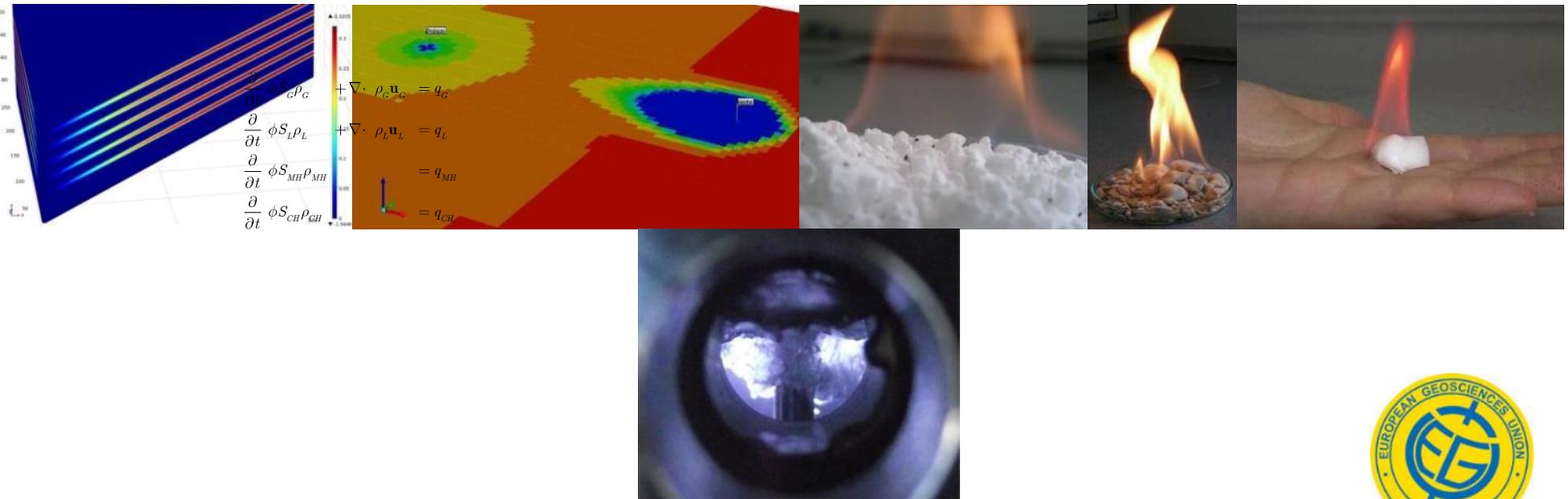


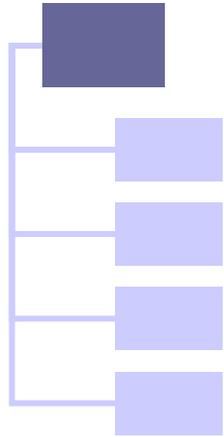
Simulation of subsea gas hydrate exploitation

EGU General Assembly, Vienna April 29th, 2014

Georg Janicki, Stefan Schlüter, Torsten Hennig, Göрге Deerberg

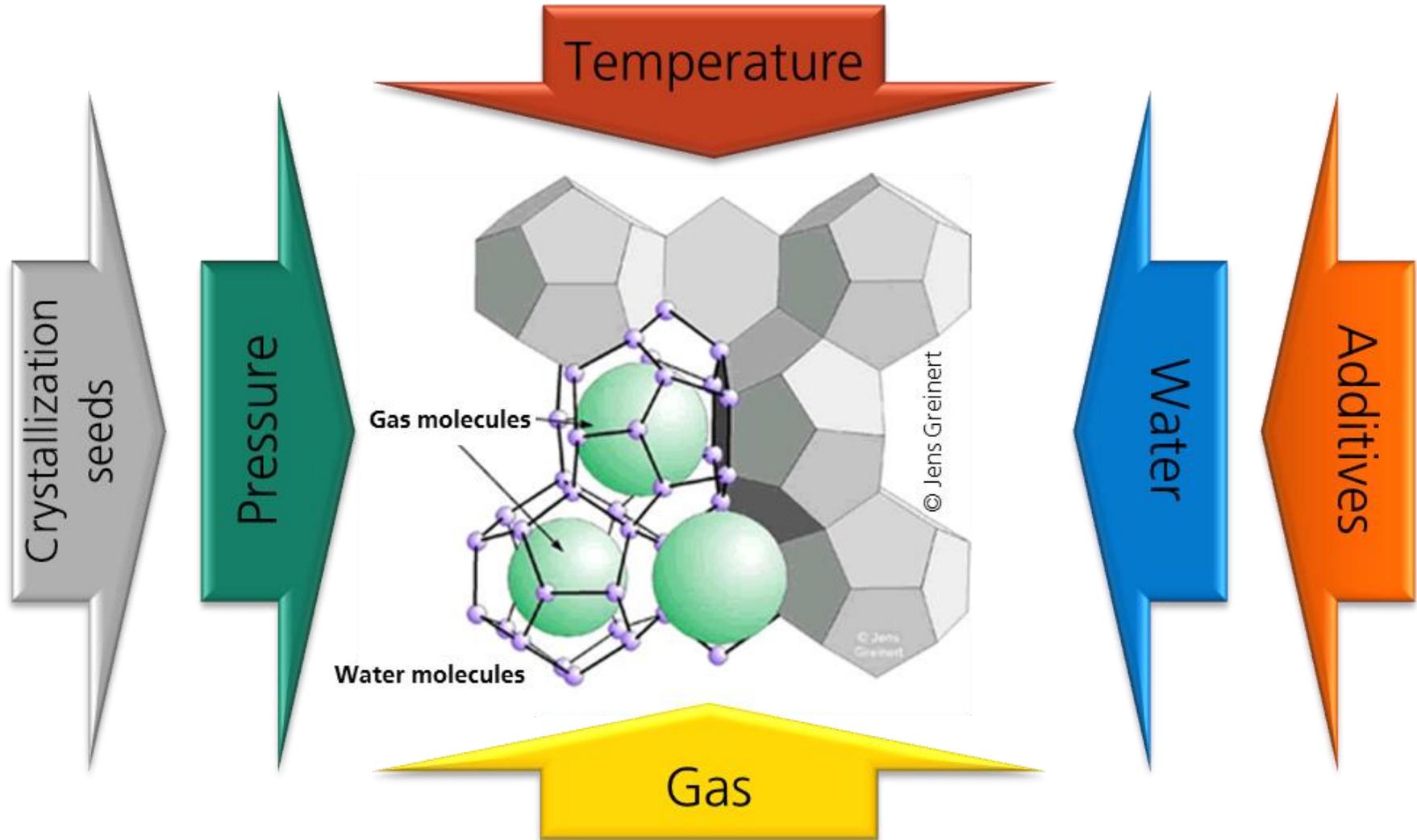


Outline

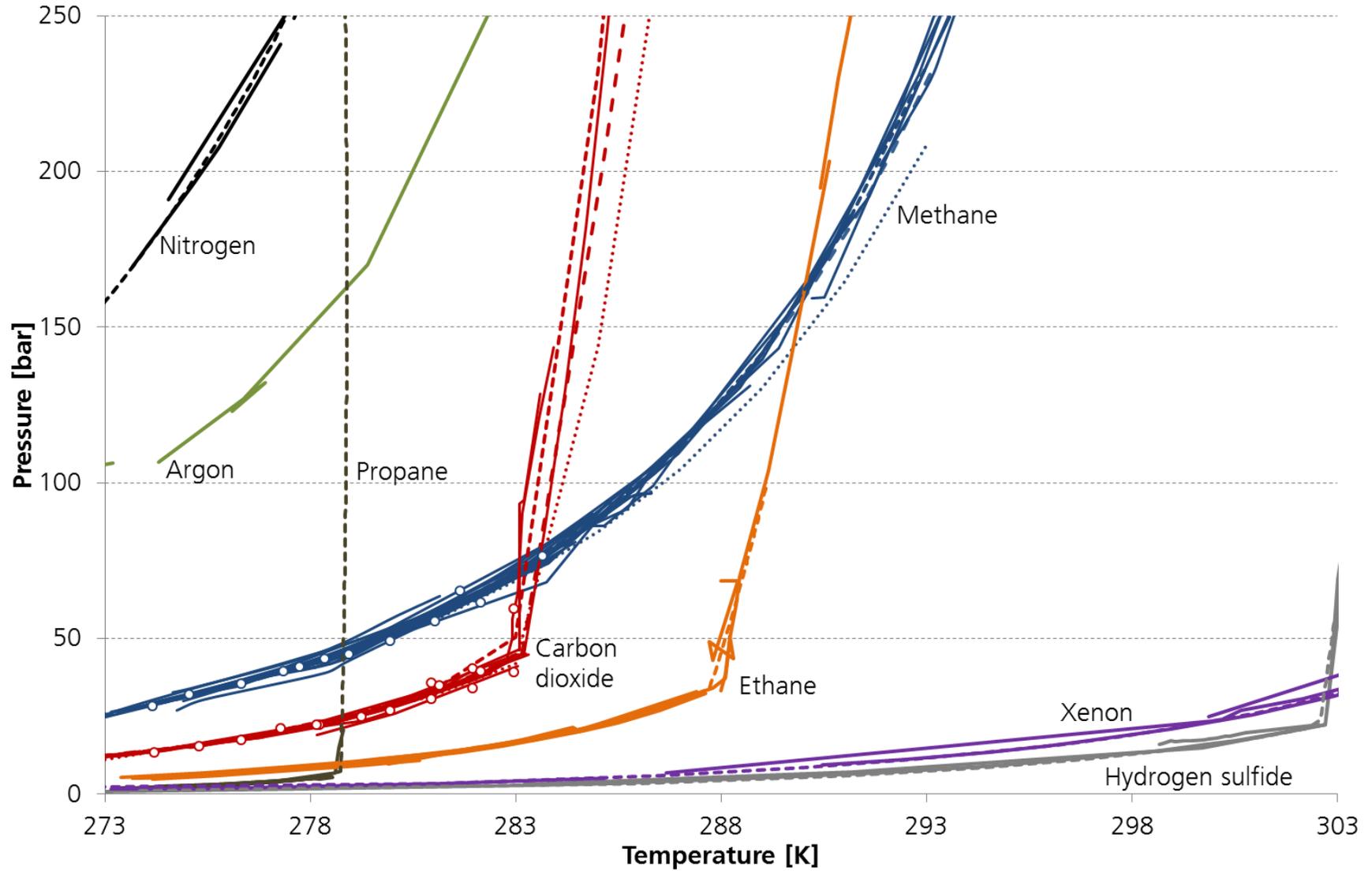


- Introduction to gas hydrates
- Gas hydrates as an energy source: SUGAR project
- Numerical simulation of hydrate exploitation
 - Simple depressurization
 - CO₂ injection
- Summary

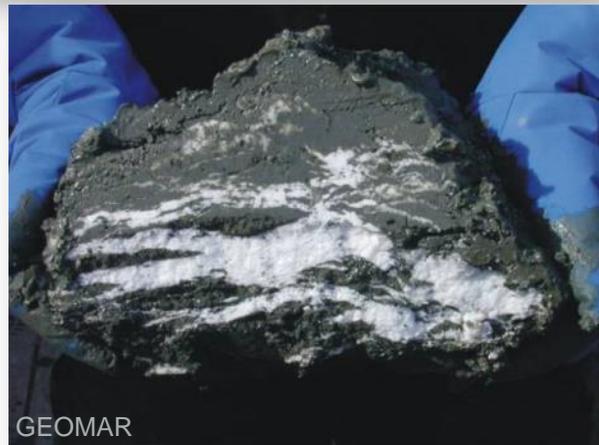
What are gas hydrates?



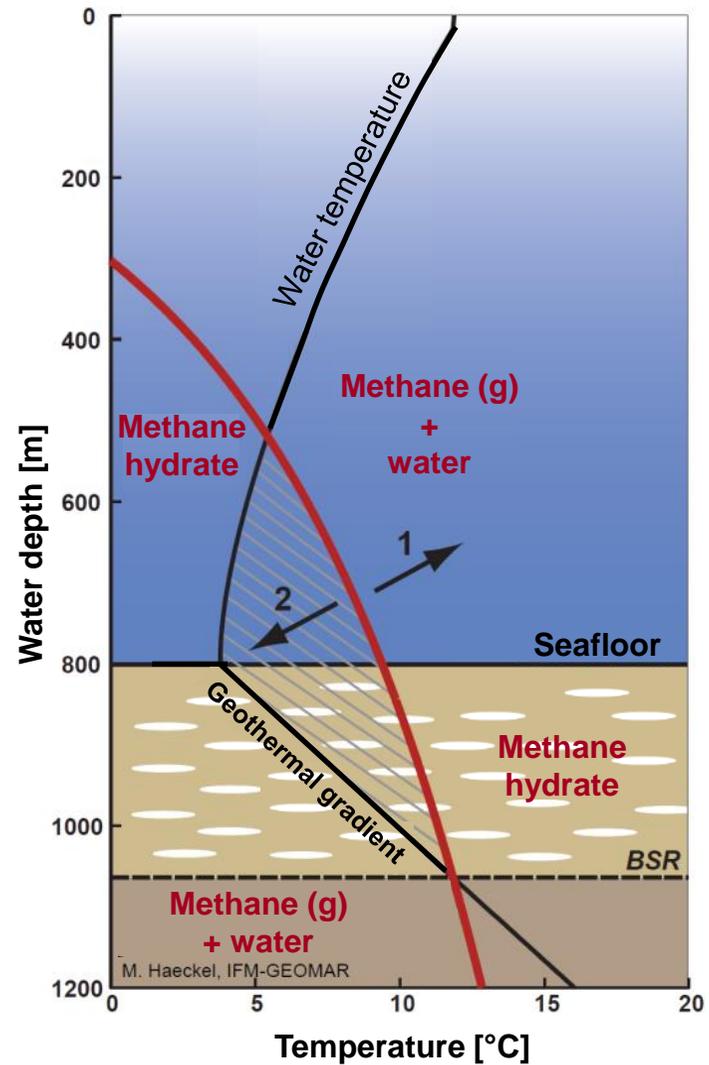
Stability of gas hydrates



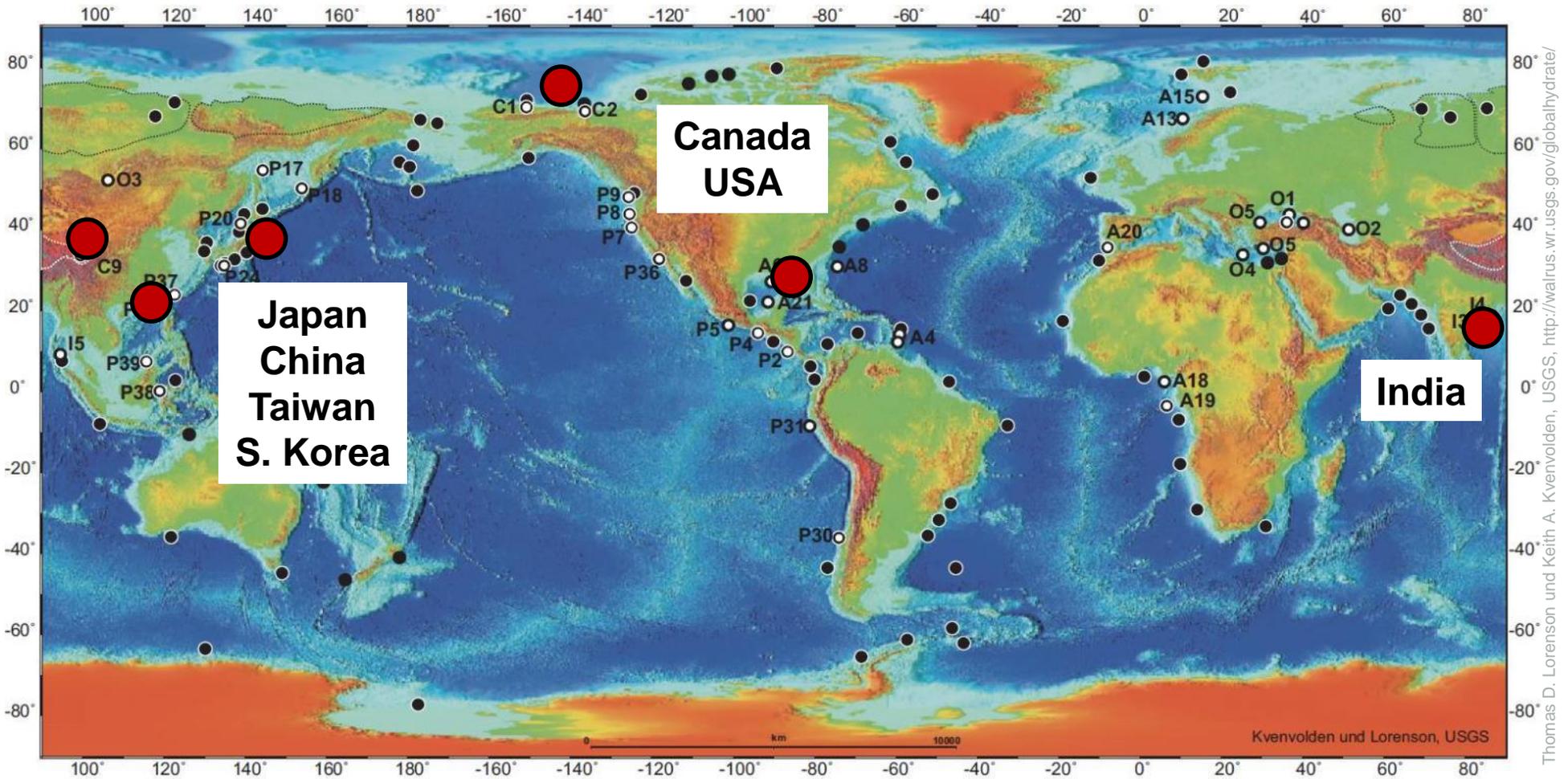
How do gas hydrates look like?



Where you can find hydrates?



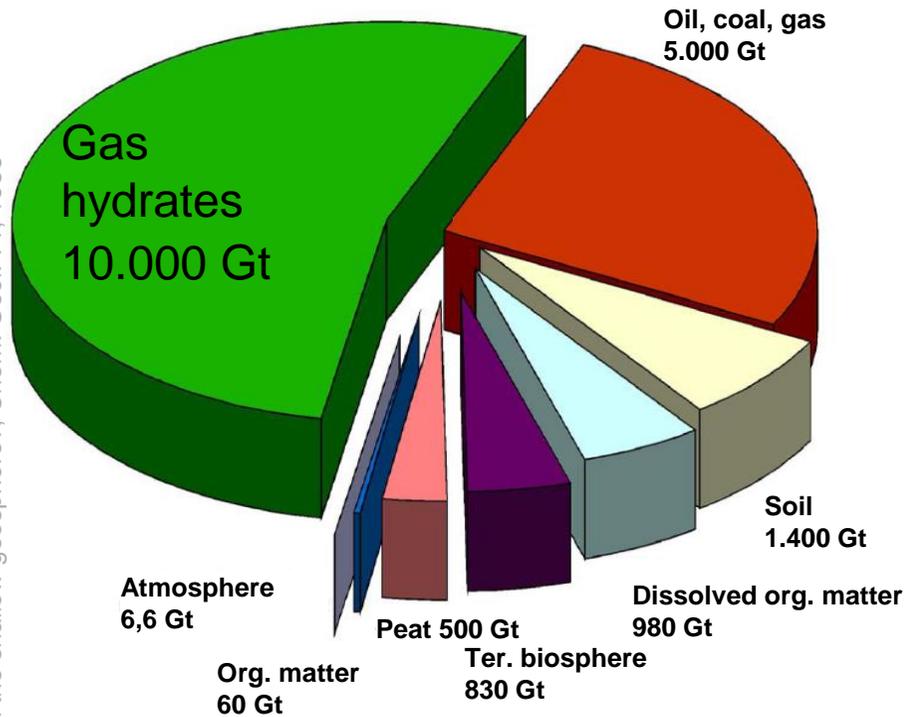
Where you can find hydrates?



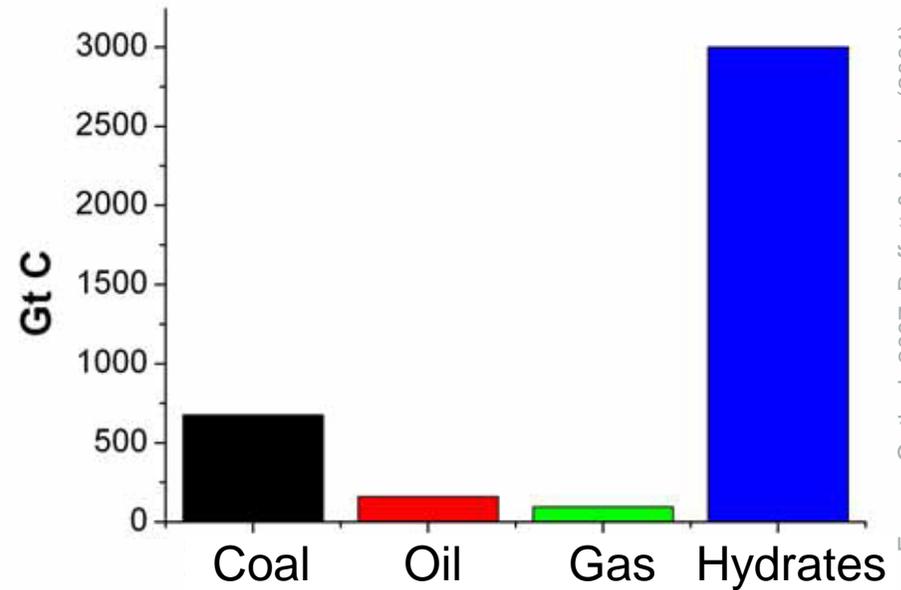
Thomas D. Lorenson und Keith A. Kvenvolden, USGS, <http://walrus.wr.usgs.gov/globalhydrate/>

Gas hydrates and carbon matter

Gas hydrates and carbon matter



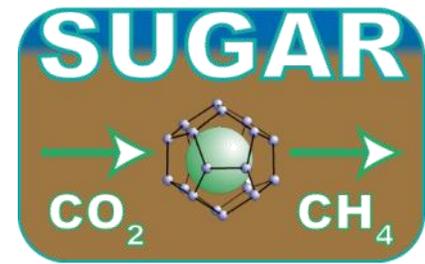
Fossil fuel reserves and submarine gas hydrates



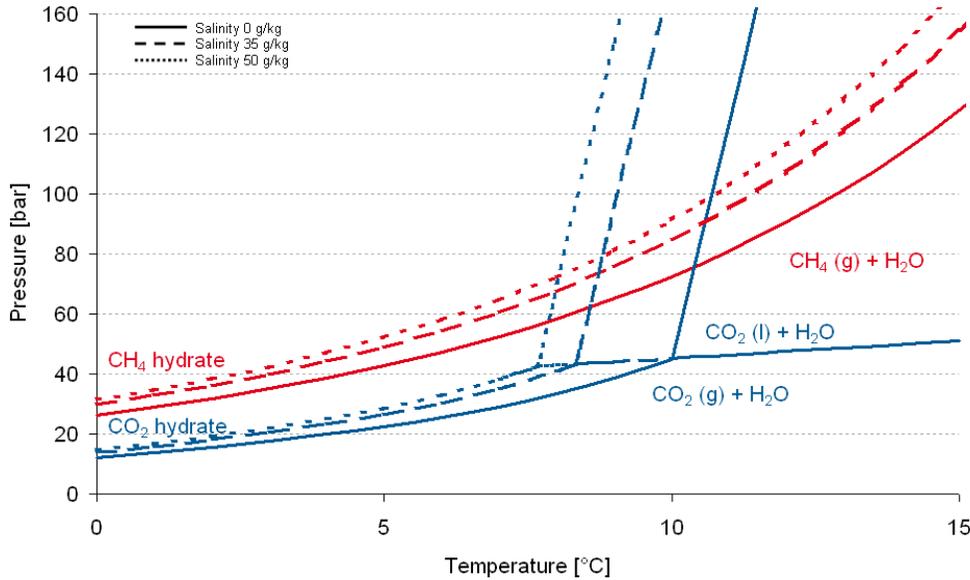
Energy Outlook 2007, Buffett & Archer (2004)

Keith A. Kvenvolden, Methane hydrate – A major reservoir of carbon in the shallow geosphere?, Chem. Geol. 71, 1988

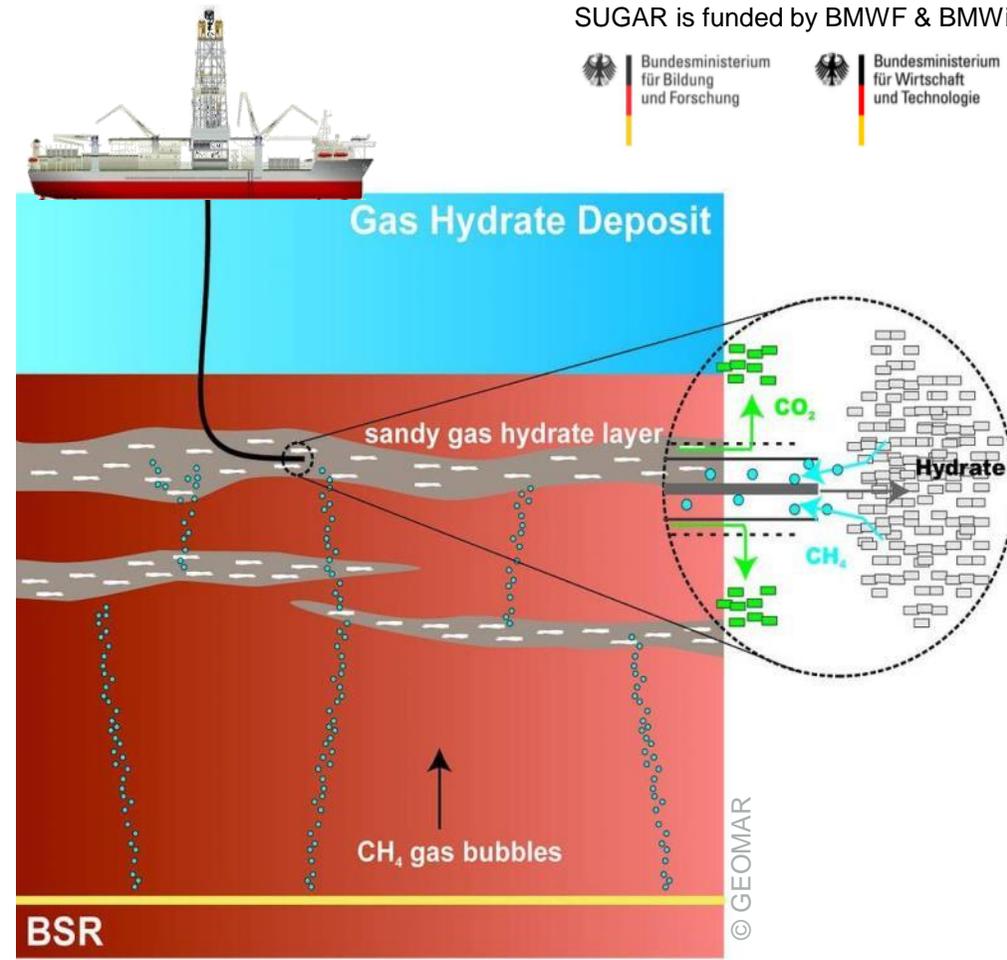
Simulation of natural gas hydrate exploitation



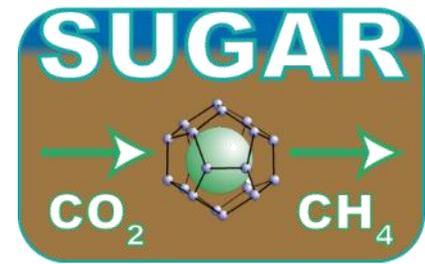
SUGAR is funded by BMWF & BMWi



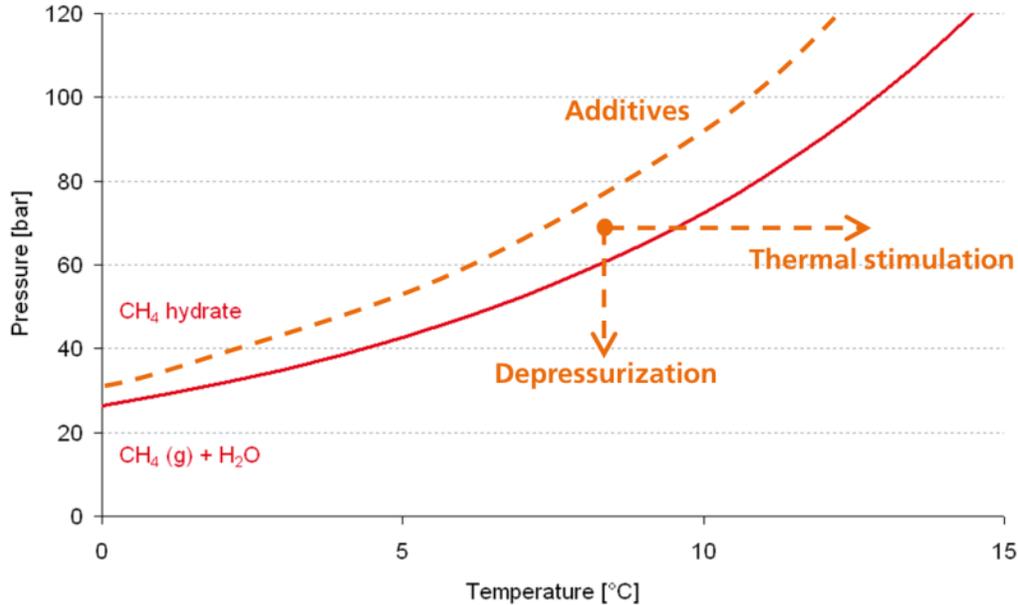
- CO₂ hydrate stable at lower pressure / higher temperature
- CO₂ higher stability
- Replacing CH₄ by CO₂
- Simultaneous production of CH₄ and storage of CO₂
- Sustainable energy supply system



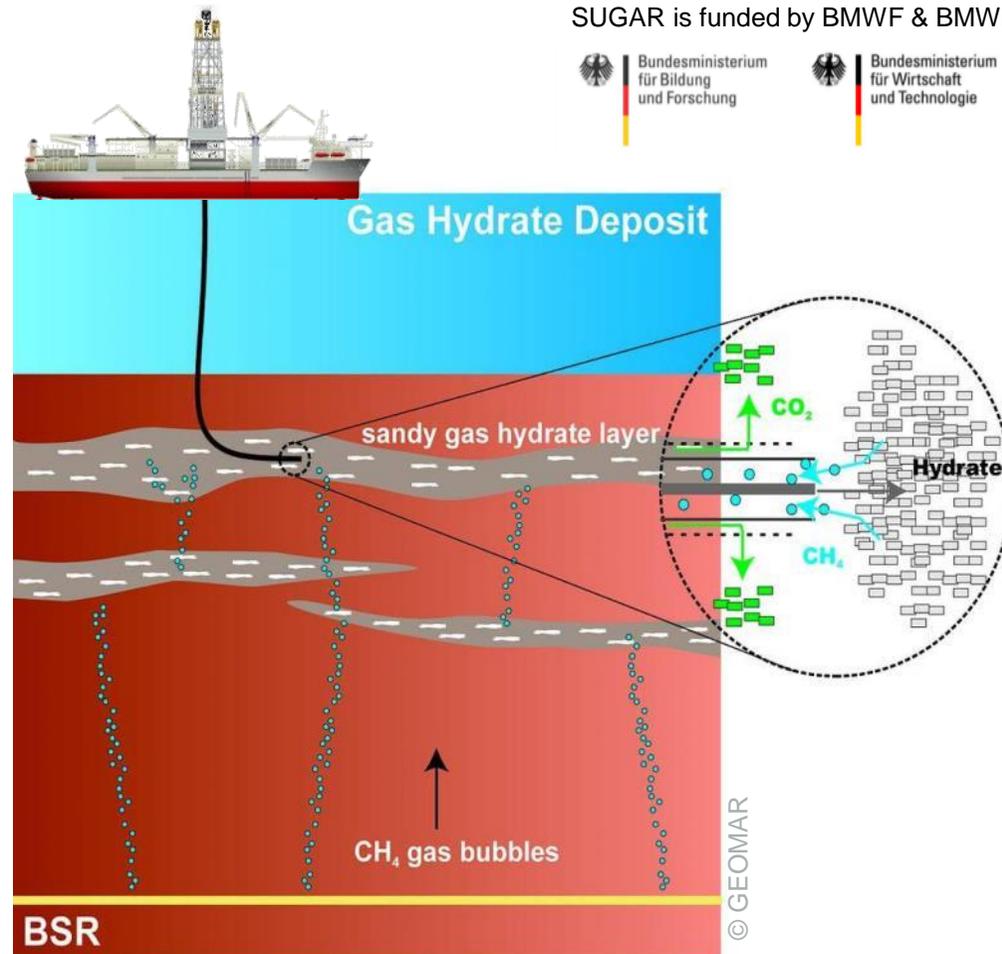
Simulation of natural gas hydrate exploitation



SUGAR is funded by BMWF & BMWi

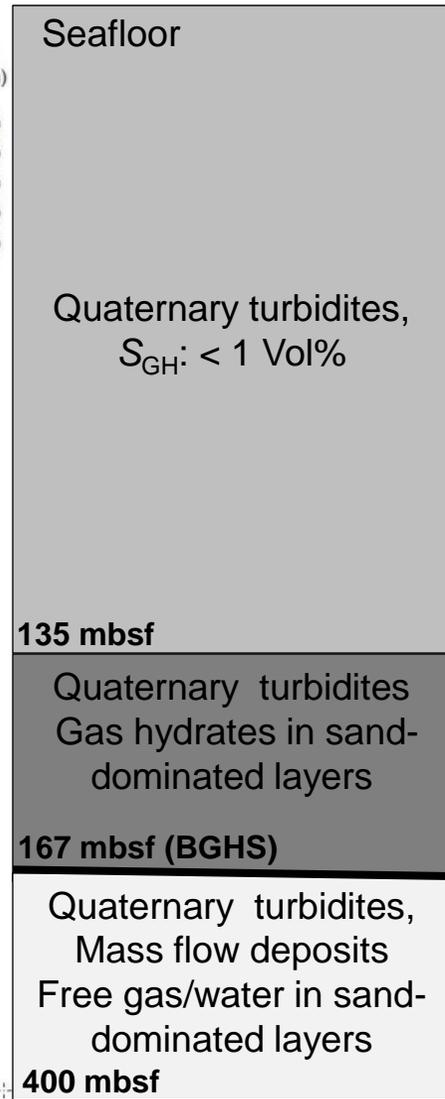
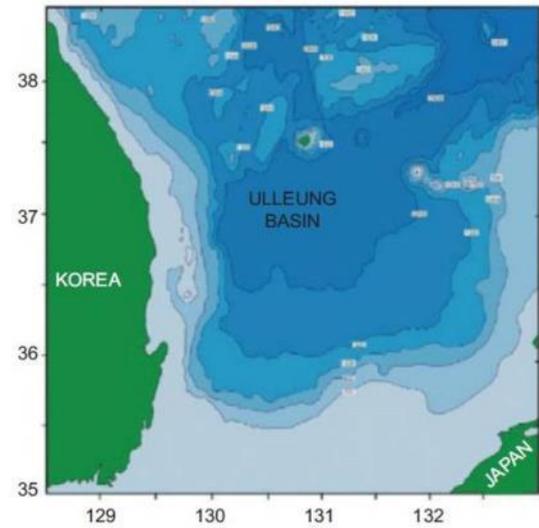
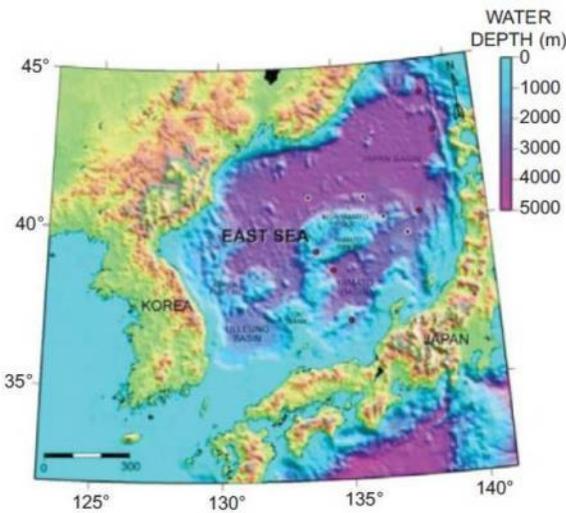


- CO₂ hydrate stable at lower pressure / higher temperature
- CO₂ higher stability
- Replacing CH₄ by CO₂
- Simultaneous production of CH₄ and storage of CO₂
- Sustainable energy supply system



Case study - Ulleung Basin, South Korea

Water depth: 2153 m,
Salinity: 34,
Geotherm: $0.2\text{ }^{\circ}\text{C} + 112\text{ }^{\circ}\text{C}/\text{km}$



Sediment depth [m]

139.5
145.0
151.5

Clay:

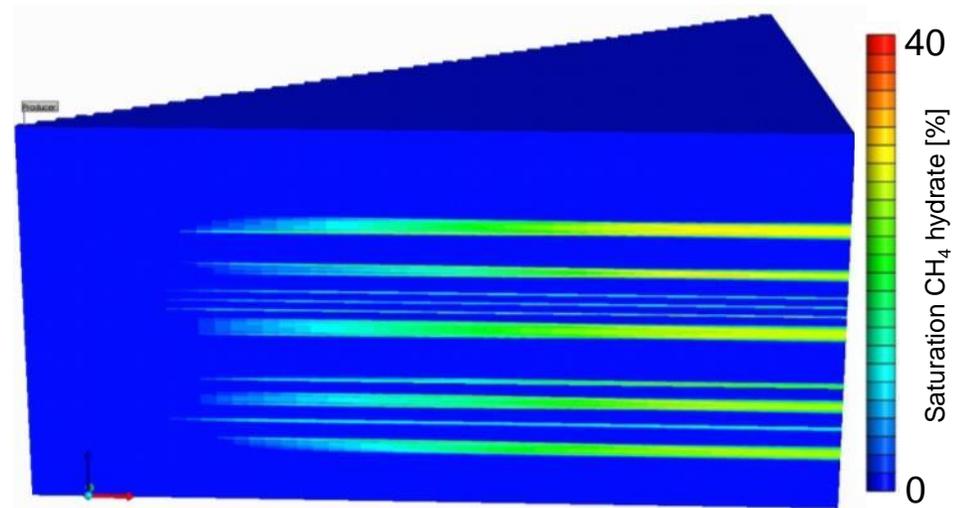
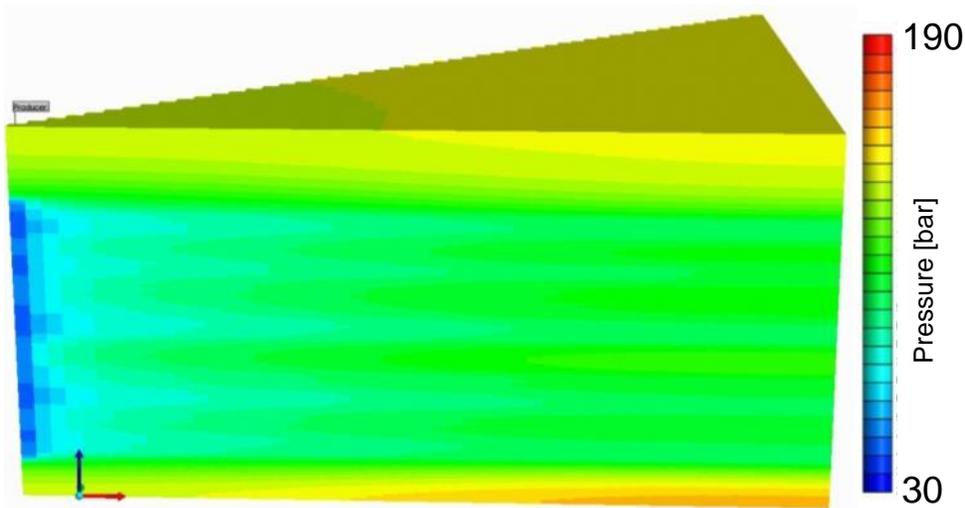
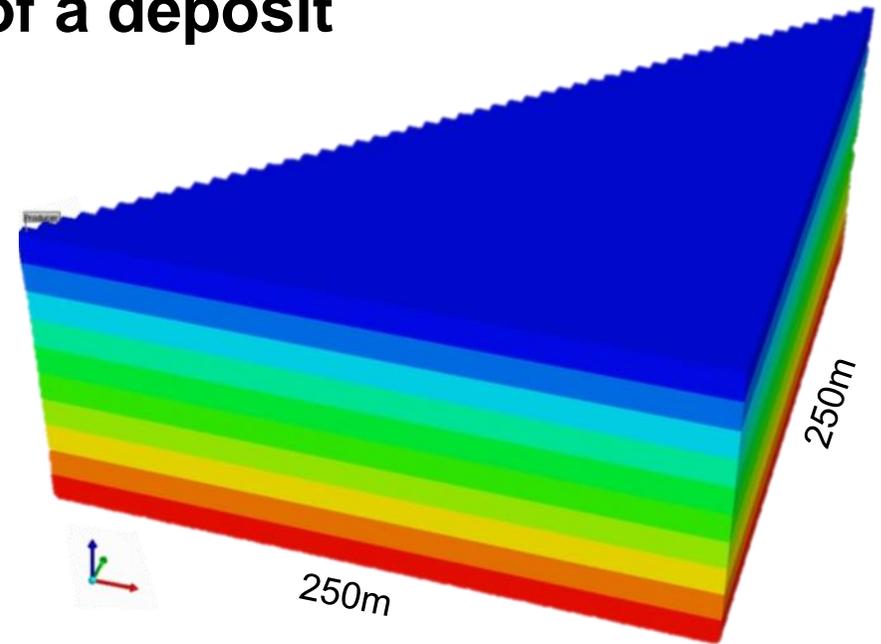
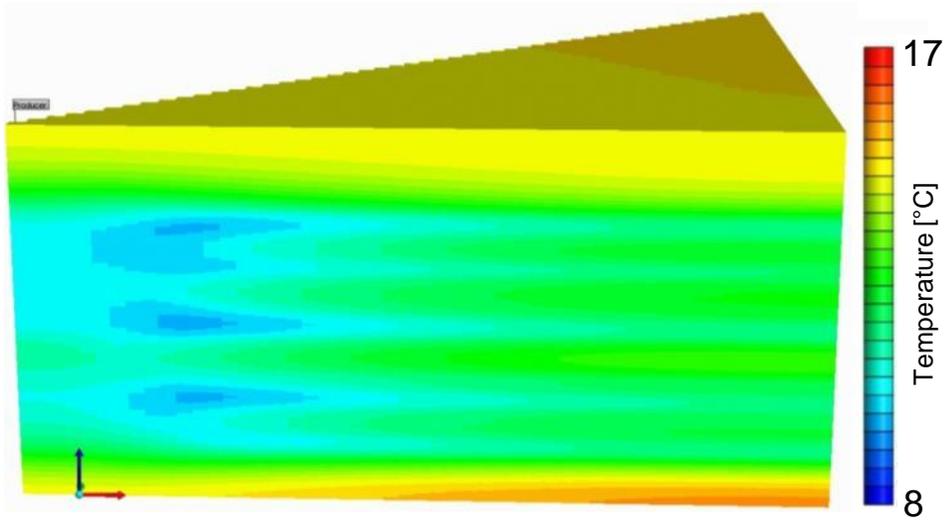
- ϕ : 0.5
- K_y : 1 mD
- K_x : 2 mD
- S_{GH} : $< 1\text{ Vol}\%$
- λ : 0.3 W/m/K

Sand:

- ϕ : 0.3
- K : 1000 mD
- S_{GH} : 40 Vol %
- λ : 1.3 W/m/K



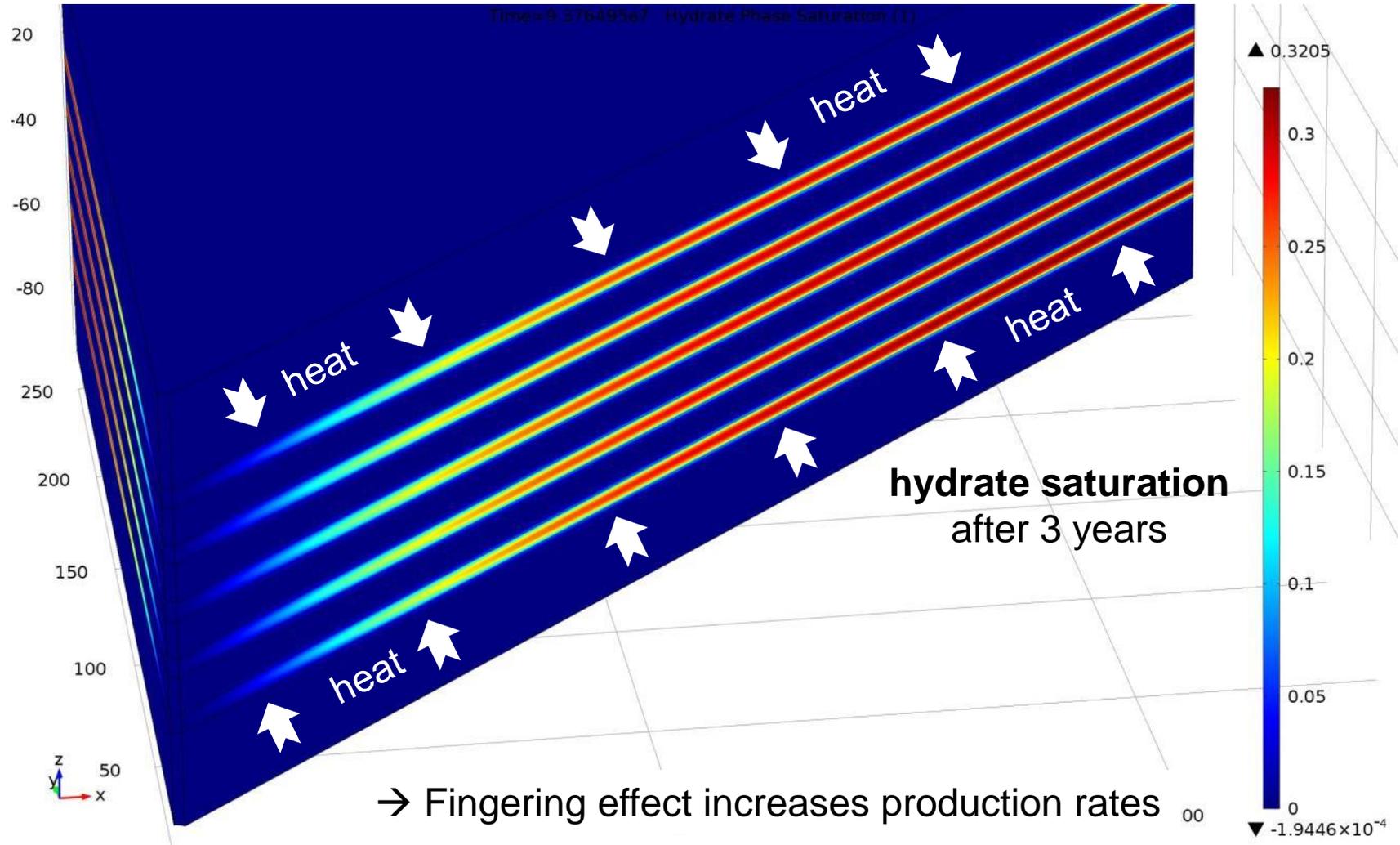
Simulation of depressurization of a deposit



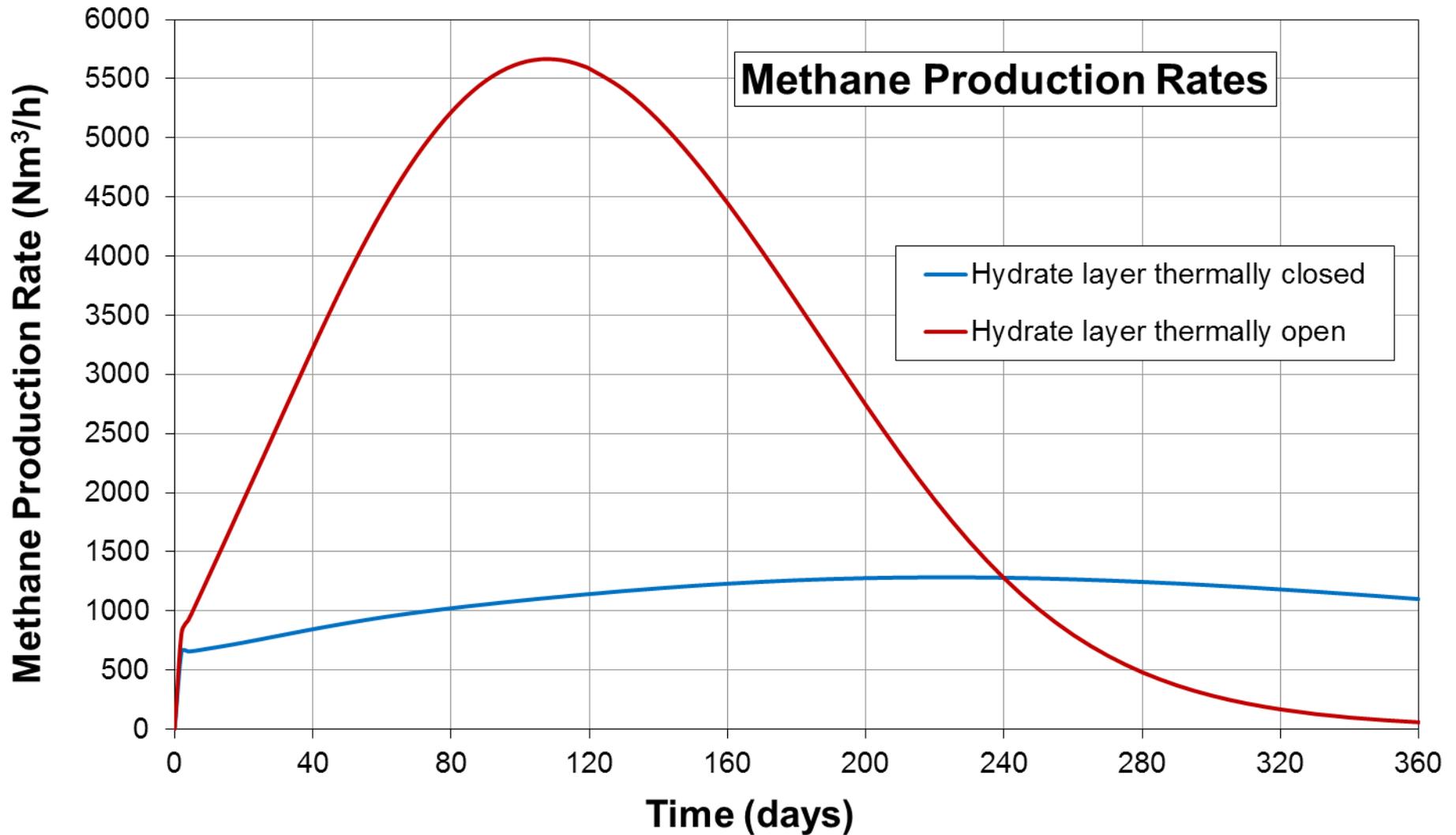
Slide 12

t = 1 month

Heat transport within layered deposits

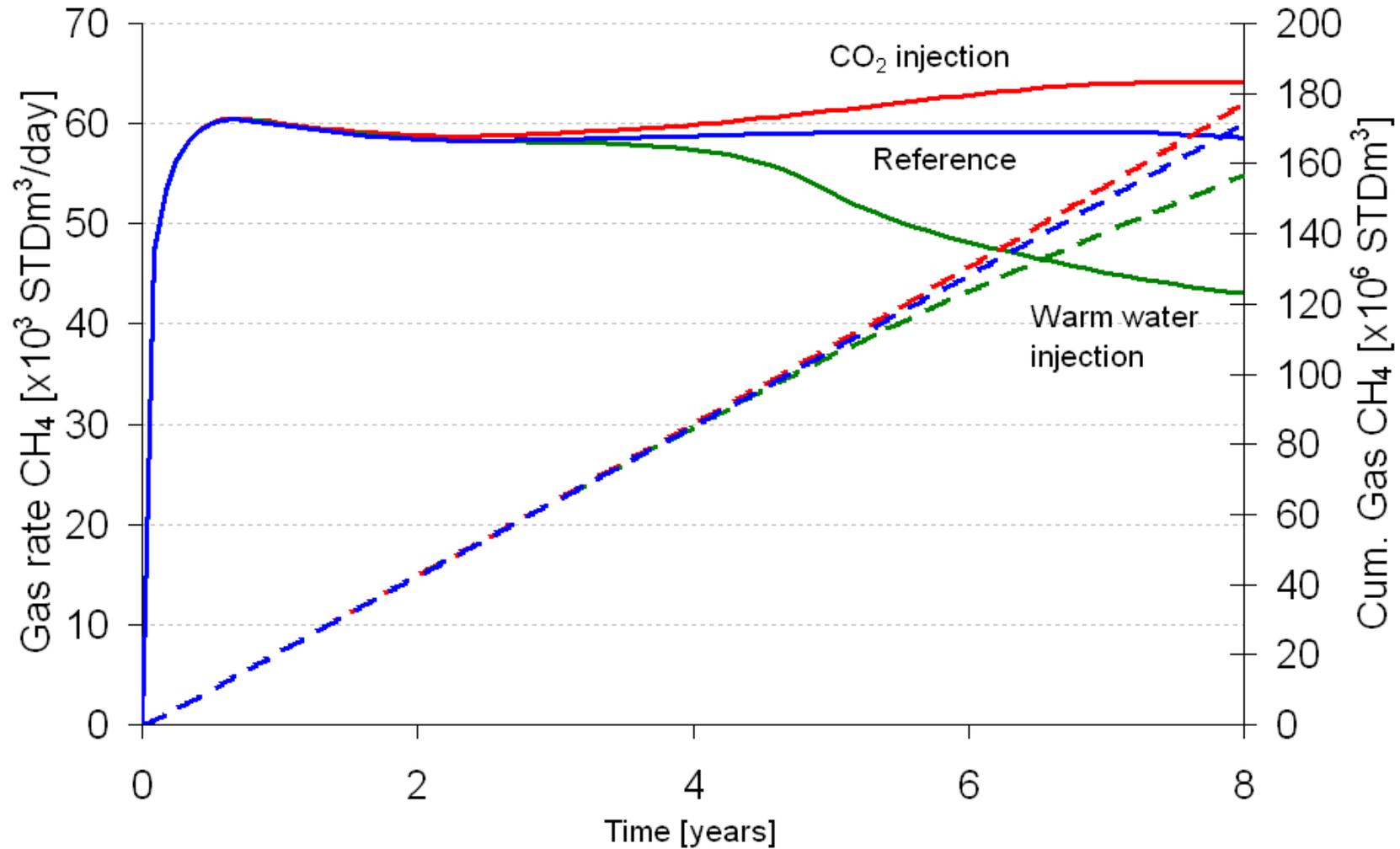


Case study II – Ulleung Basin, Site UBGH 2.6



Gas production

2-well approach



Summary

- Immense amount of natural gas hydrates is presumed
- Simulation with commercial code (CMG STARS) and in-house development (implemented in COMSOL Multiphysics)
- Case studies
in general: depressurization, CO₂ injection
specific: South Korea (Ulleung basin), Black Sea (in future)
- Simultaneous or stepwise CH₄ production and CO₂ injection is possible with acceptable rates
- Results strongly depend on deposit conditions
→ multiphase flow is dominating: Permeability controls production rates
→ heat transport within layered deposits
- Large potential but need for further research to understand the occurring mechanisms and development of applicable technologies

FRAUNHOFER UMSICHT

Processes

Thank you for your attention!

Contact:

Fraunhofer UMSICHT

Osterfelder Strasse 3

46047 Oberhausen

E-Mail: info@umsicht.fraunhofer.de

Internet: <http://www.umsicht.fraunhofer.de>



Foto: photocase.de

Dipl.-Ing. Georg Janicki

Telefon: 0208-8598-1420

E-Mail: georg.janicki@msicht.fraunhofer.de