THE GAS HYDRATE STABILITY ZONE OF SVALBARD

Implications for hydrate occurrence

NFiP Sedimentary Gas Hydrate

Workshop 2019

Peter Betlem

Kim Senger, Andy Hodson, Snorre Olaussen, and others.

UNIS

``***Making Arctic Norway Sustainable***''

Outdoor laboratory of Svalbard

Negating Norway's last coal fired powerplant

Longyearbyen CO2 Lab (2015), The Longyearbyen CO2 Lab Phase 2 Final Report, http://co2-ccs.unis.no/Pdf/Longyearbyen CO2 lab Phase 2 Report_10_2015.pdf

PROJECT ORIGINS: LONGYEARBYEN CO_2 LAB OF ARCTIC NORWAY

Initiated in 2007, Phase II completed in 2015

Coal source, power plant, and storage site within a 7 km radius

No land use conflict nor NIMBY

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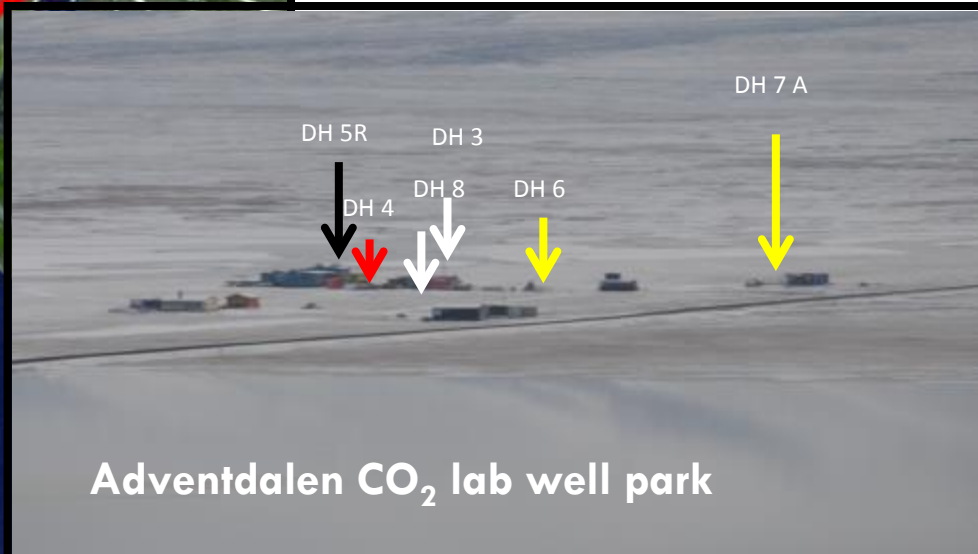


Adventdalen CO_2 lab well park

PROJECT ORIGINS: CO_2 LAB KEY FINDINGS

An efficient **seal** for buoyant fluid (i.e. until 125 Bar) is confirmed

High(er) pressure near permafrost base (**overpressure**)

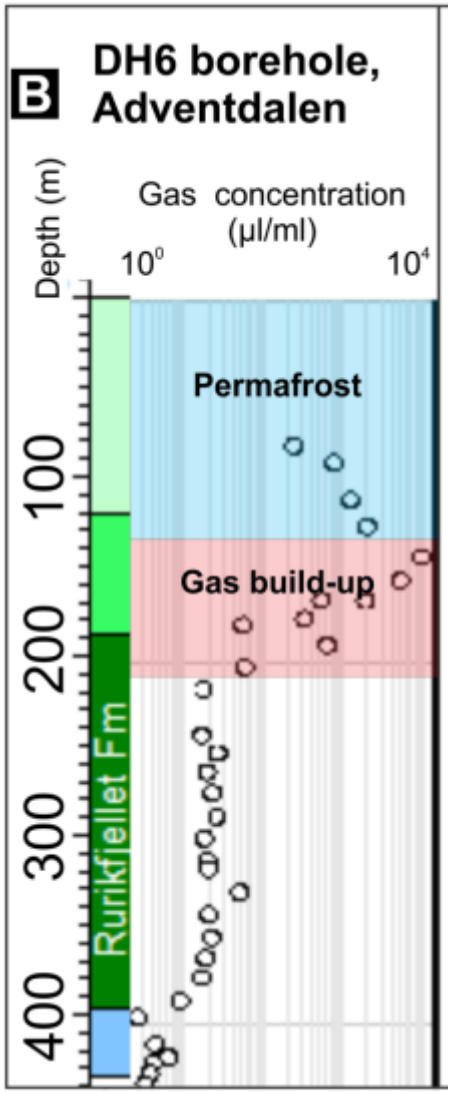
Low pressure reservoir (might change phase of CO_2)

Storage capacity and **injectivity** is confirmed

Fractures are the main fluid flow conduits, very low matrix permeability

Unconventional segmented reservoir

Natural gas is present in the subsurface



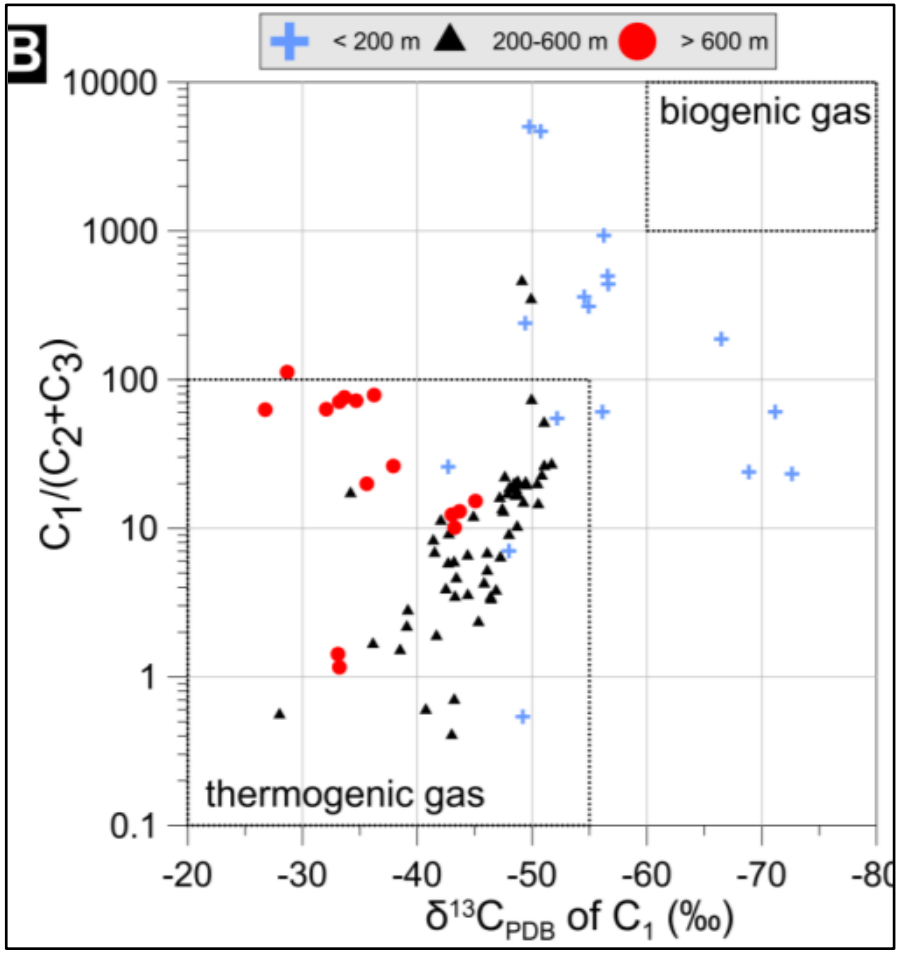
Longyearbyen CO2 Lab (2015), The Longyearbyen CO2 Lab Phase 2 Final Report, http://co2-ccs.unis.no/Pdf/Longyearbyen CO2 lab Phase 2 Report_10_2015.pdf
Braathen, A. et al. (2012), The Longyearbyen CO 2 Lab of Svalbard , Norway — initial assessment of the geological conditions for CO 2 sequestration, *Nor. J. Geol.*, *92*(4), 353–376.

SVALBARDIAN HYDRATES: SVALBARD HAS IT ALL

Extremely favourable temperature and pressure conditions

All five elements of the petroleum system are represented on Svalbard

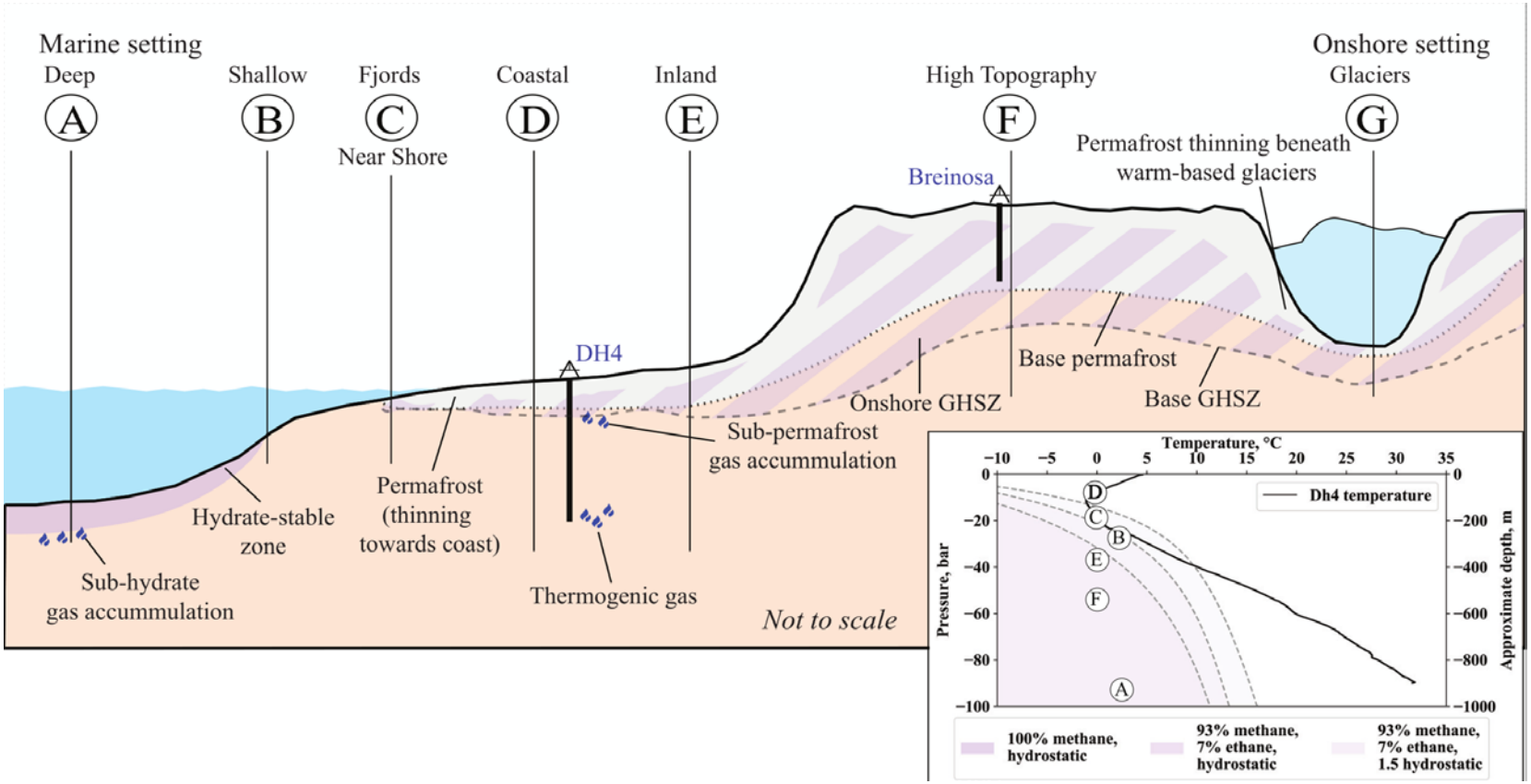
Hydrates observed offshore Svalbard (Vestnesa) – **<u>onshore?</u>**



Senger, K., P. Betlem, M. Liira, S. Roy, K. Midttømme, W. Wheeler, T. Beka, S. Olaussen, and S. Ohm (2017), Integrated thermo-baric moddelling of the gas hydrate stability zone onhore Svalbard, Arctic Norway, in *Ninth International Conference on Gas Hydrates*.

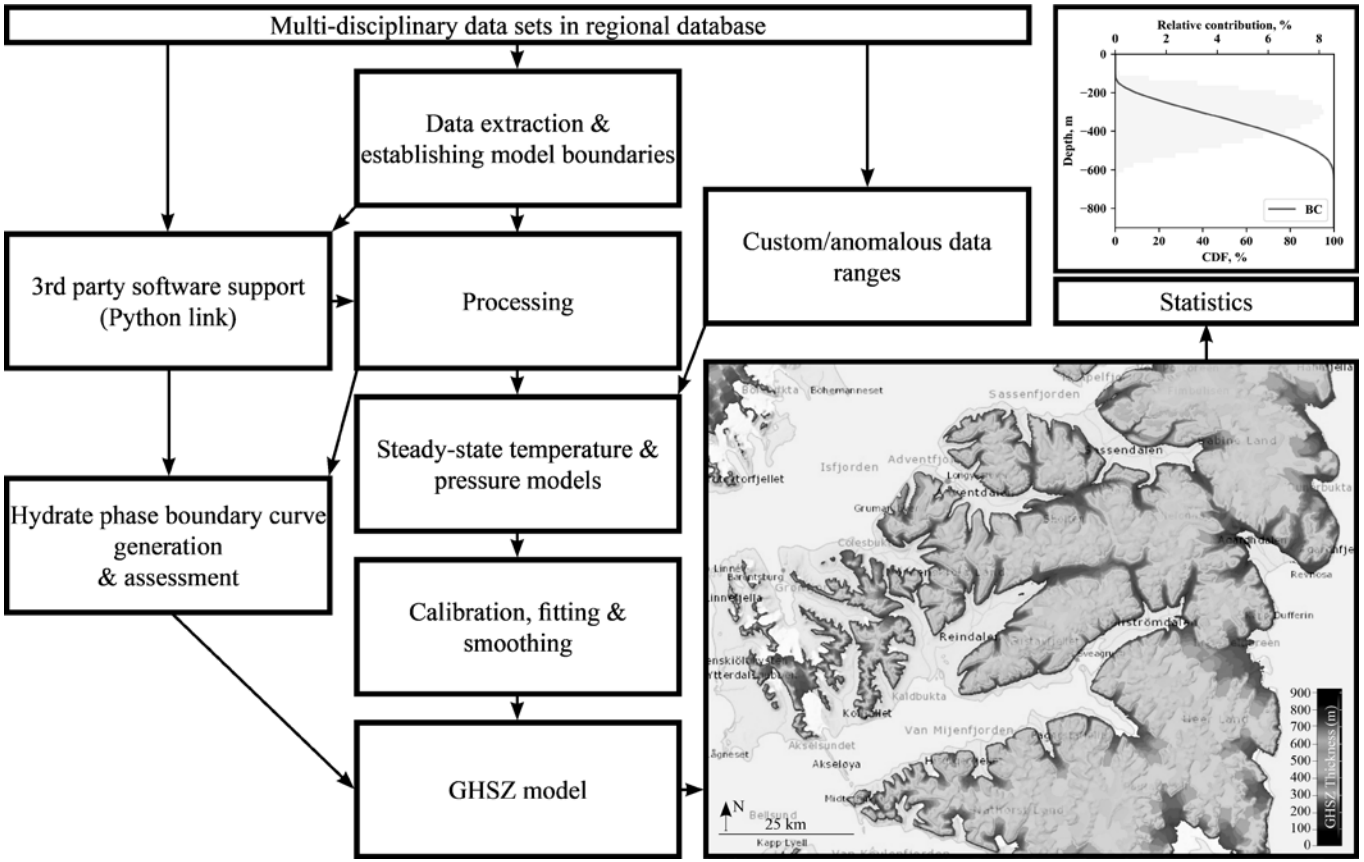
Huq, F., P. C. Smalley, P. T. Mørkved, I. Johansen, V. Yarushina, and H. Johansen (2017), The Longyearbyen CO2 Lab: Fluid communication in reservoir and caprock, *Int. J. Greenh. Gas Control*, *63*, 59–76, doi:10.1016/j.ijggc.2017.05.005.

PROPOSED SETTINGS ON SVALBARD



Betlem, P., Senger, K., & Hodson, A. (2019). 3D thermobaric modelling of the gas hydrate stability zone onshore central Spitsbergen, Arctic Norway. Marine and Petroleum Geology, 100, 246-262.

STEADY-STATE HYDRATE WORKFLOW



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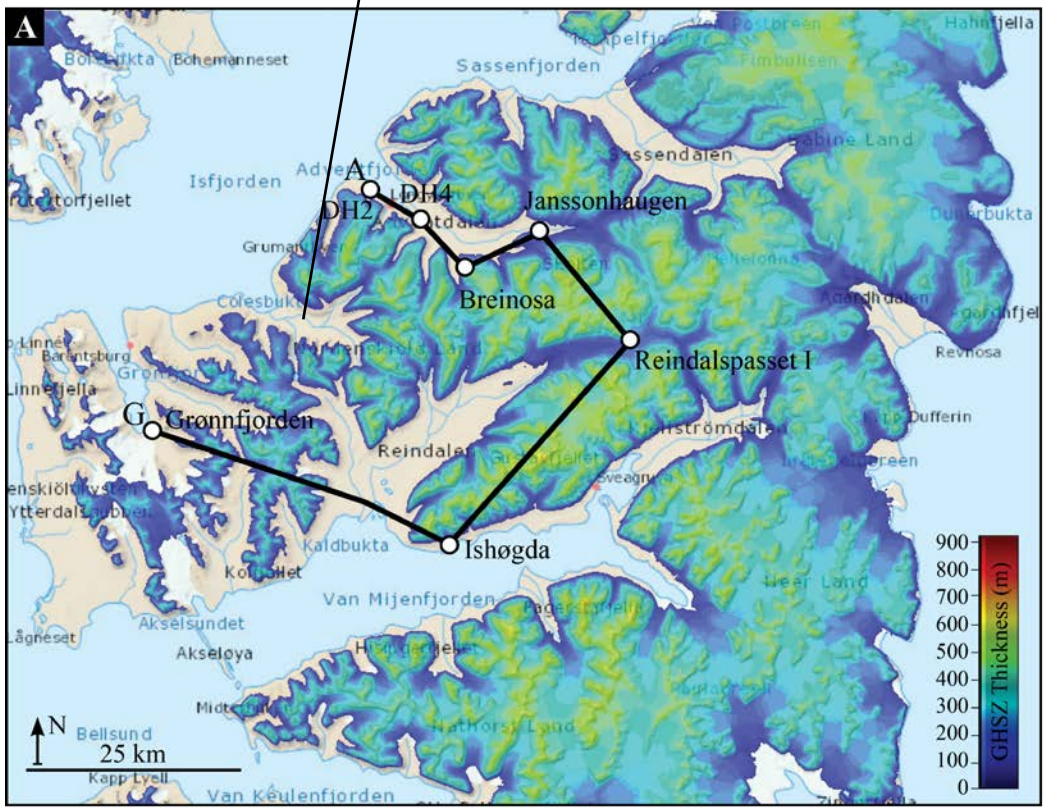
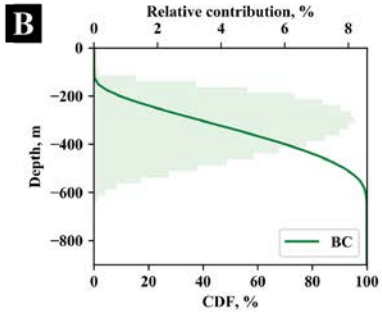
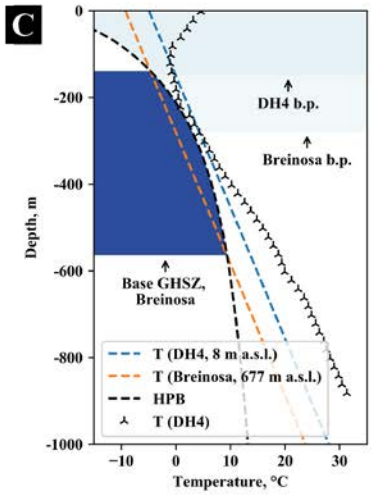
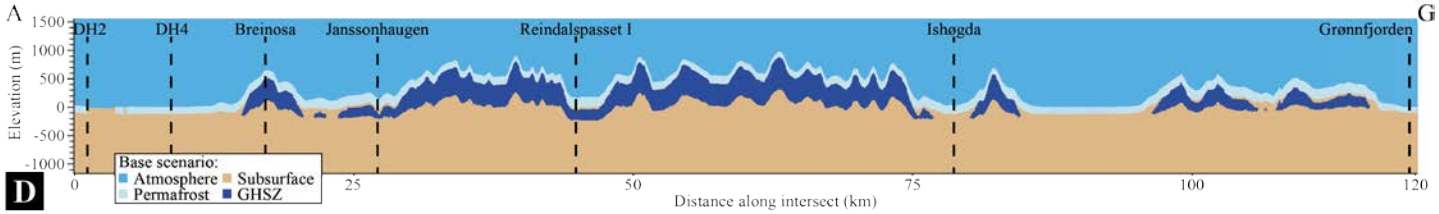
CENTRAL SPITSBERGEN: A DETERMINISTIC BASE CASE

?Observation? by Store Norske









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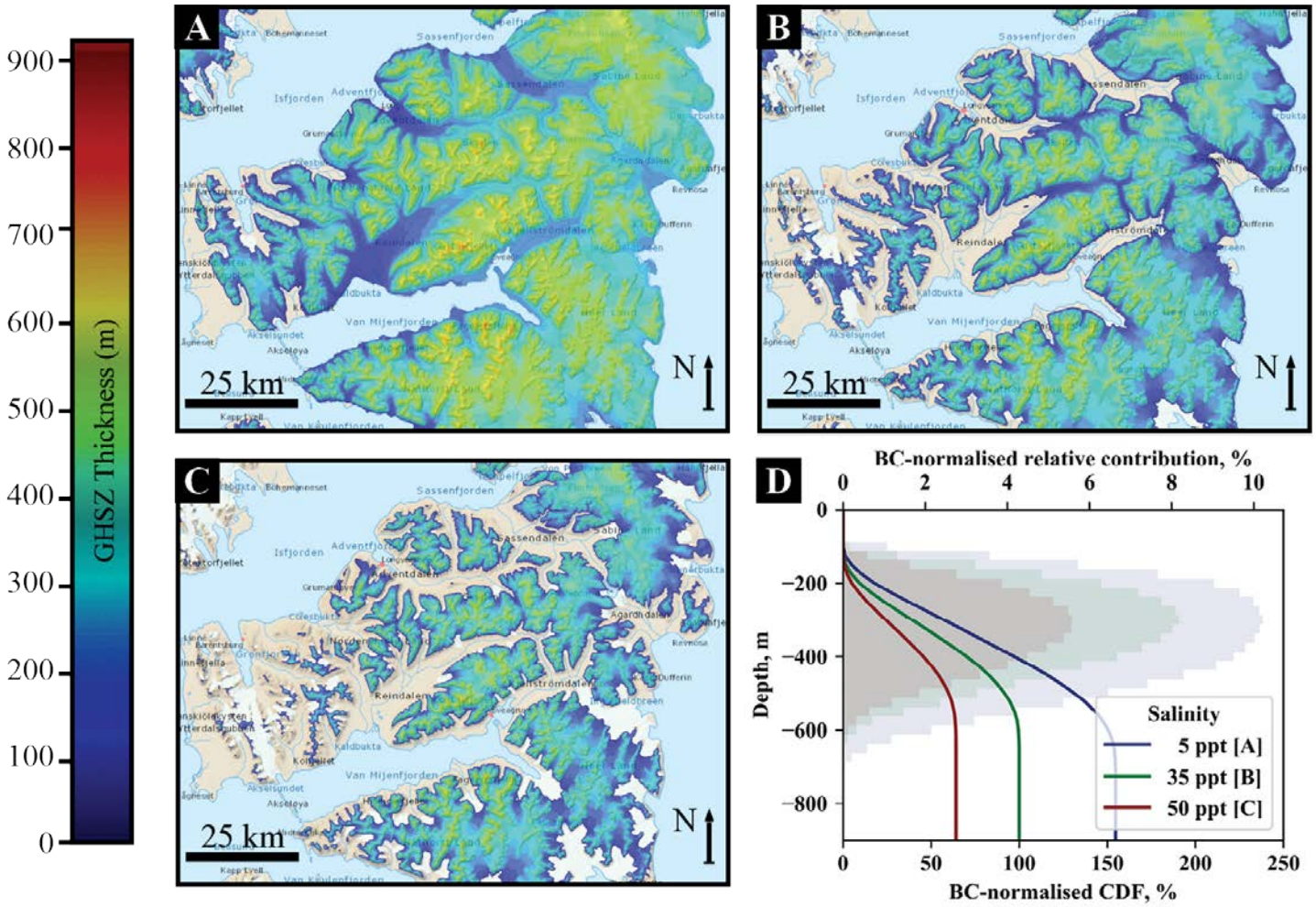
A CASE-BASED APPROACH: PICKING THE CORRECT SCENARIO



Low salinity levels are (likely) observed further inland, mountainous setting, fresh-water aquifers

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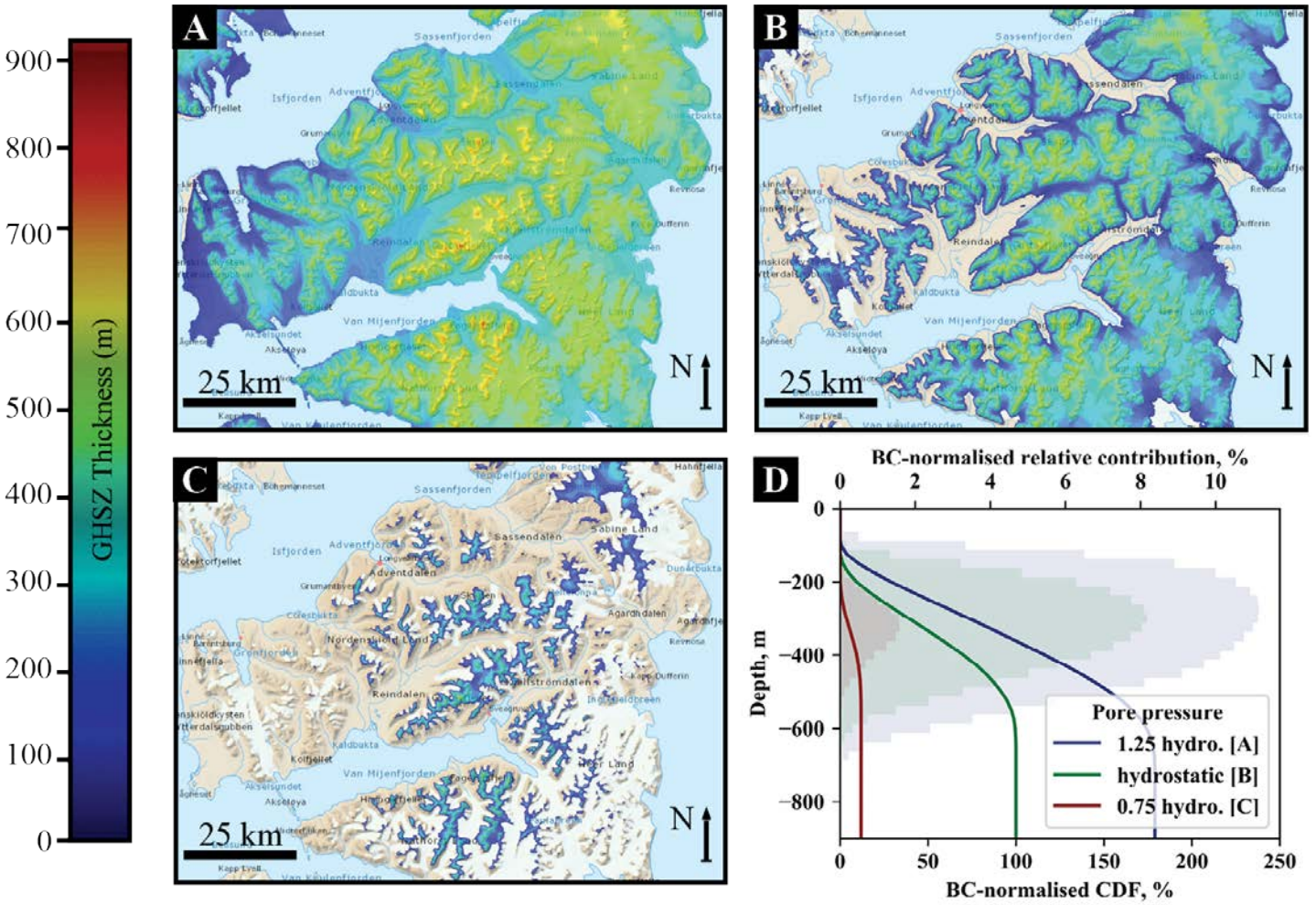

Overpressure near base permafrost and at other heterogeneities (e.g., pingos)

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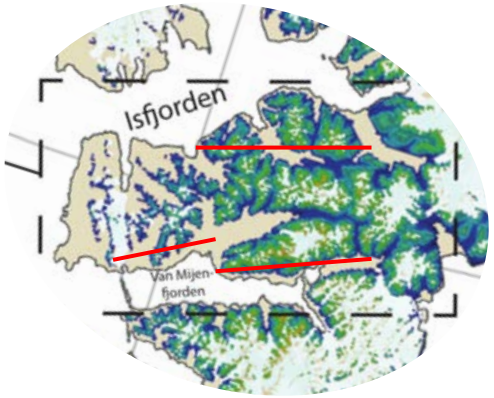
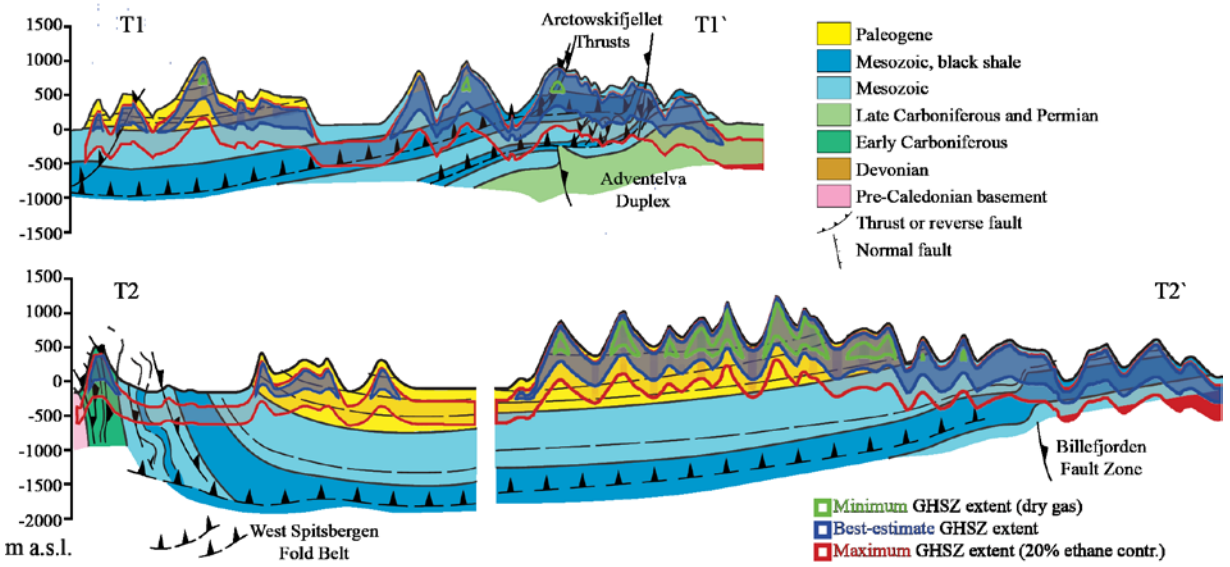
HOST ROCKS AND SWEET SPOTS: WHERE TO EXPLORE NEXT?

Just some of the possibilities:

- Sandstone-dominated sequences of the Van Mijenfjorden Group (*Paleogene*);
- Lowermost coal-bearing Firkanten Formation (*Paleogene*);
- The Early Cretaceous **Helvetiafjellet Formation;**
- The Late Triassic-Middle Jurassic Wilhelmøya Subgroup;





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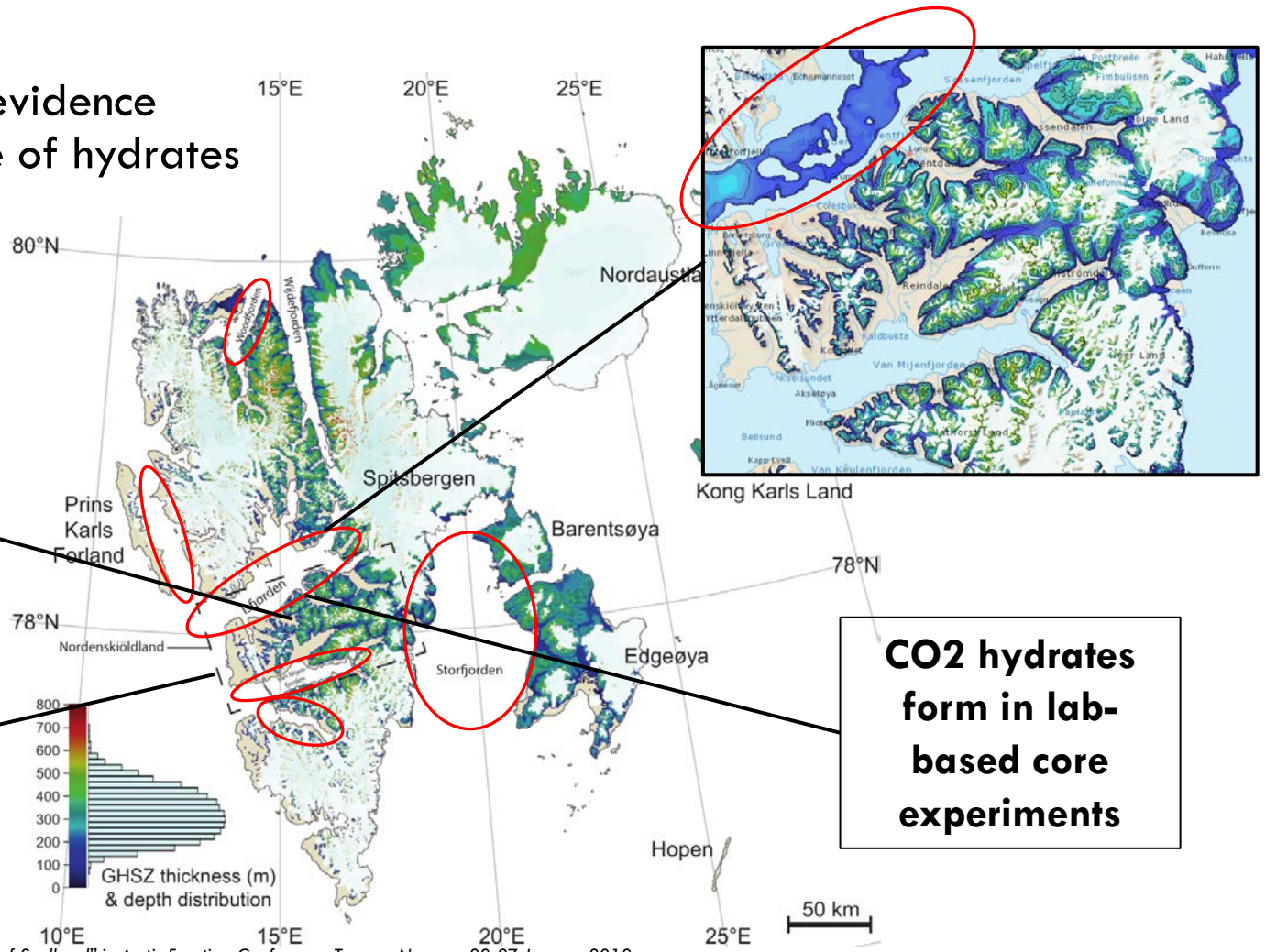
PINGOS

Hodson et al., *In Review*

SUMMARY AND FUTURE EFFORTS

Strong indirect evidence for the presence of hydrates



?Observation? by Store Norske

Pingos and other heterogeneities

CO2 hydrates form in lab-based core experiments

Almenningen et al., *manuscript*

Minshull et al., *submitted*

Roy et al., "Gas Hydrate formation potential in the fjords of Svalbard" in Arctic Frontiers Conference, Tromsø, Norway, 22-27 January 2012.

Betlem, "3D Thermobaric Modelling of Central Spitsbergen - Implications for Gas Hydrate Occurrence". Skemman.is, Master's thesis, June 2018.