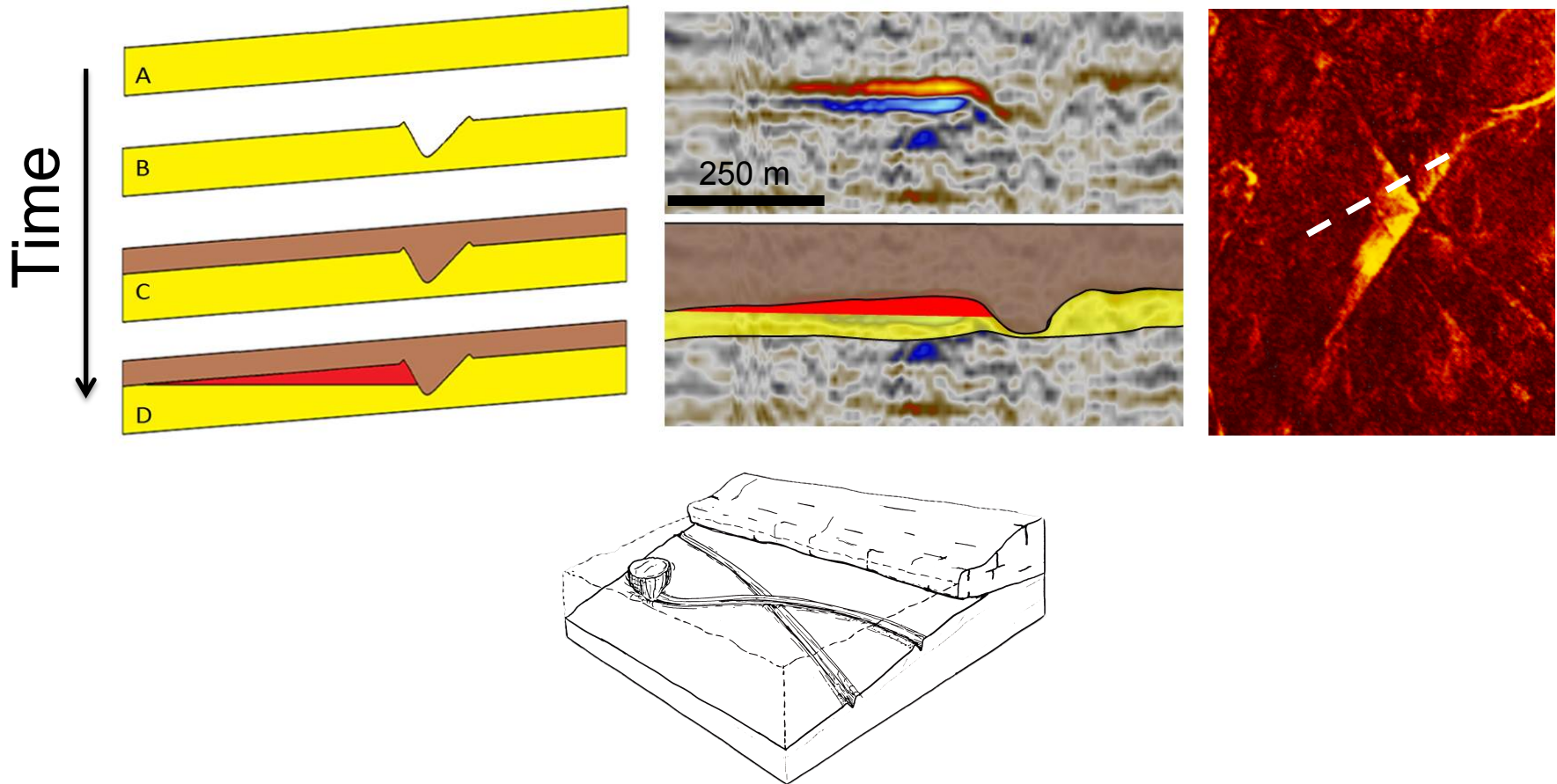
Icebergs are created when glaciers/ice sheets calve into their marine termini

Iceberg ploughmarks in the Barents Sea



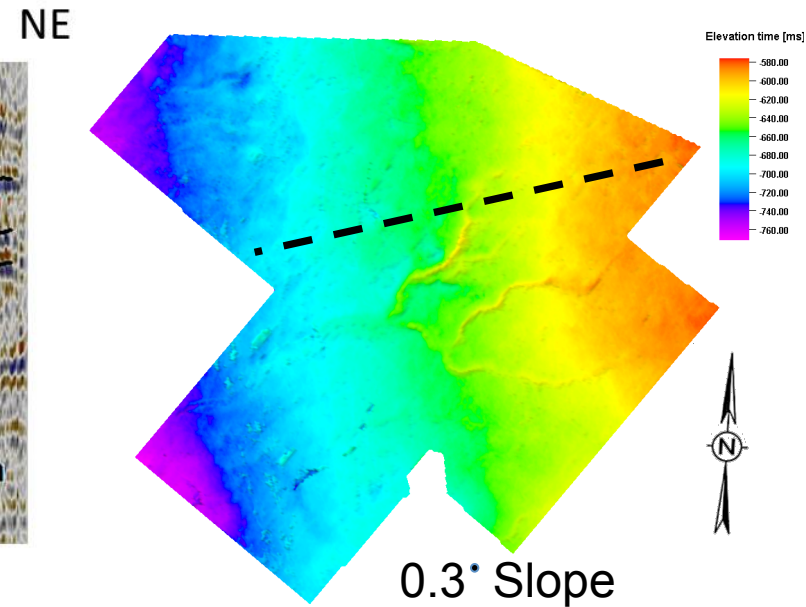
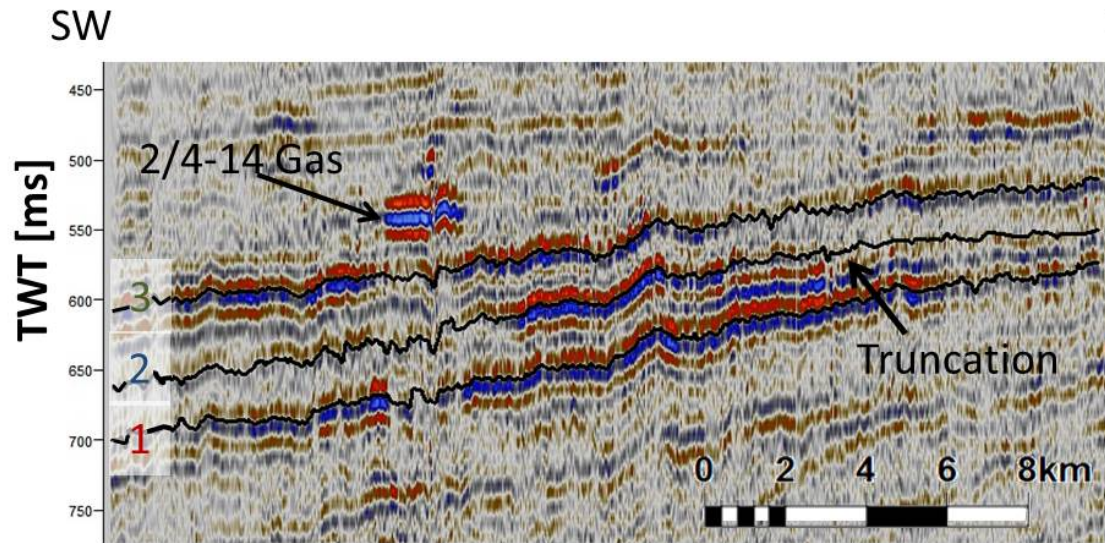
Isfjellpløyemerke som er formet som et 9-tall. 9-tallet er 1000 meter langt. 9-tallet er tegnet av isfjellet med en 60 meter bred penn, som er trykt 8 meter ned i sedimentene. Havdyp ca 260 meter.

Iceberg ploughmarks as trap for shallow gas



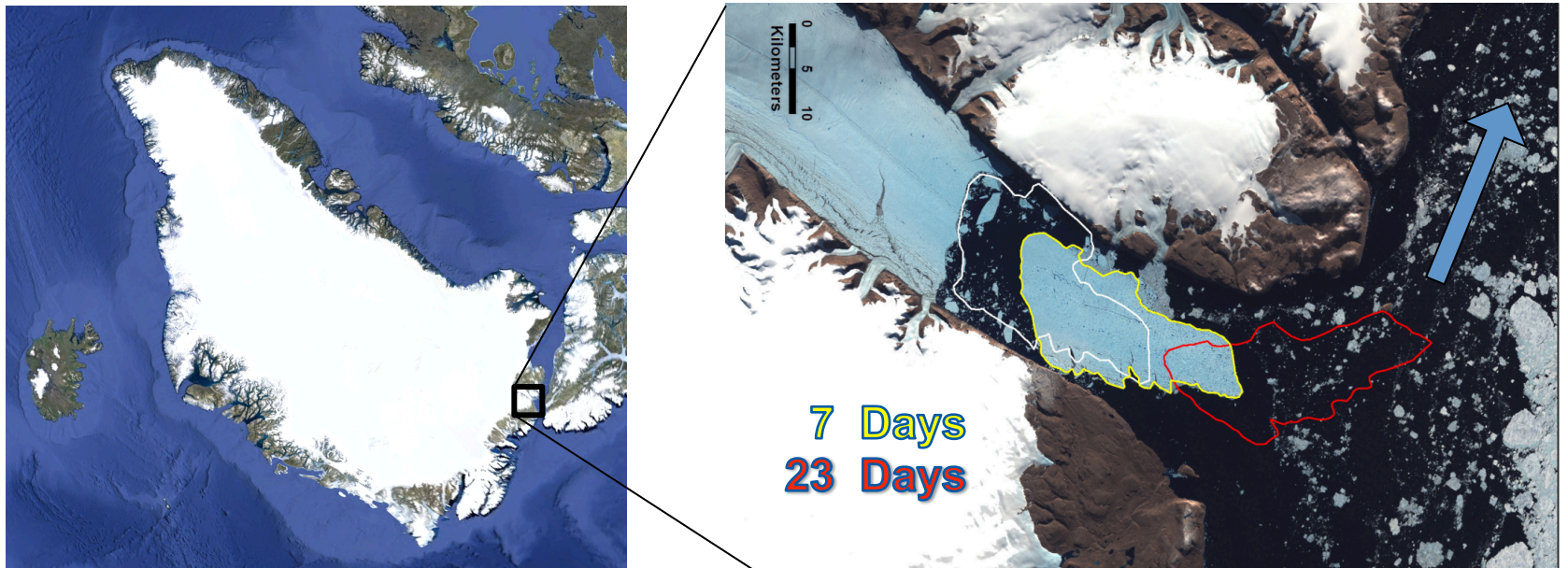
Iceberg ploughmarks continued..

- Amplitude analysis for detection of buried ploughmarks
- AVO analysis
- Time-lapse study
- Source of gas

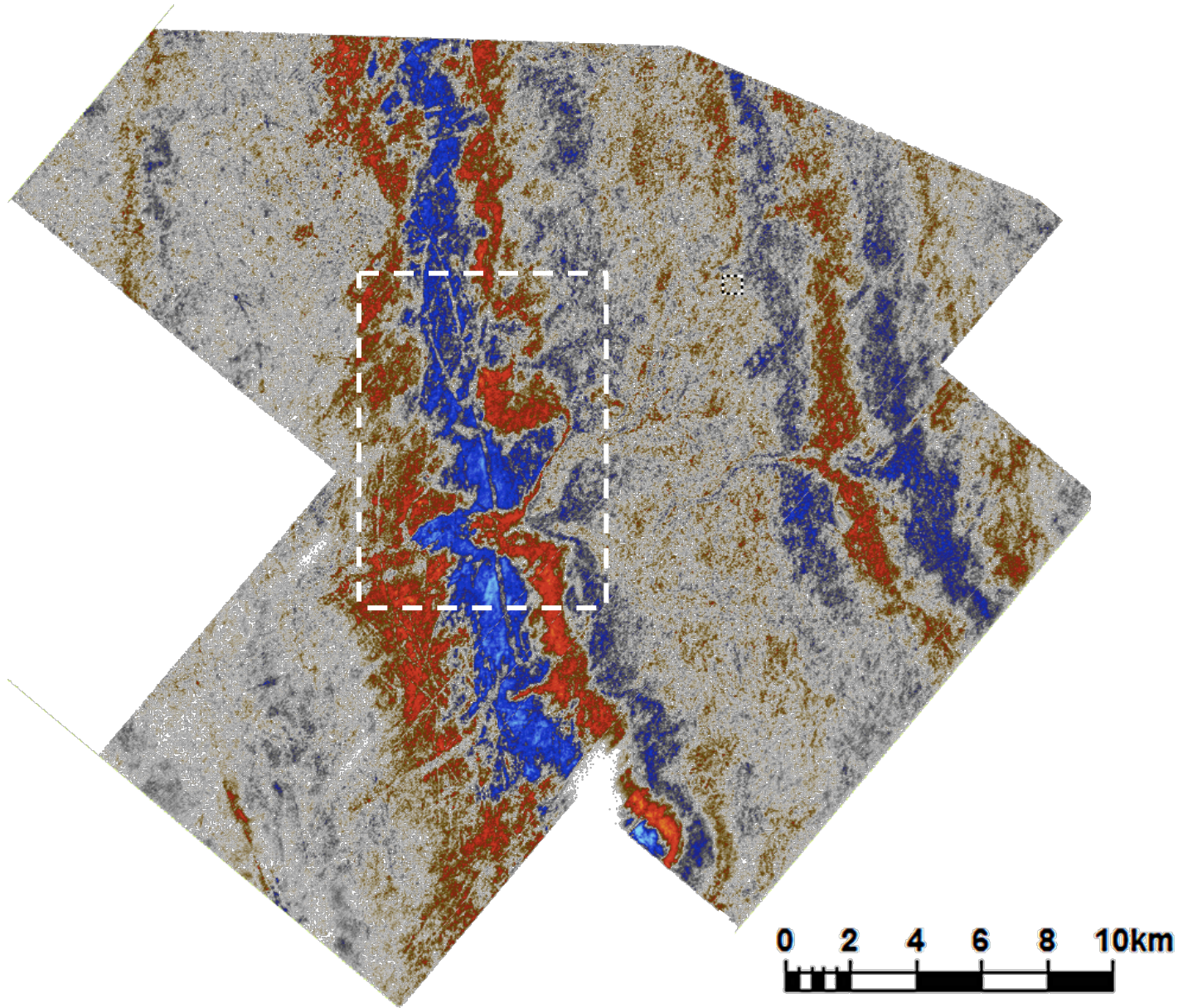


Iceberg Ploughmark detection

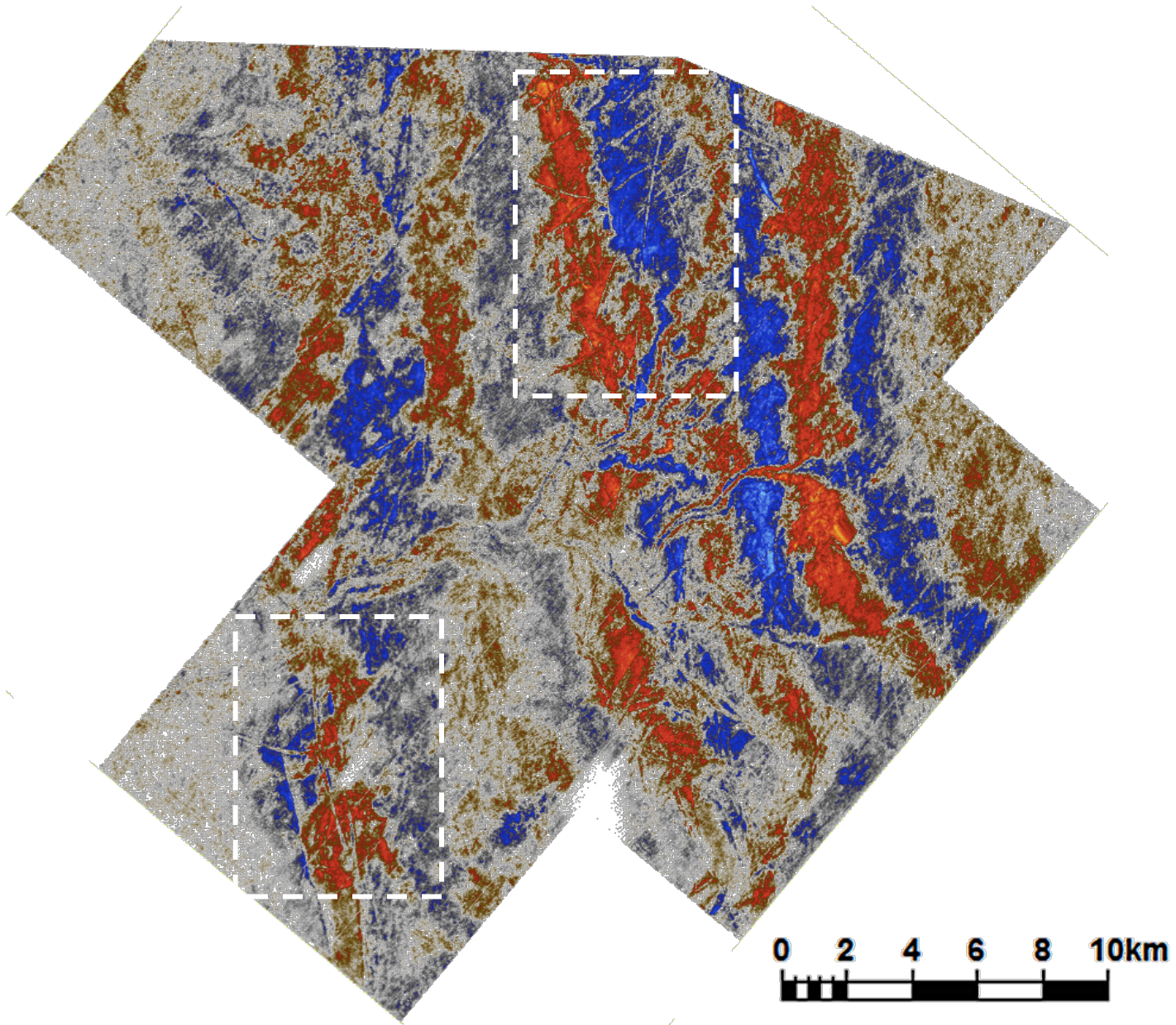
- Demonstrate that the sediments are deposited under glacial influence
- Give inferences about palaeo-current and source area of IP
- Ice sheet dynamics if mapped through larger sediment record



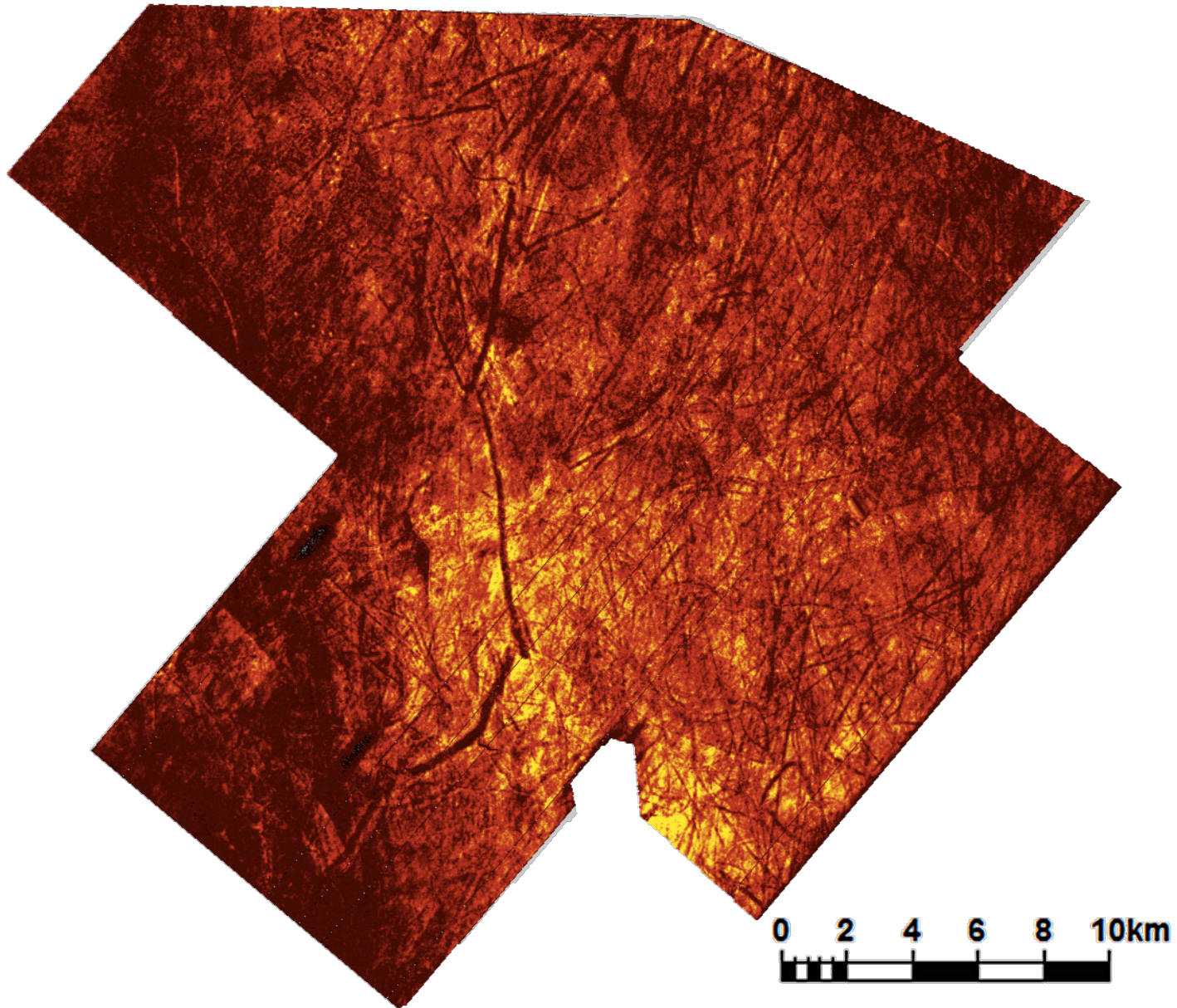
Time-slice at 680ms



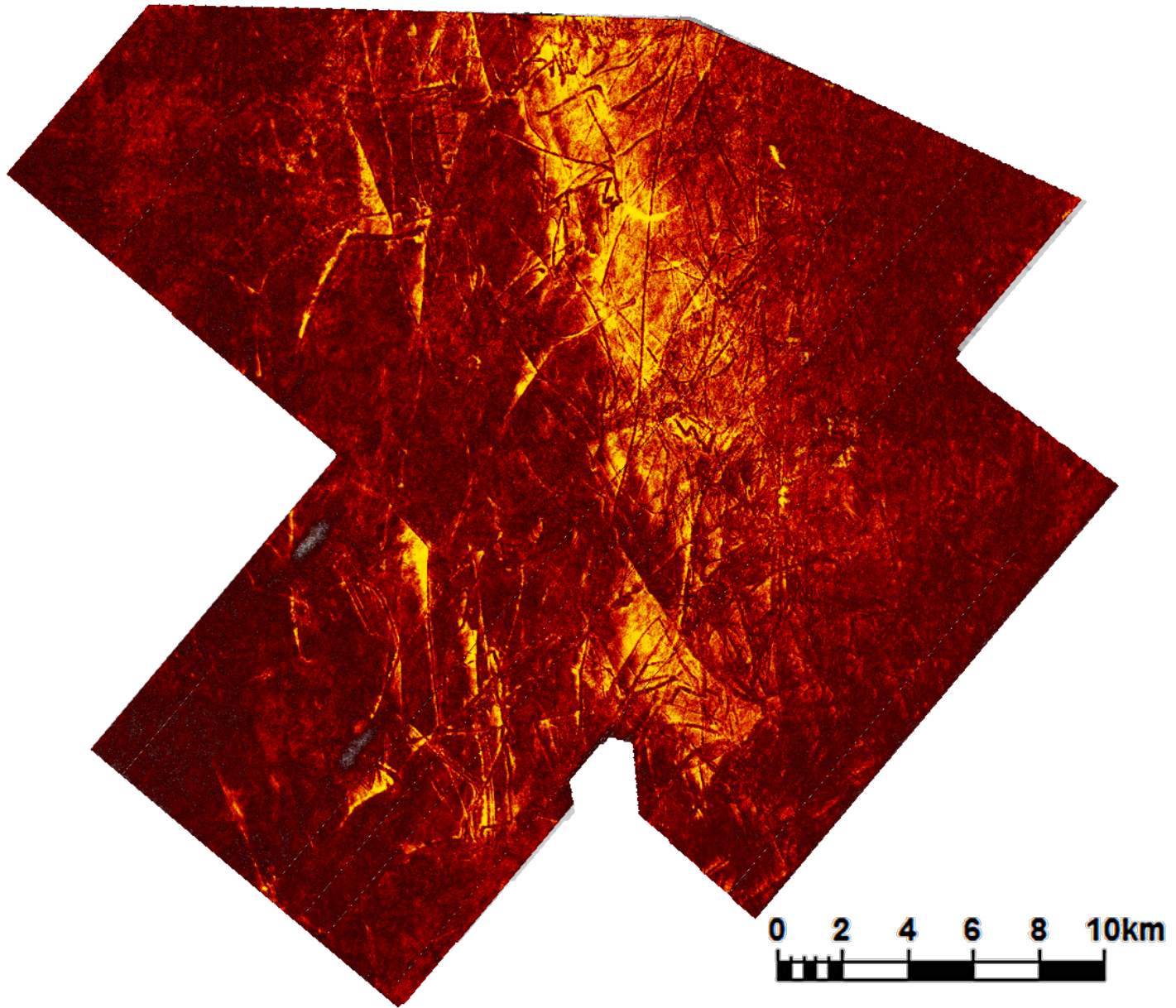
Time-slice at 600ms



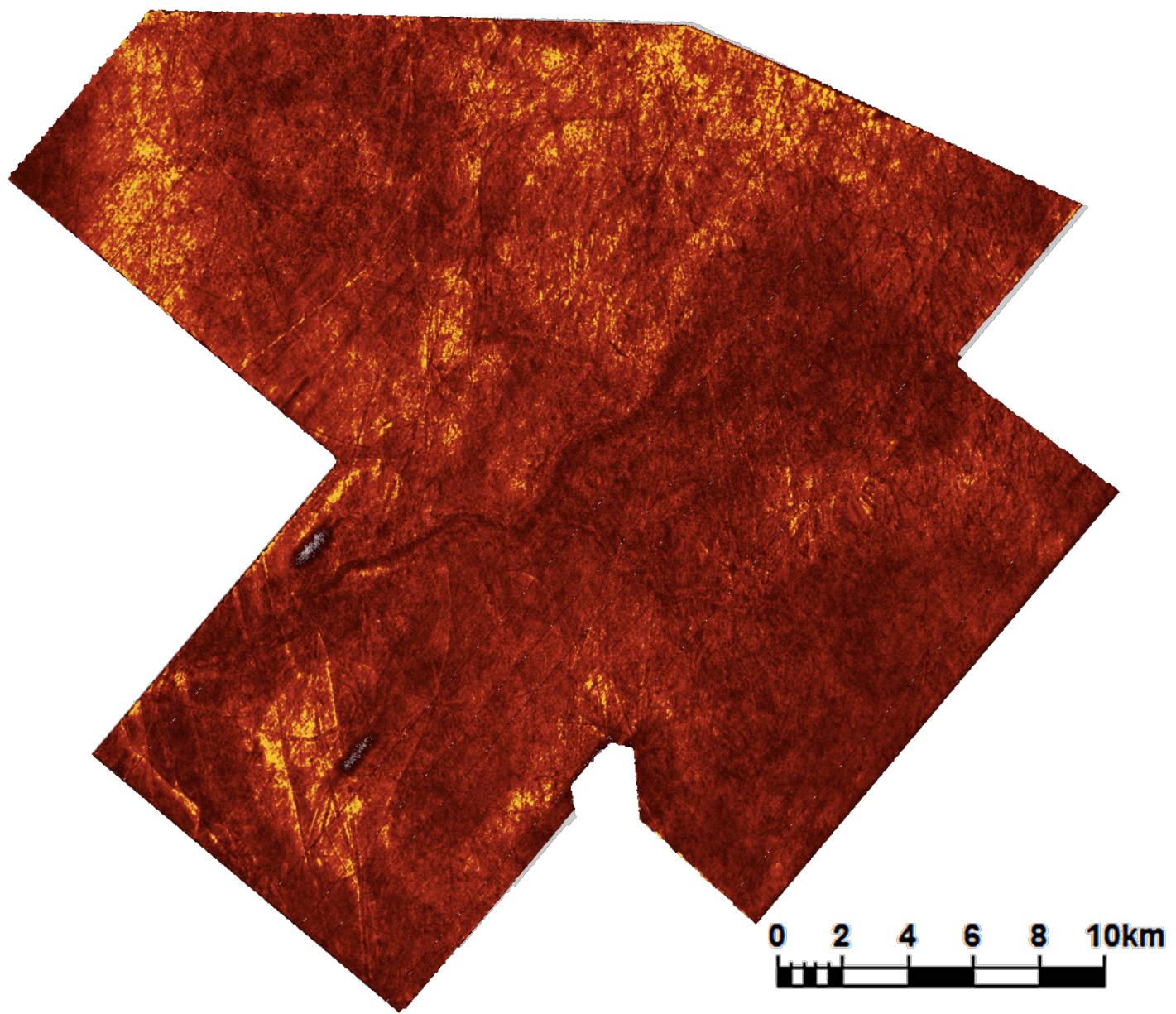
RMS-amplitudes Level 1



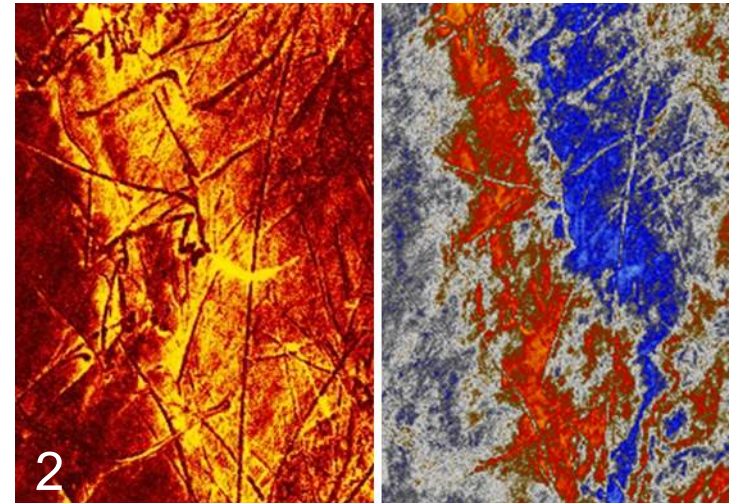
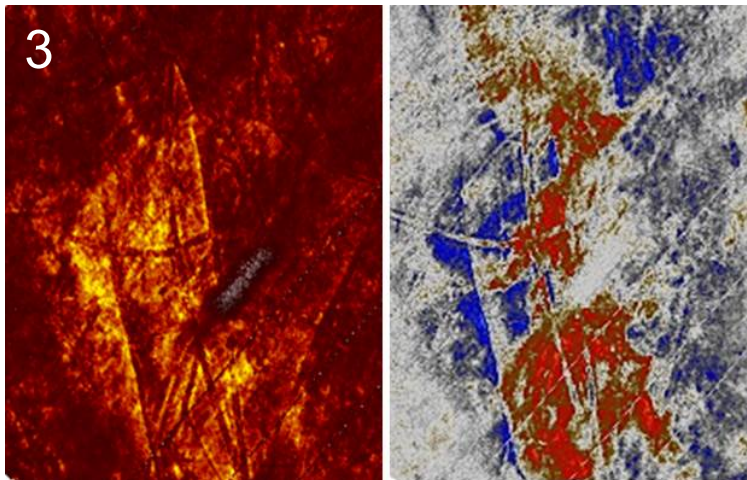
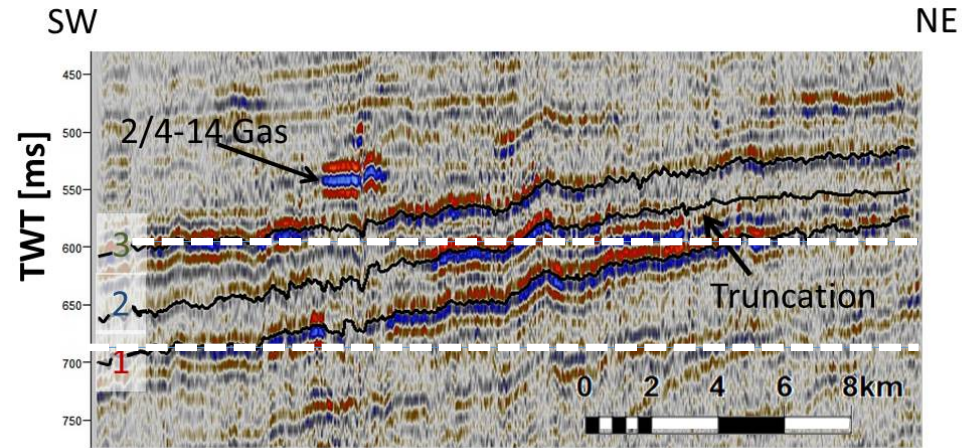
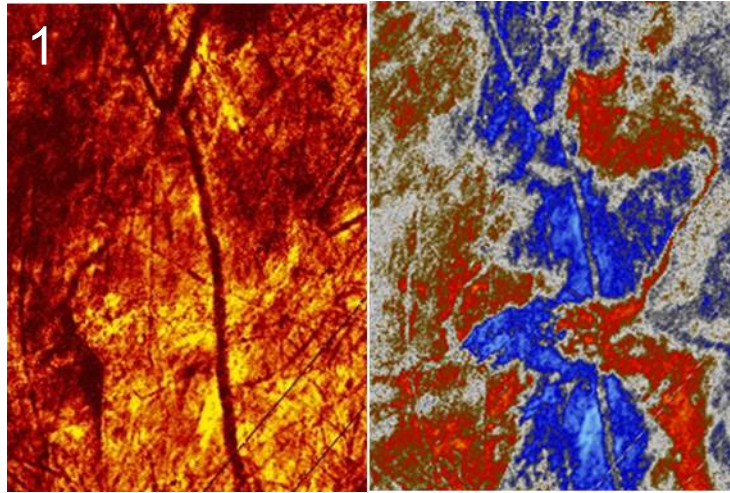
RMS-amplitudes Level 2



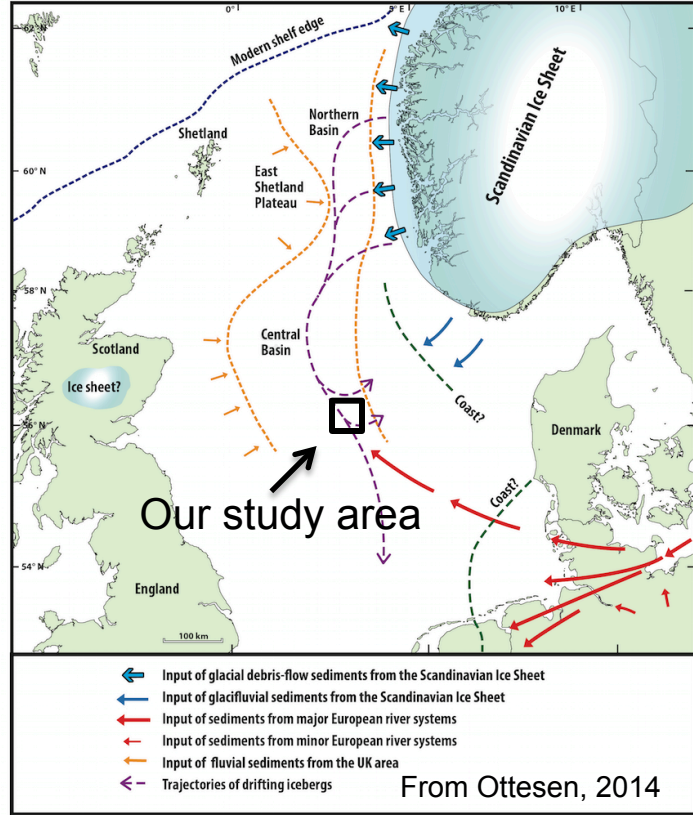
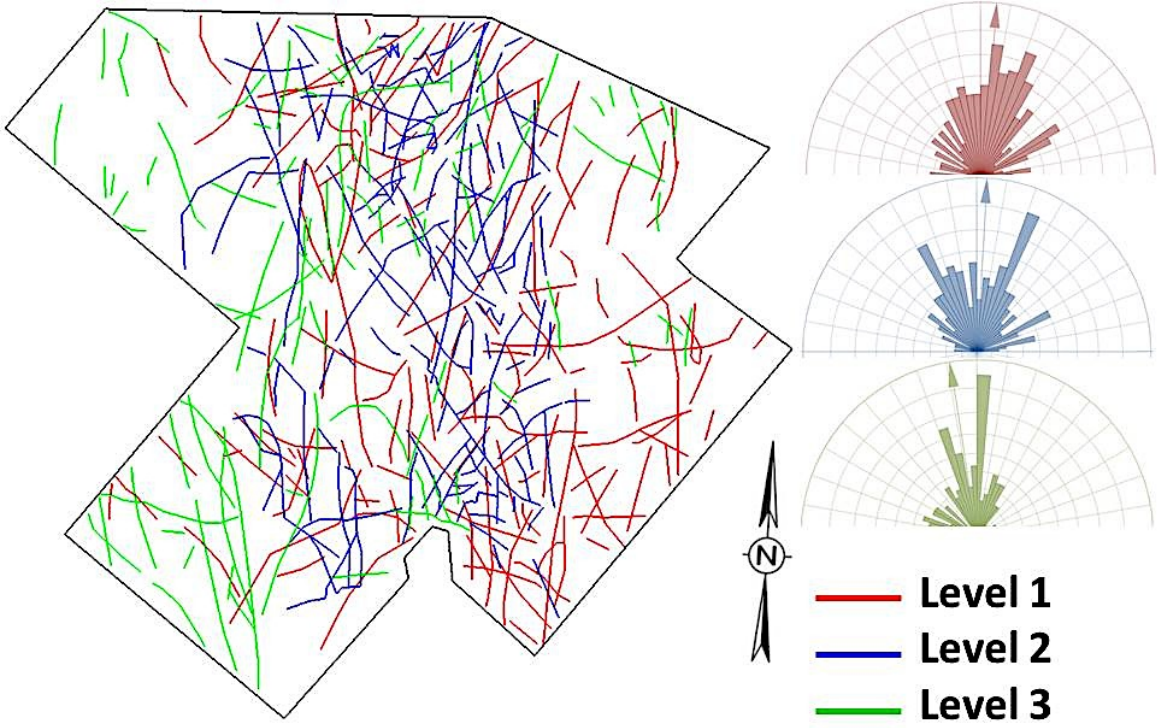
RMS-amplitudes Level 3



Amplitude attribute vs. Time-slice

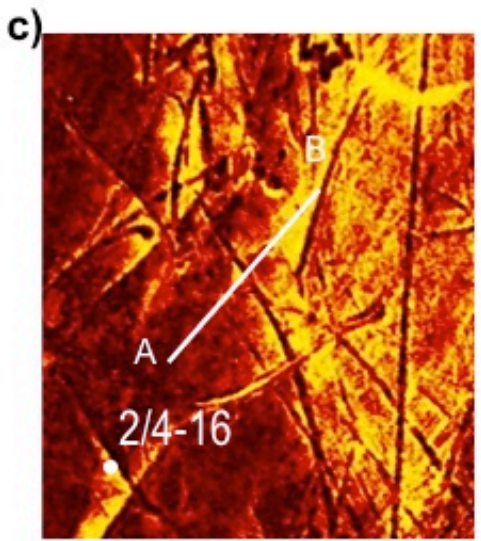
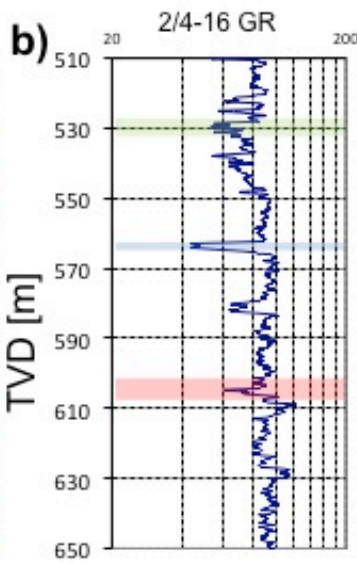
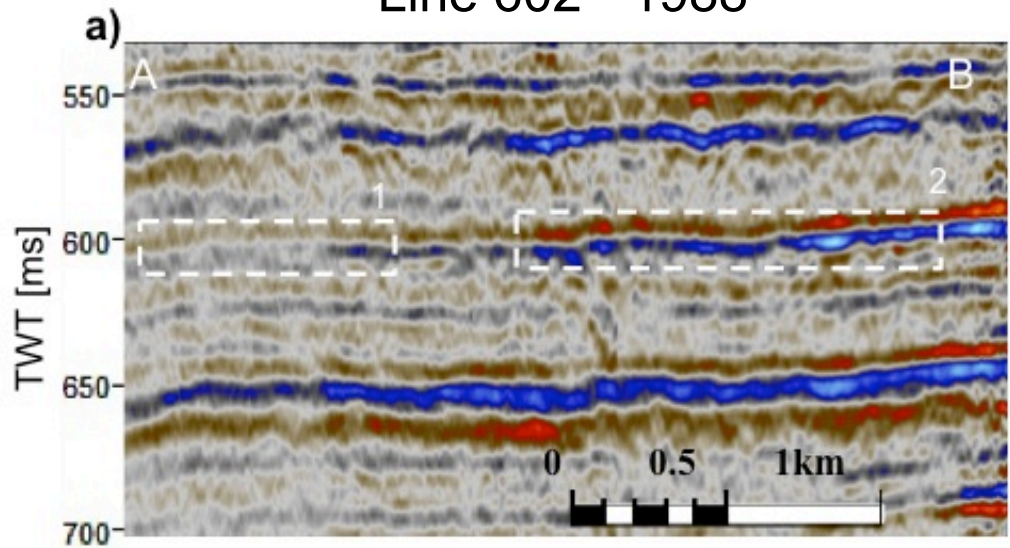


Ploughmark directions in Ekofisk Area



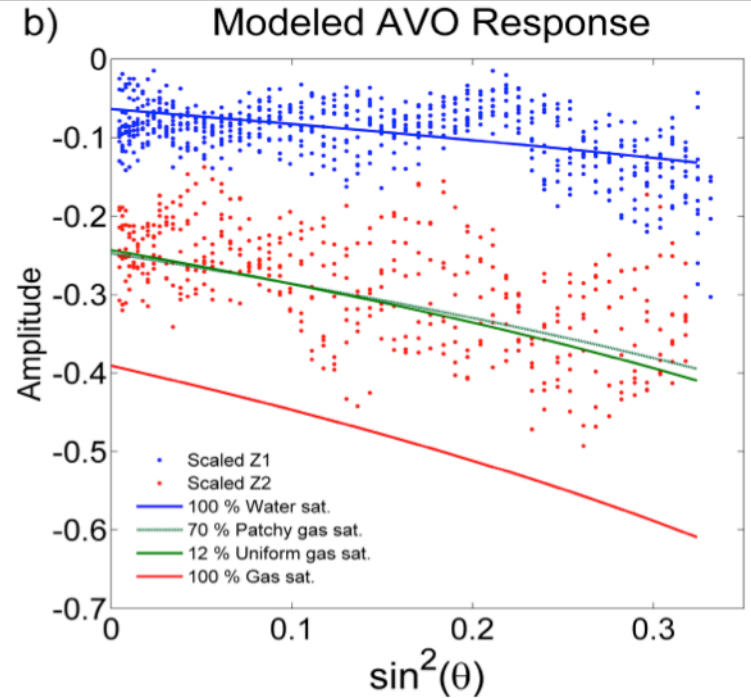
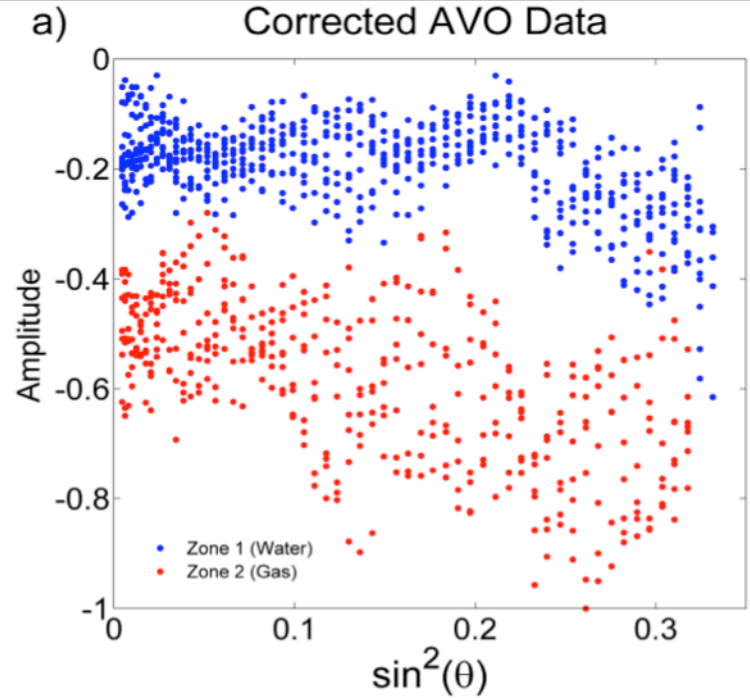
AVO Analysis

Line 602 - 1988



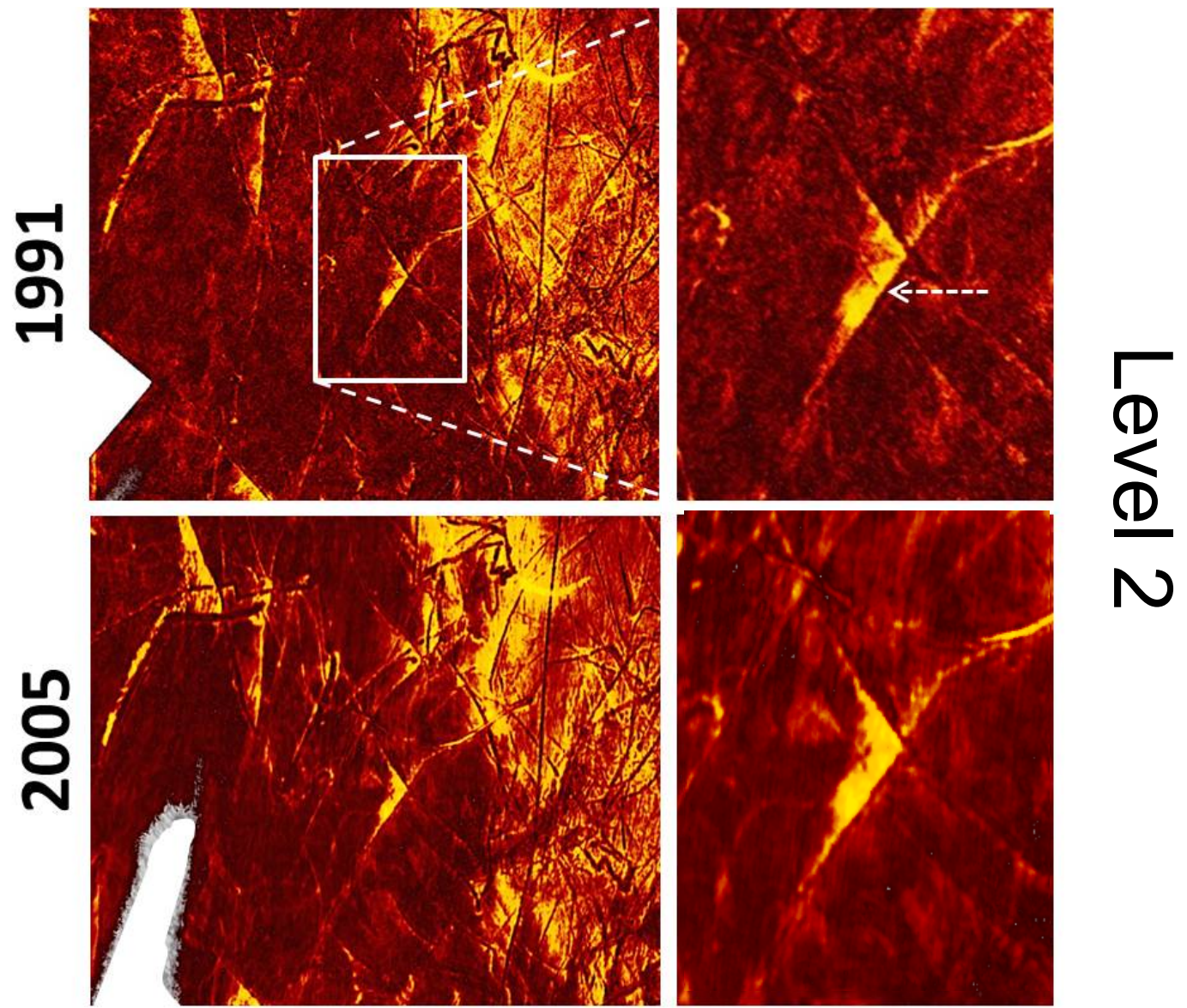
CDP's taken from bright and dim zones
Amplitudes picked from reflection from sand in Level 2

AVO Analysis - Results

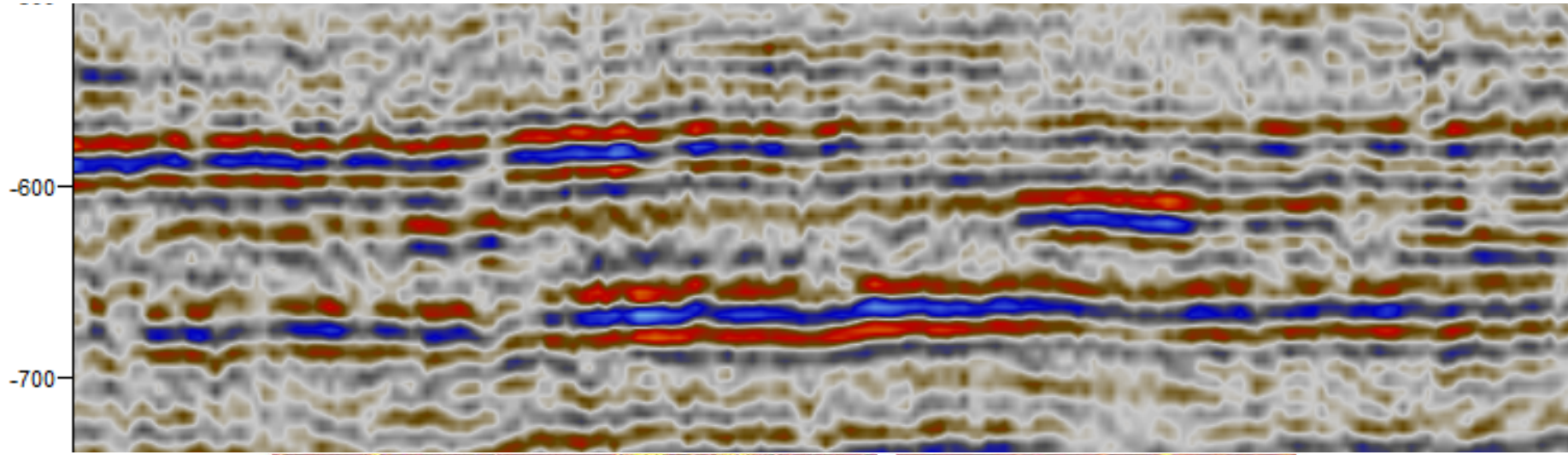


70 % patchy or 12 % uniform gas saturation fit the data

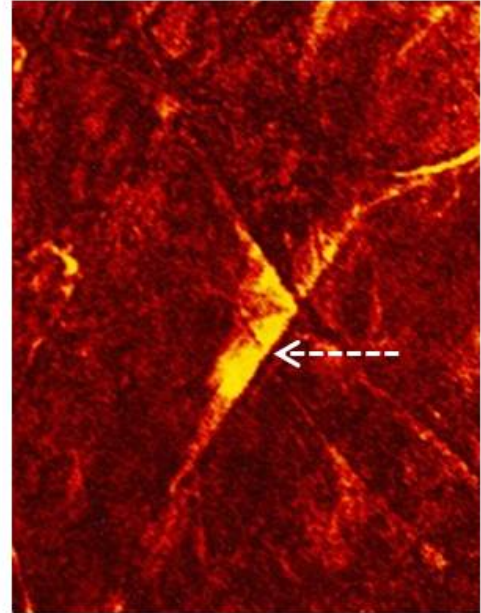
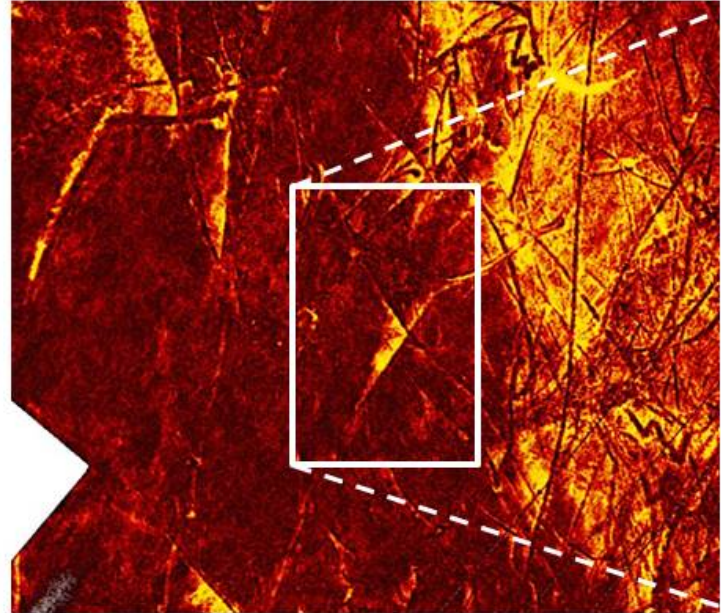
Time-lapse amplitude analysis



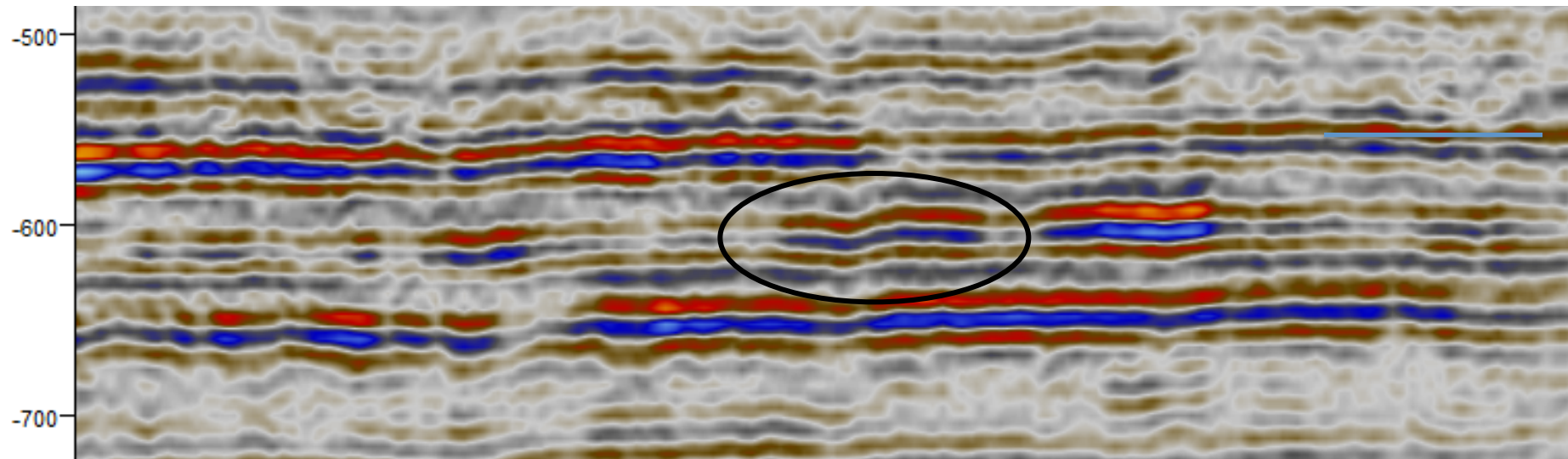
New amplitude anomaly in Level 2



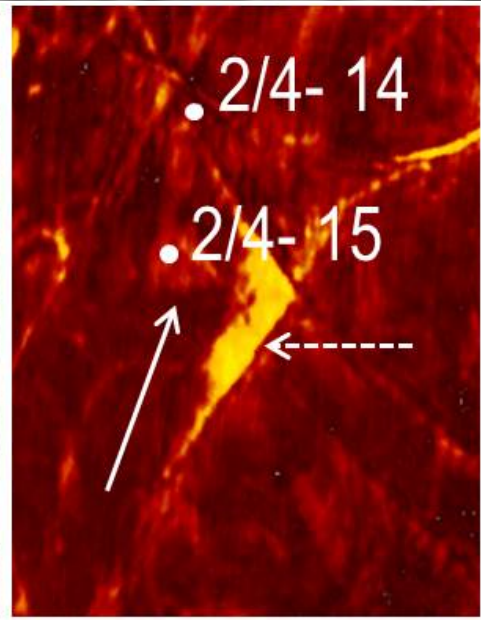
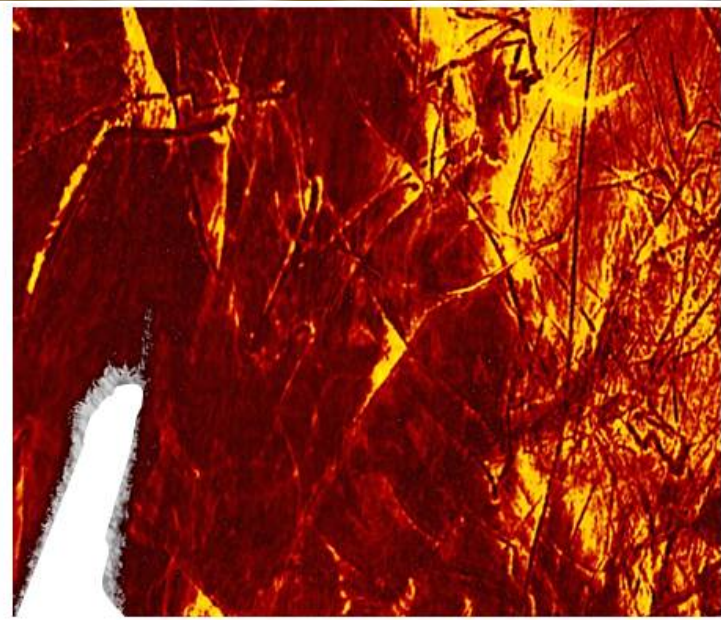
1991



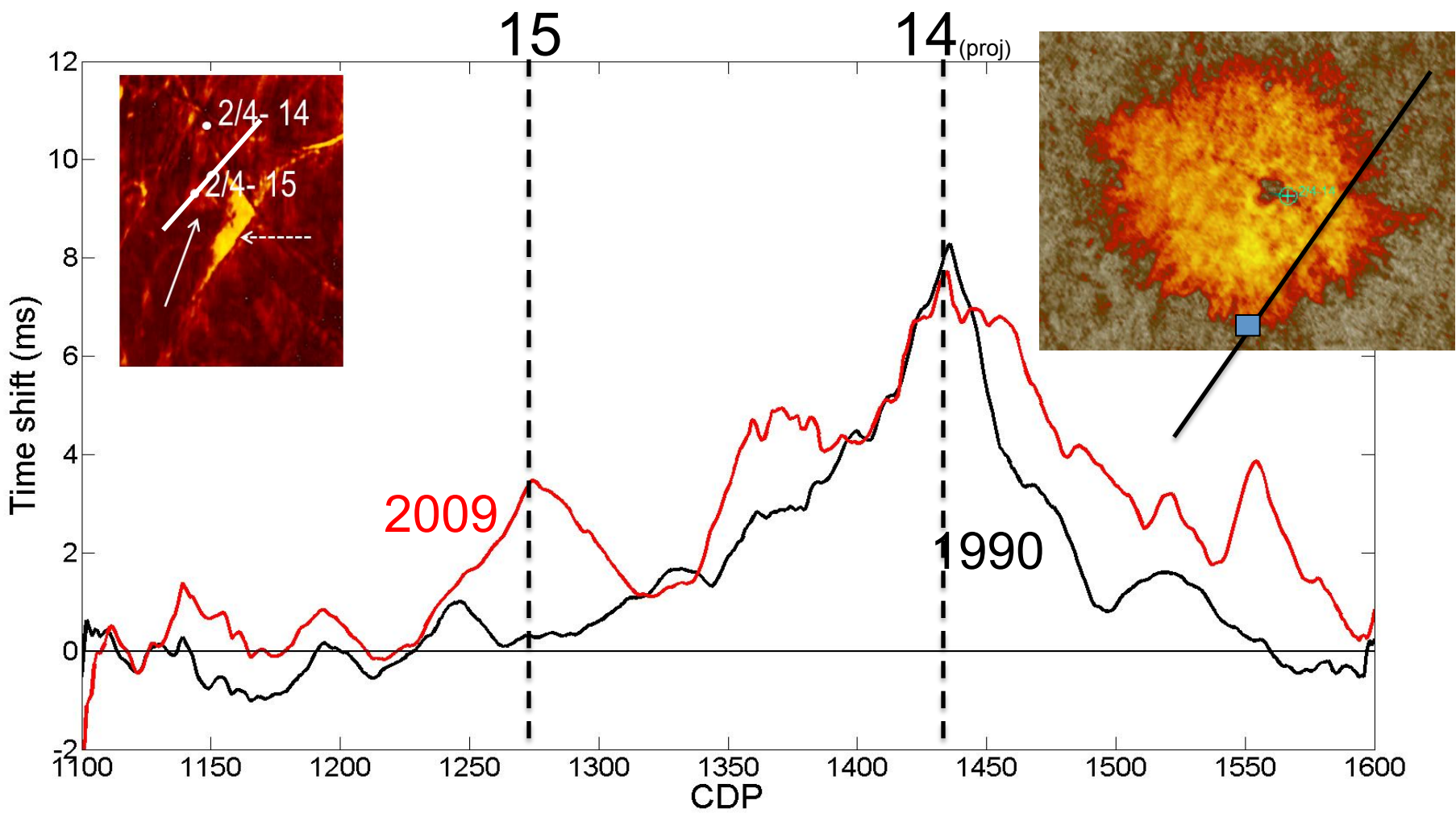
New amplitude anomaly in Level 2



2005

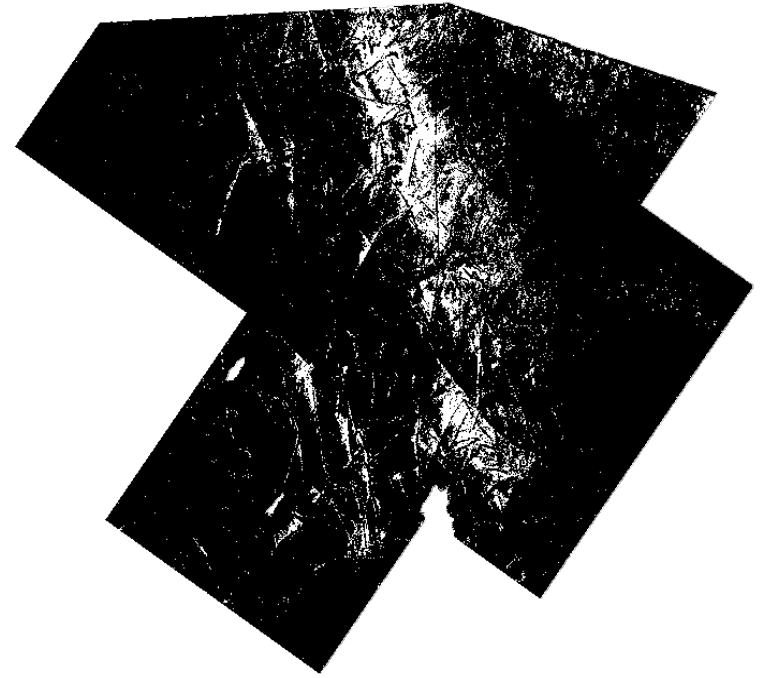
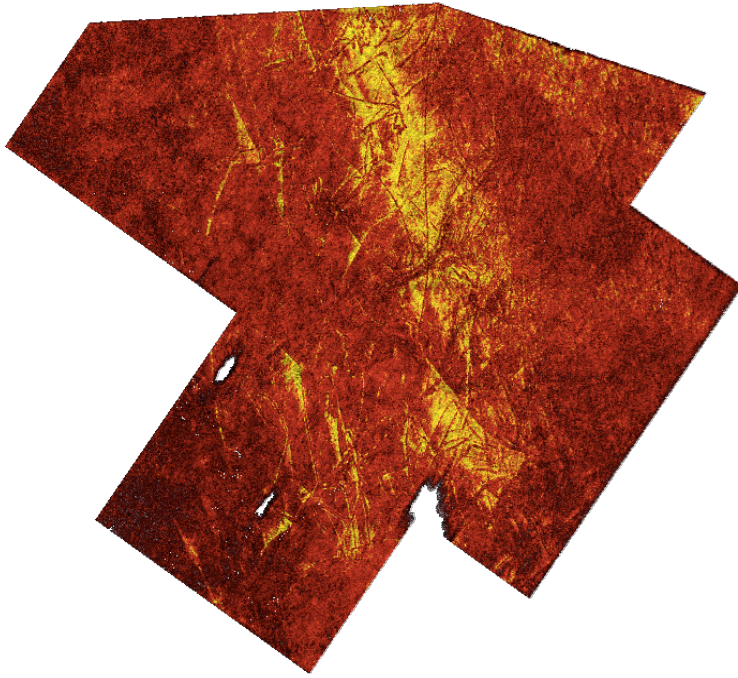


Time-shifts to Level 1



Significant time shift increase close to relief well between 1990 and 2009

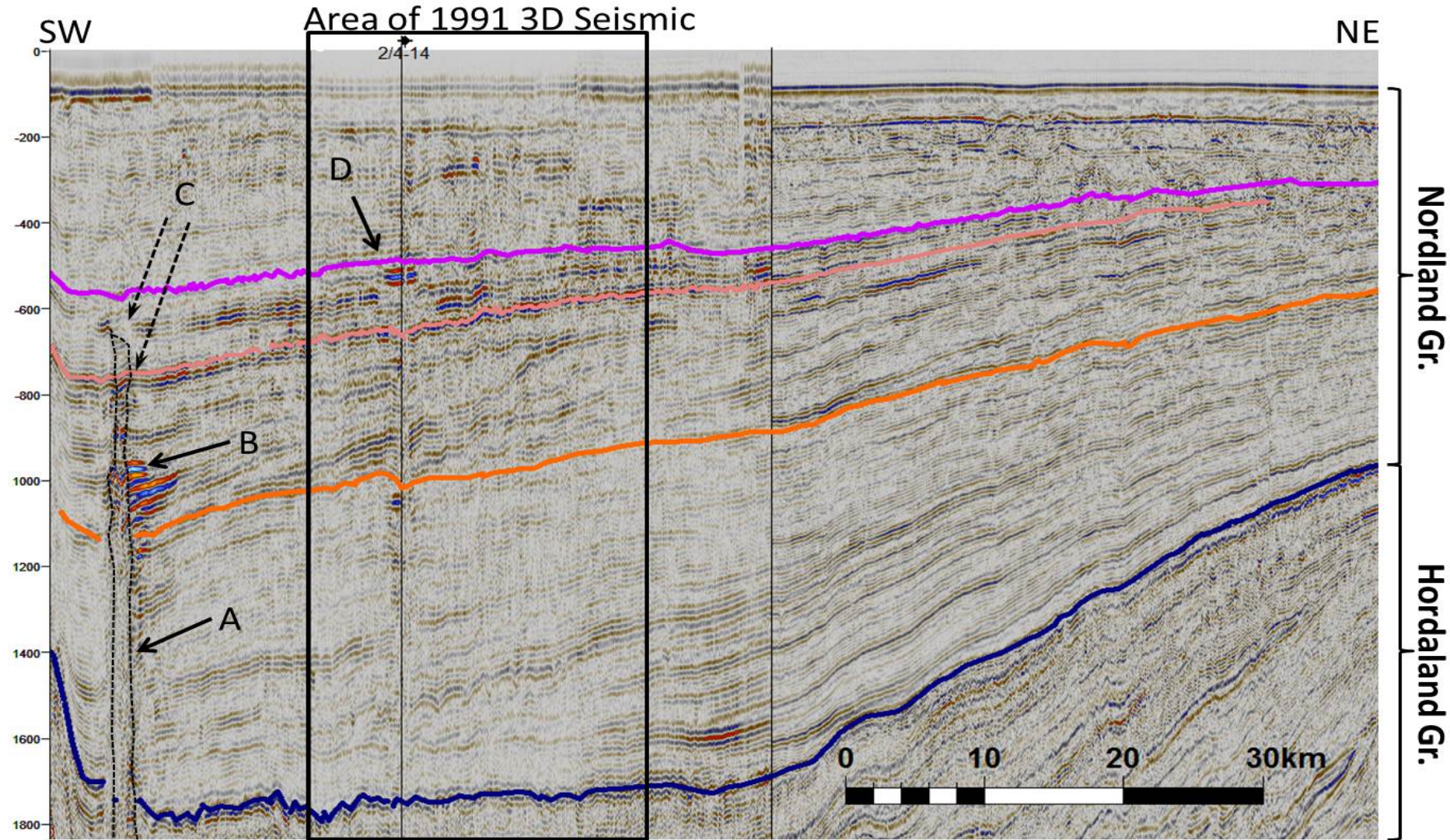
A rough estimate of gas volumes



$$V_g = \sum_A \Delta A * S_g * h * \frac{N}{G} * \frac{P_{res.}}{P_{atm.}} * \varphi$$

$$= \Delta A * h * \frac{N}{G} * \frac{P_{res.}}{P_{atm.}} * \varphi * S_g \sum_A 1 = 0.37 - 2.22 \text{ GSm}^3$$

Origin of gas



Conclusions

- Sand layers deposited under glacial influence during Pleistocene are visible in seismic data and illuminated by shallow gas.
- Interpretation of these sand layers followed by amplitude attribute analysis improves detectability of iceberg ploughmarks compared to time-slice method.
- For the three Pleistocene sand layers studied here we find that the iceberg ploughmarks have a principle flow direction in a North-South trend.
- AVO-analysis confirms that high amplitude anomalies are most likely caused by the presence of shallow gas.
- The shallow gas present in the sand layers under investigation are most likely of thermogenic origin, based on migration pathways located on seismic.
- Estimated gas volumes in Level 2 is in the range 0.37 – 2.22 GSm³.

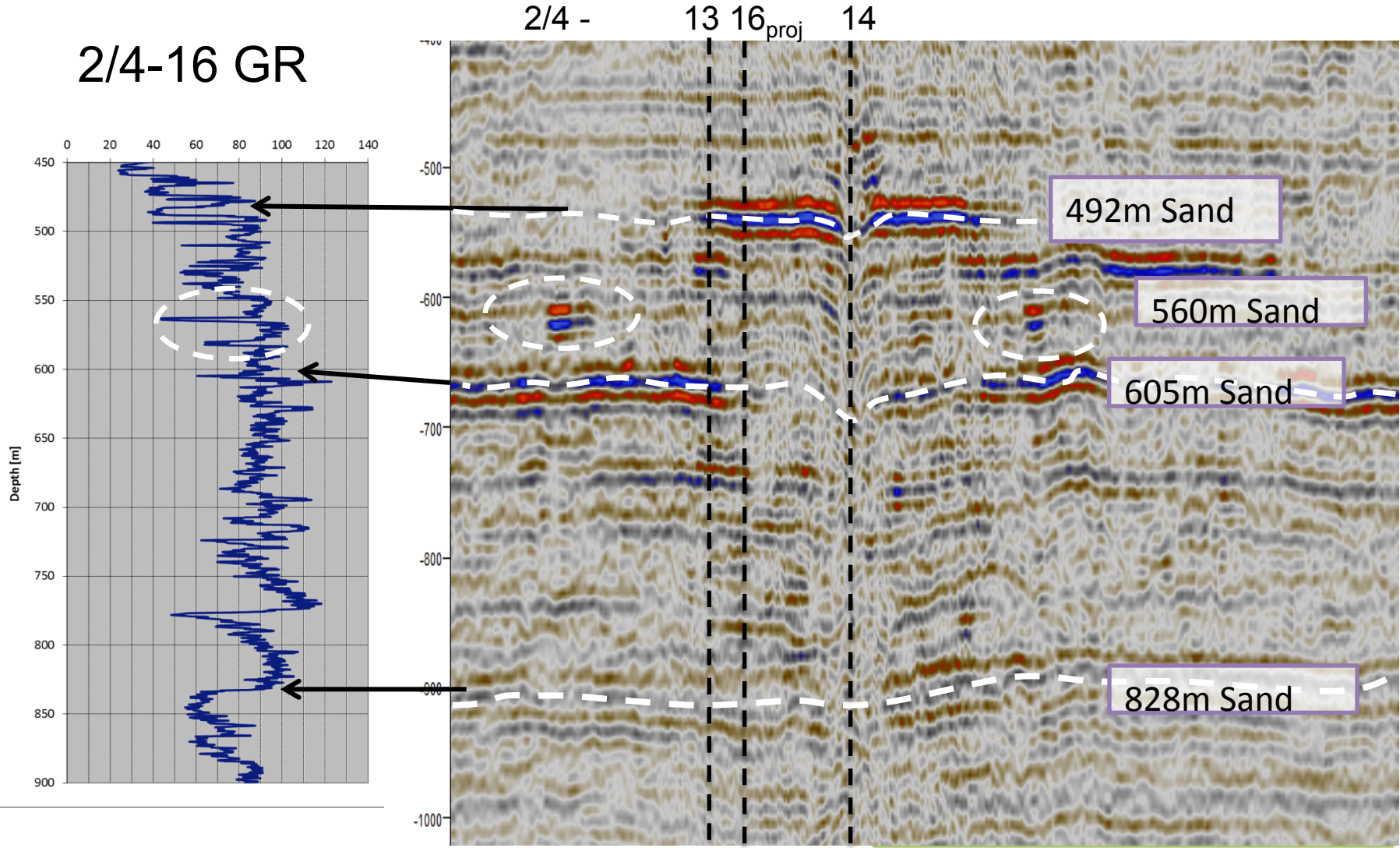
Acknowledgements

We acknowledge the ROSE sponsors for their financial support to the ROSE project at NTNU.

Furthermore, the Norwegian Research Council is acknowledged for financial support to the ROSE project at NTNU.

Thanks to Kjersti Eidissen for providing the CDP's for the AVO analysis.

Sand and Shallow Gas

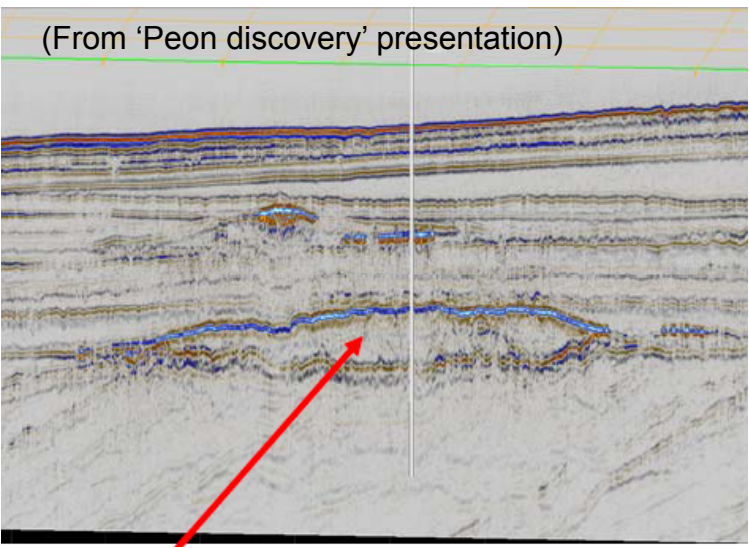


References

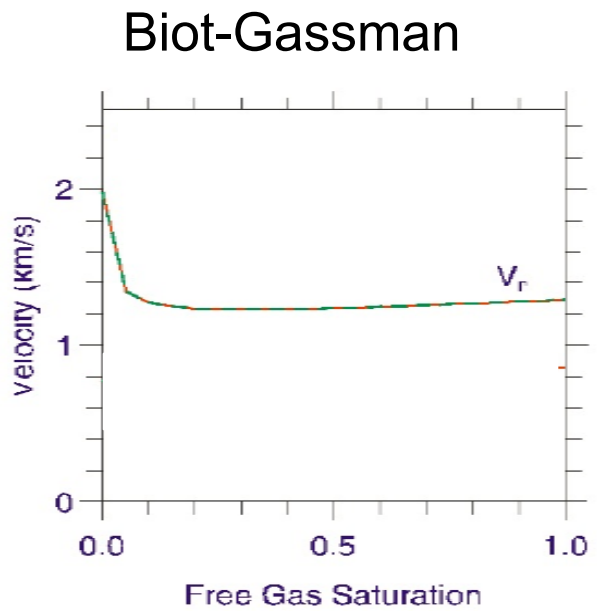
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Backup Slides

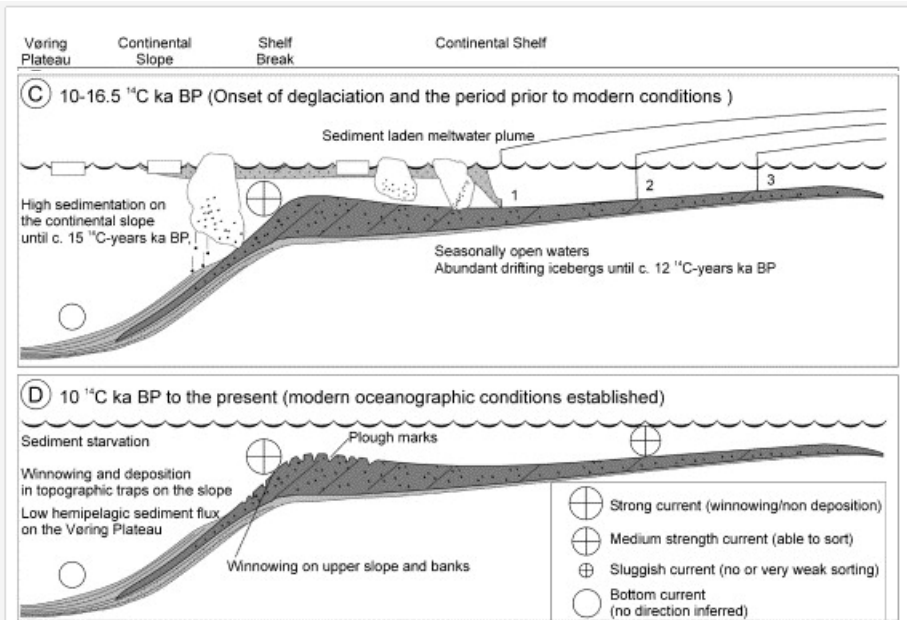
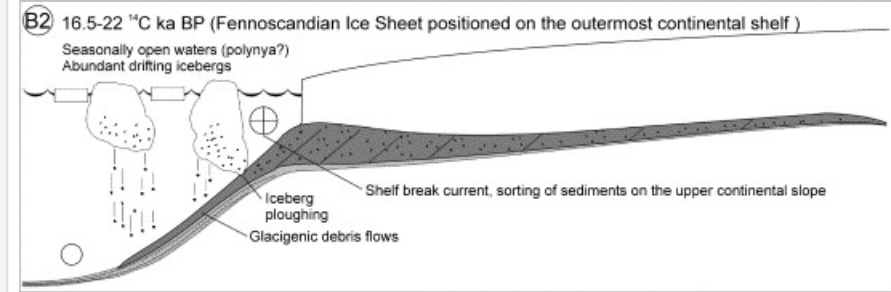
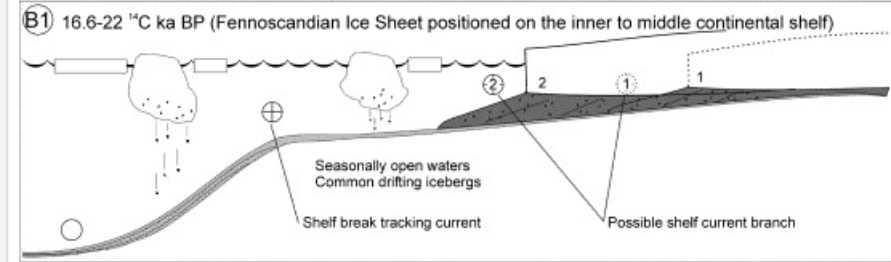
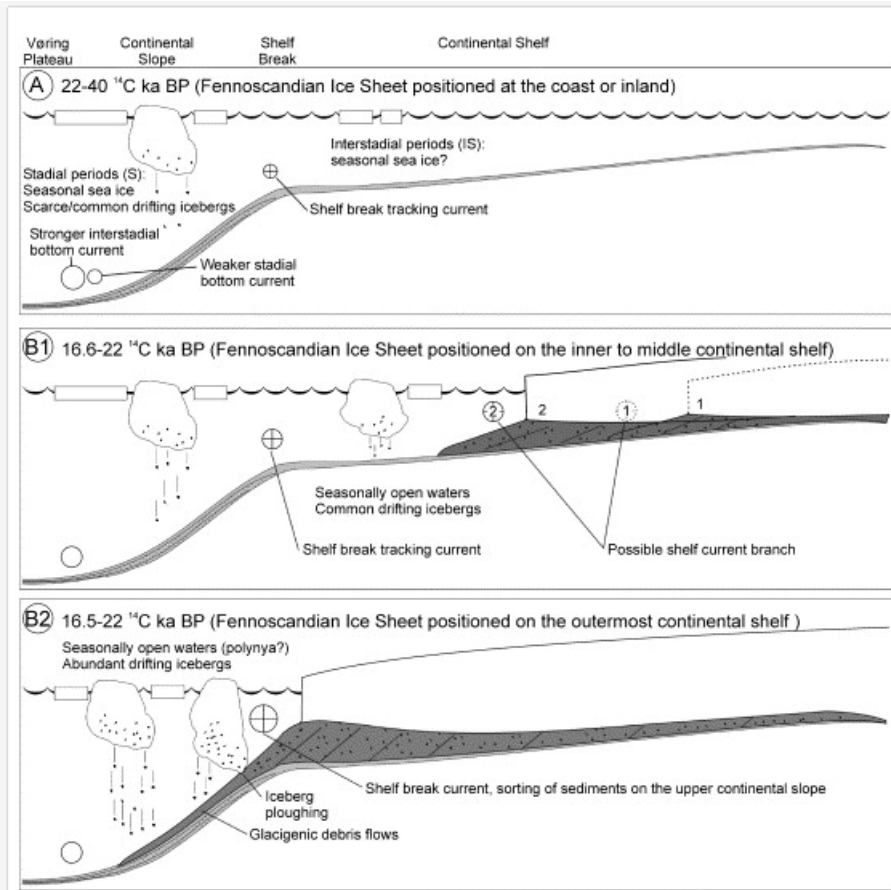
What kind of seal? Do we need a seal?



Peon Field

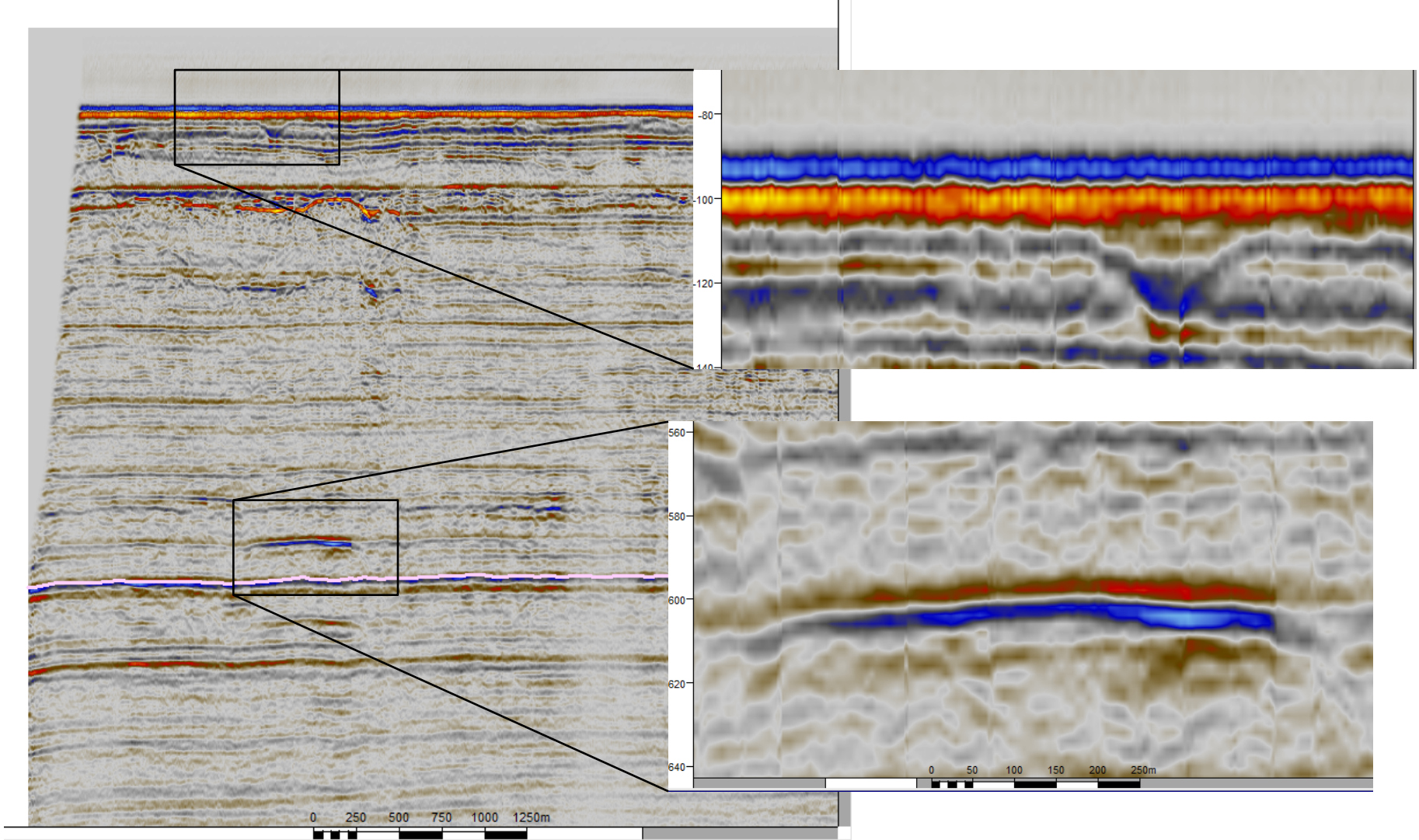


From K.I. Torbøjrnr Dahlgren , Tore O. Vorren (2003)



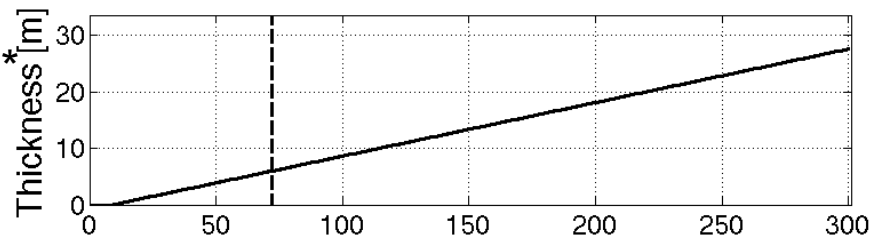
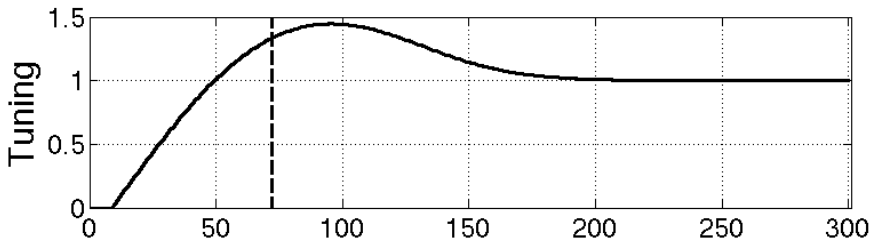
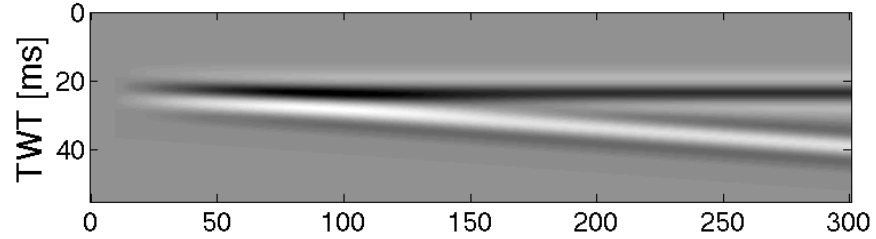
E Transgression and deposition of finer sediments

Soft event

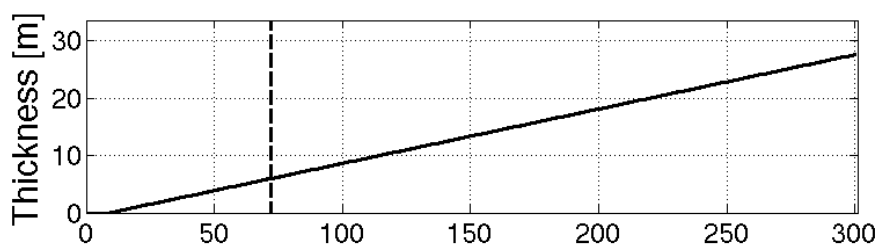
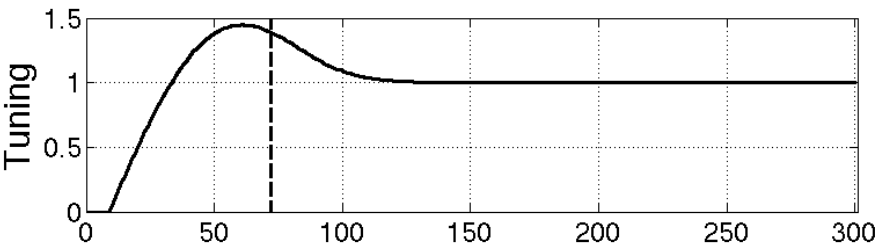
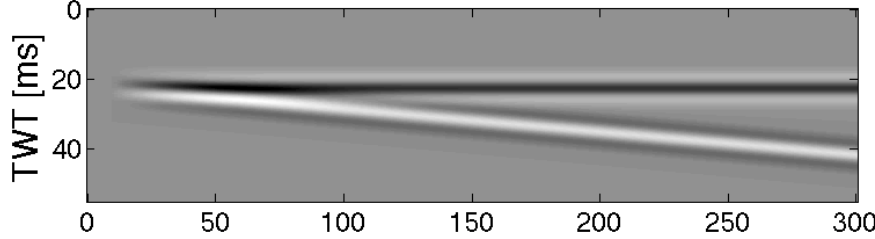


Tuning

45 Hz Ricker



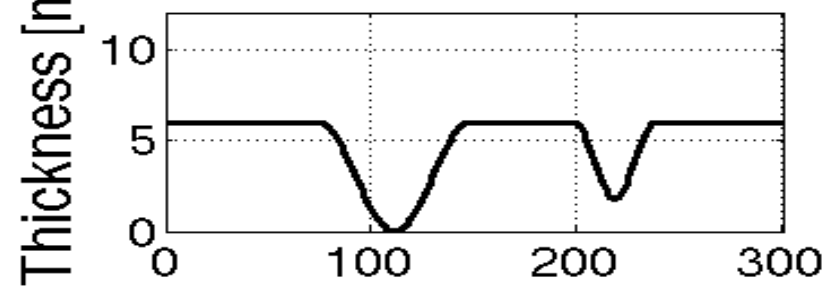
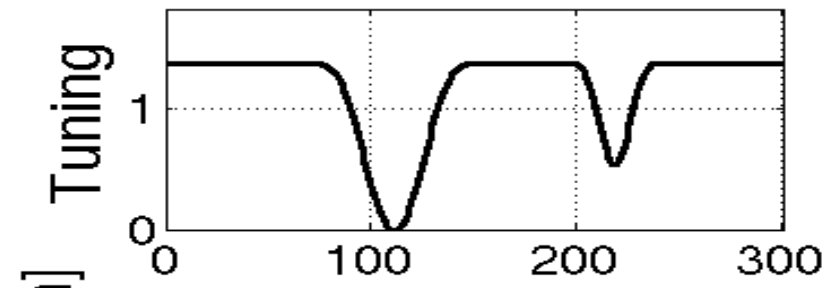
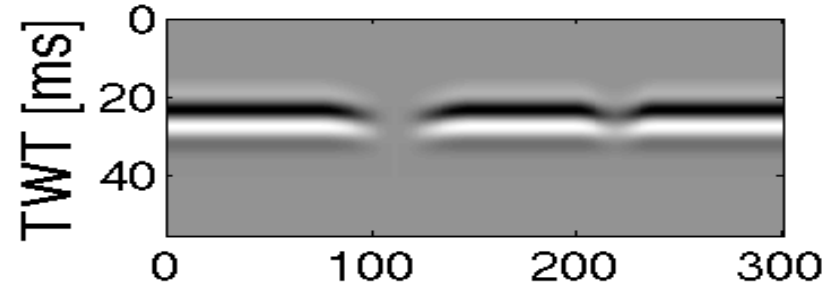
70 Hz Ricker



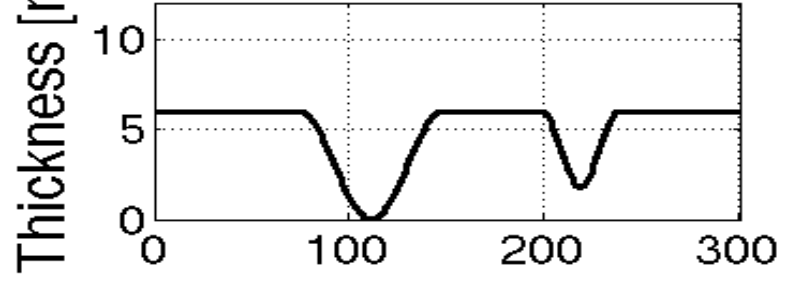
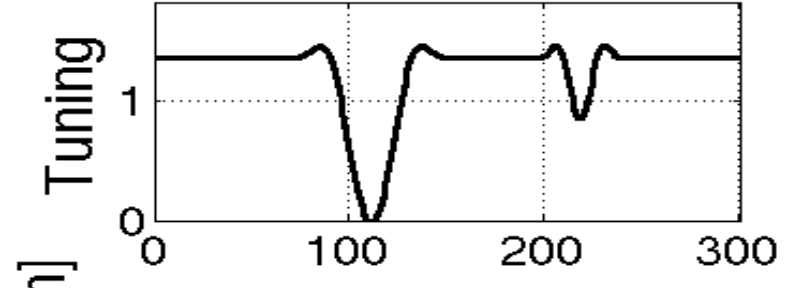
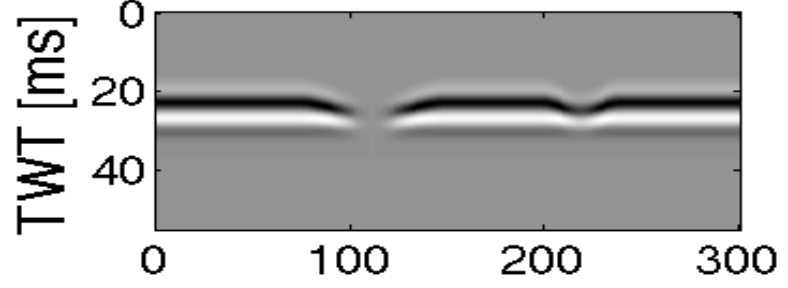
* Thickness calculated using velocity $c=1900\text{m/s}$

Tuning Analysis

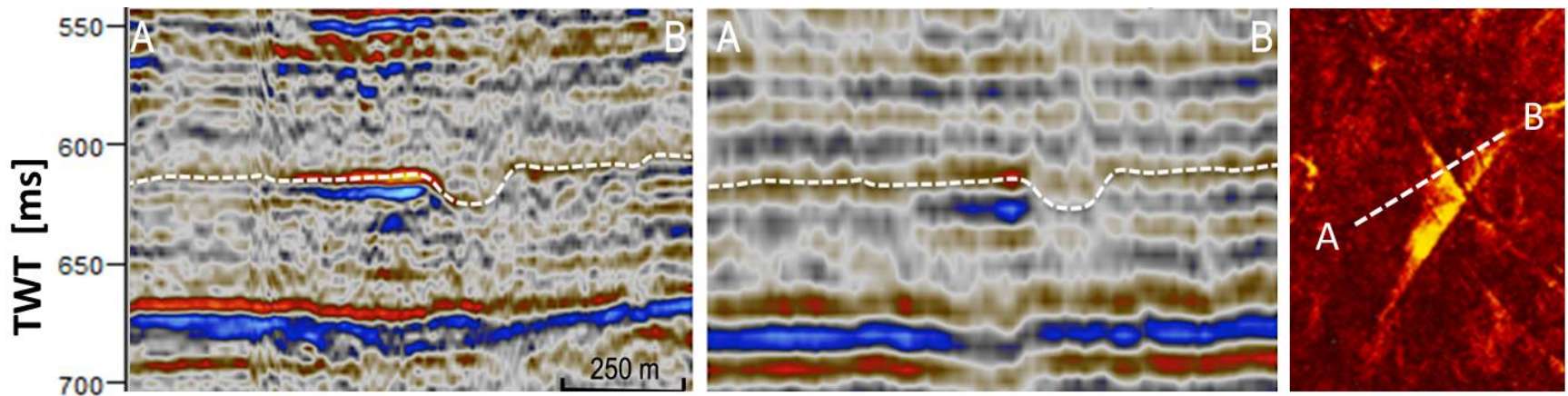
45 Hz Ricker



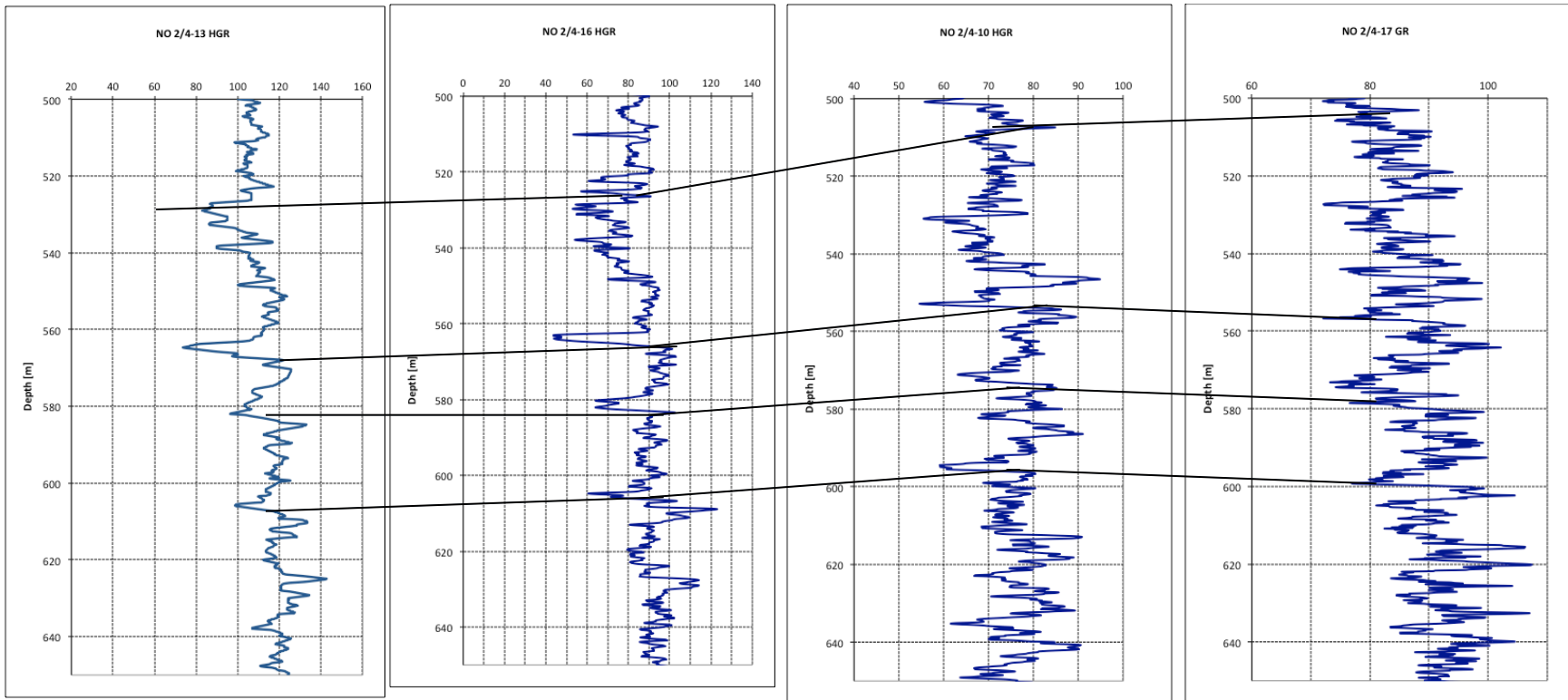
70 Hz Ricker

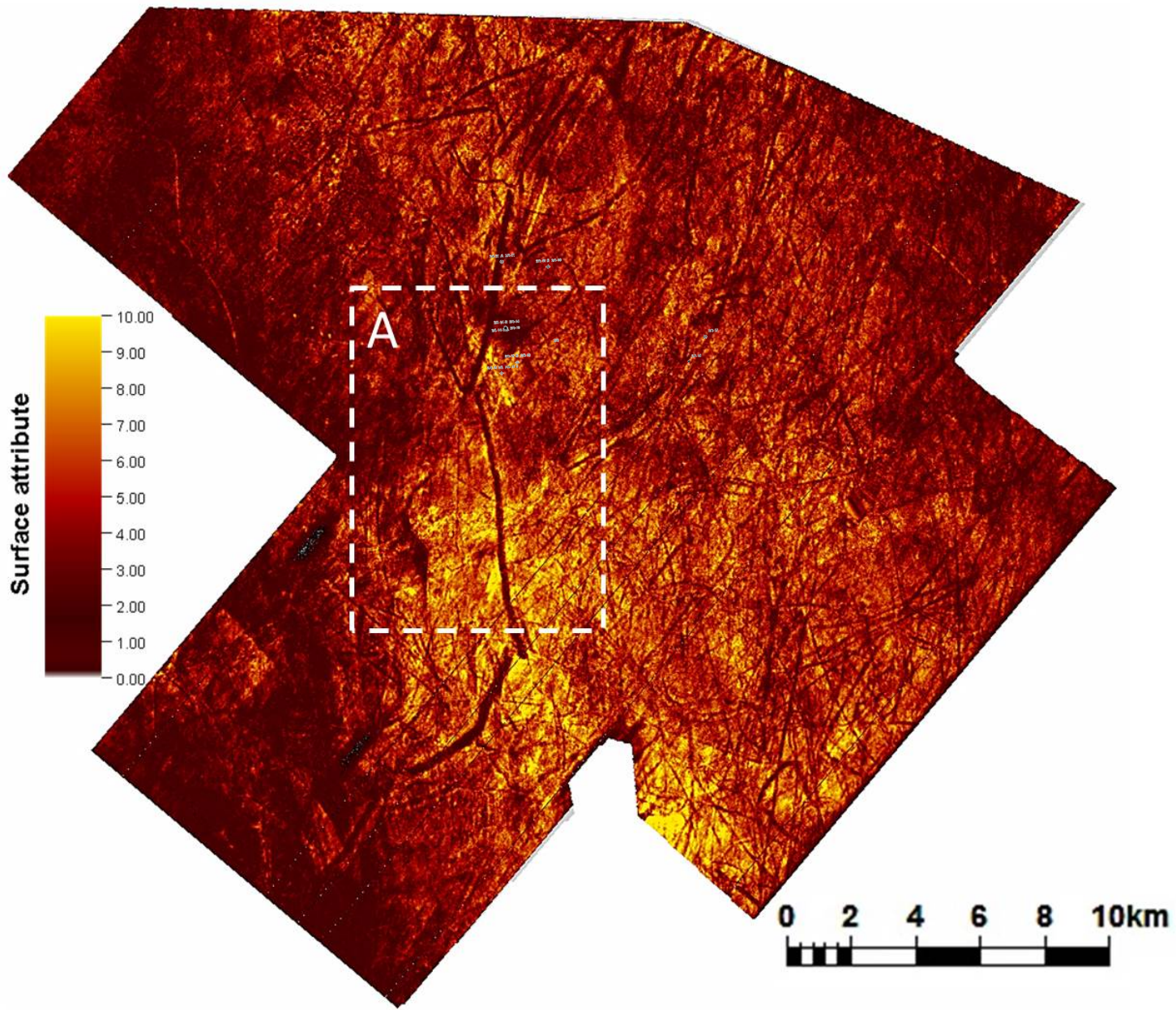


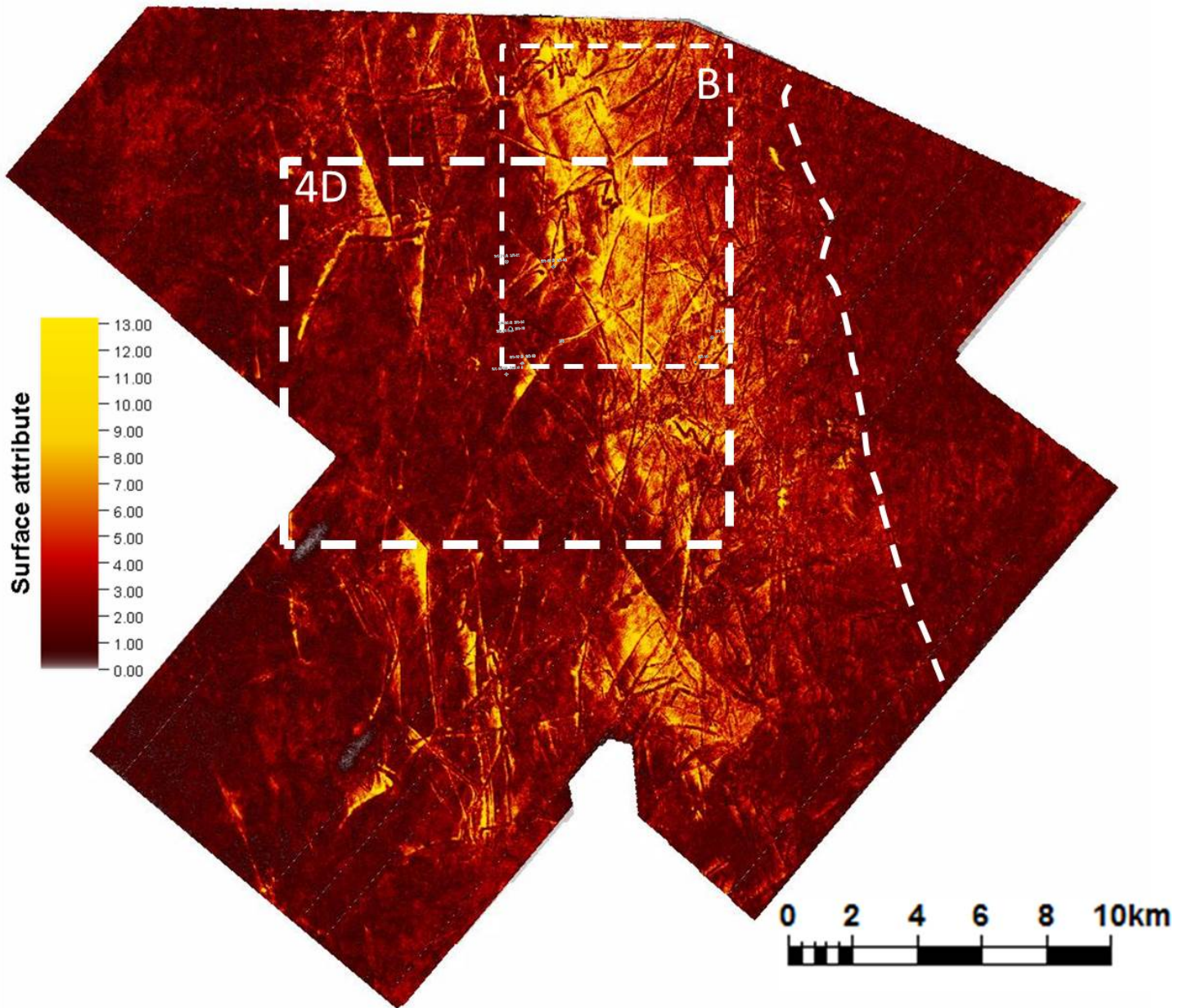
High res. 2D vs. Conventional 3D



Gamma-Ray Logs







10 Minute effort

