



SwedSTORE^{CO2}: Plans for a Swedish onshore test site for CO₂ storage via seismic surveying and drilling on Gotland, Sweden

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SwedSTORE^{CO2} Goals

- Advance methods for site characterization of CO2 storage sites
- Answer the question: Do suitable aquifers and caprocks exist for CO2 storage in offshore Sweden?
- Build up national competence in geological storage of CO2 concerning evaluation of deep saline aquifers and their caprocks
- Perform a land based injection test
- Focus on the Faludden sandstone in the Swedish sector of the Baltic Sea





Why the Faludden?







Cambrian reservoirs



CO₂ storage capacity assessment:

- Structural closures in the Viklau, När and Faludden
- Stratigraphic trap in the Faludden reservoir

(Sopher et al., 2014: IJGGC)



12 larger structural closures identified







(Sopher et al., 2014: IJGGC)





Faludden stratigraphic trap



(Sopher et al., 2014: IJGGC)







- Faludden stratigraphic trap capacity: c. 5500 Mt
- Largest Faludden structural trap capacity: c. 75 Mt
- Only the stratigraphic trap is of real interest for commercial storage
- Swedish domestic CO2 emissions: c. 40 Mt





SwedSTORE^{CO2} Rationale

We can investigate and test the Faludden reservoir and trap onshore at a much lower cost than offshore

Need to better understand the Faludden sandstone stratigraphic trap!



 Southern Gotland for Faludden reservoir

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 Central Gotland for Faludden trap





X (m)



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Ч (m)





- Southern Gotland Reservoir test
 - Faludden depth: c. 600 m
 - Faludden thickness: c. 30 m
- Central Gotland Trap test
 - Faludden depth: c. 450 m
 - Faludden thickness: c. 0-5 m

Current activities



- Access to over 33000km of marine seismic data (blue lines opposite)
- Access to 100s of km of land data on Gotland
- Initiating cooperation with small exploration company
- Current research:
 - How to get more information out of the available seismic data.
 - Using the seismic data to better map the geological structure, with focus on the Faludden.

D. Sopher, C. Juhlin / Journal of Applied Geophysics 95 (2013) 1-15





Reprocessing of existing seismic data from the Hanö Bay area



Distance (km)



Reprocessing of the entire seismic data set will potentially allow more accurate estimates of storage capacities to be made



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Land data from central Gotland: Reprocessing and reinterpretation to study Faludden pinchout





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Drilling and logging



Swedish National Drilling Rig "Riksriggen" Operated by Lund University



Uppsala University logging system





- S Drilling Capacity 2500 m N-size
- Main hoist 178 kN
- § Hydraulic feed cylinder: 200 kN
- [§] Cummins QSL.9 Tier III
 224 kW (305 hp)
- § 3.5 m feed stroke
- [§] P size drill head (120 mm ID)
- SCT20 for crawler mounted
- Some of the second s



(courtesy JE Rosberg)

Productive, safe and service friendly

SwedSTORE^{CO2}

P-size

Core diameter 63.5 mm Hole diameter 96 mm

H-size

Core diameter 85 mm Hole diameter 122.6 mm

Need core to understand the reservoir and caprock properties



Core diameter 47.6 mm Hole diameter 75.7 mm

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Proven drilling competence in the Swedish mountains

- Tectonic evolution
 - Channel flow
 - Basement involved thrusting
- Comparison with the Himalayas
- Present day and past deep fluid circulation patterns
- Current heat flow and climate modeling
- Deep biosphere
- Calibration of high quality surface geophysics







COSC-1 borehole



Objective: Drill as thick a section as possible through the high grade metamorphic Seve Nappe, through the thrust zone and into the lower grade metamorphic units below





Core drilling: 1 May to 26 August 2014



Bit size	Interval (m)	Recovery	m/day
HQ3	102-1616	100%	33-63
NQ	1616-2496	100%	36









SwedSTORE^{CO2} potential phases UNIVER

- Phase 1: Feasibility study \leftarrow 2012-2013
- Phase 2: Site characterization \leftarrow 2016-2019
- Phase 3: Test injection \leftarrow 2020-2021
- Phase 4: Abandonment \leftarrow 2022-2025



Phase 1 identified Gotland and SW Skåne as locations for test injection of CO2









SwedSTORE^{CO2} Status as of 2014 UNIVERSITET

- 1 May 2012: Project start for Phase 1
- 15 September 2013: Final report for Phase 1 to the Swedish Energy Authority
- November 2013: Application for Phase 2 submitted to the Swedish Energy Authority ← Rejected in late 2014





Phase 2 potential funding

- Application submitted to Swedish Research Council in 16 April 2015 for southern Gotland
- Application to be submitted to Energimyndigheten during 2015 for central Gotland
- Application with INTERREG?





Desired phase 2 activities

- Seismic surveying
- Drilling
- Hydraulic testing and sampling
- Geophysical logging
- Core analysis
 - Off-site
 - On-site
- Integration of results
- CO2 source and transport options
- Detailed cost estimate for Phase 3

- Stress tests
- Raman spectroscopy
- Fluid composition
- Modeling CO2 injection
 - Short term
 - Long term
- Establish a SAC



Phase 3



- Observation boreholes CO2 injection 300 m O \mathbf{O} test aquifer for CO2 storage
- The test site will consist of 4-5 boreholes, one of which is for CO2 injection
- Monitoring at the site will be an important component of the project
- Will build on the experiences at other test sites

Pathway to two degrees

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Thank you