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Examples of training activities in EU projects MUSTANG, Panacea and TRUST

Auli Niemi

Uppsala University, Department of Earth Sciences

BASRECCS/ENOS meeting Tallinn, Estonia 26.9.2018

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Outline

- A few words about the projects
- Examples of the training activities
- Book Niemi et al. (eds.) ’Geological Storage of CO2 in Deep Saline Aquifers’

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Projects

MUSTANG – large-scale integrating project for **quantifying saline aquifers** for CO2 Geological Storage (2009-2014)

- UU Coordinator

Panacea – project focusing on **long term effects** of CO2 Geological Storage (2012-2014)

- UU WP leader (led by EWRE, Israel)

TRUST – project continuing and **expanding the field experiment** of MUSTANG (2012-2017)

- UU WP leader (led by EWRE, Israel)

CO2QUEST – project focusing on effect of impurities of CO2 stream (2013- 2016)

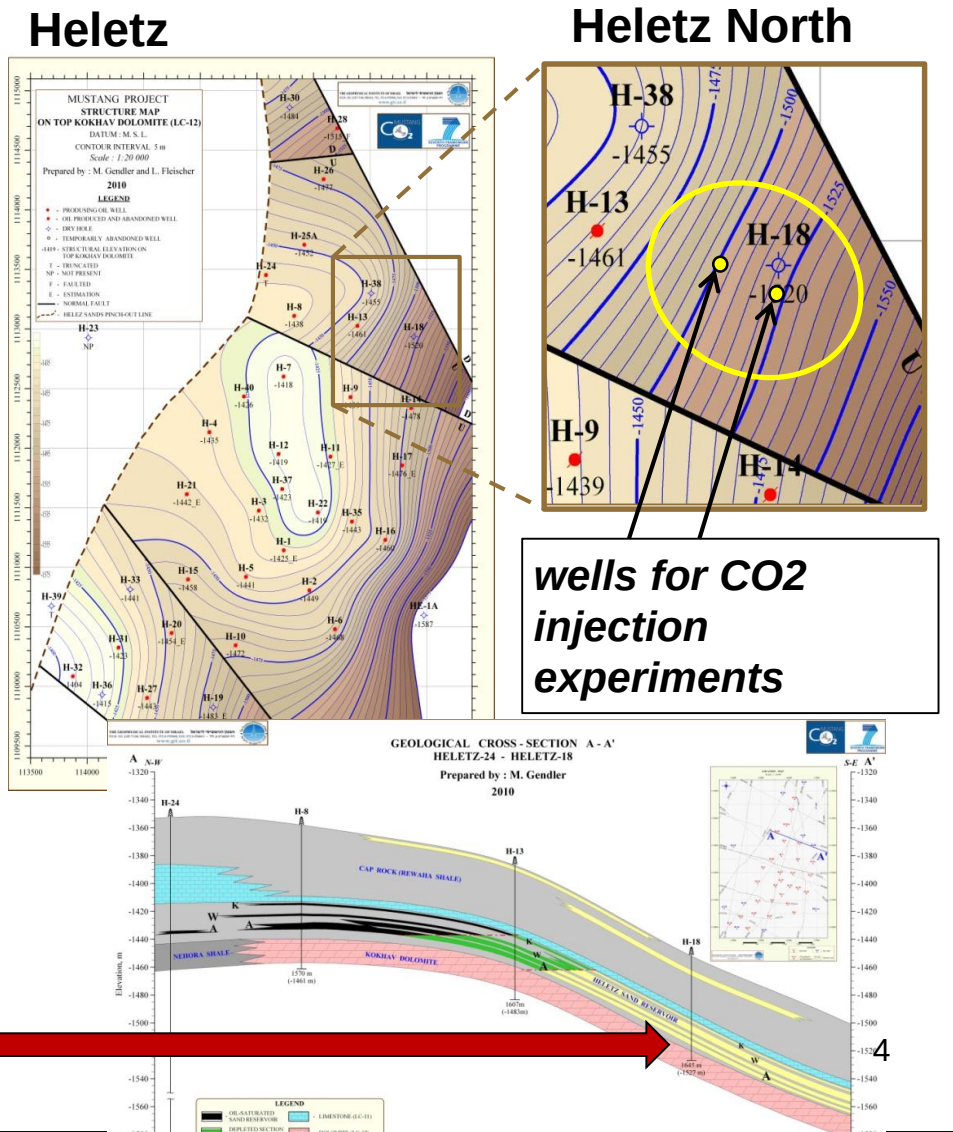
- UU WP leader (led by UCL, England)

In the context of these projects also devepoled the Heletz, Israel CO_2 injection site

- Scientifically motivated CO_2 injection experiment site of scCO2 injection to a reservoir layer at 1600 m depth, with comprehensive monitoring and sampling

- Developed in the frame of EU FP7 projects MUSTANG, TRUST and CO2QUEST

Target reservoir layers of total ~11 m thickness



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Heletz - Residual Trapping Experiment - 2016

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Tracer injection and sampling - Residual Trapping Experiment II (Aug – Oct 2017)

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Key training activities (of Mustang, Panacea, Trust)

- Training courses
- Education of PhD students, MSc students, Post Docs
- Other dissemination activities such ’Brainstorming days’ , organizing sessions at EGU etc., incorporation of learnings to regular curriculum courses at partner universities
- Book Niemi et al. (eds.) ’Geological Storage of CO2 in Deep Saline Aquifers

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Training Courses

- CSIC, Barcelona, Spain, June 2010
- Edinburgh University, Edinburgh, Scotland, June 2011
- iTOUGH short course, Uppsala, Sweden, November 2012 (by LBNL, USA, personnel)
- Göttingen University, Göttingen, Germany October 2013
- CNRS, Montpellier, France, October, 2015
- CSIC, Barcelona, Spain, September, 2017

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Edinburgh, Scotland, June 2011

TRAINING COURSE PROGRAM OUTLINE	
Tuesday 21st June	
14:00	Registration
14:30	Introduction to course
15:00- 17:00	Visit to University Edinburgh CCS laboratory
18:00 -20:00	Evening meal Royal Mile, Networking with MUSTANG partners
Wednesday 22nd June	
OVERVIEW KEYNOTE LECTURES	
8:30 – 9:15	CCS Global Status and Challenges. John Gale (IEA-GHG),
9:15 – 10:00	Recent advances and key questions in modelling CO2 geological storage. Karsten Pruess (LBNL, USA)
10:00 – 10:30	Coffee Break
10:30 – 11:45	Review of global status of CCS projects, and experiences from US Regional partnership program. Larry Myer (LBNL retired, USA)
11:45 -12:30	Christian Bernstone Industry experiences of CCS in Europe and European CCS Demonstration Plant in Janschwalde.(Vattenfall AB)
12:30 – 1:15	Lunch
1:30 – 18:00	Field visit to St Andrews Caprock and Reservoir Analogue Site
Thursday 23rd June	
TOPICAL LECTURES	
9:00 – 9:45	Industrial CO2 storage (STAOIL,Torp)
9:45 – 10:15	Coffee break
10:15 – 10:25	Introduction to lectures (Uppsala University, Niemi)
10:25 – 10:55	Risk Management of CCS projects. (OXAND, Le Guen)
10:55 – 11:25	HTT tests for characterisation and monitoring. (Göttingen University, Sauter)
11:25 – 11:55	Application of seismic methods for CO2 monitoring, an example from the Ketzin site, Germany. (Uppsala University, Juhlin)
11:55 – 12:15	Instrumentation of CO2 and injection experiments.(EWRE, Bensabat)
12:15 – 13:15	Lunch
13:15 – 13:45	Mathematical models of two phase flow, energy and multicomponent reactive transport in deep formations. (Tecchnion, Bear)
13:45 – 14:15	Simulation of CO2 geological storage with multiphase multicomponent models. (Uppsala University, Niemi)
14:15 – 14:45	Scale effects of processes in geological CO2 storage. (CSIC, Dentz)
14:45 – 14:55	Coffee
14:55 – 15:25	Novel numerical techniques for modelling crack formation. (Nottingham University, Power)
15:25 – 16:15	Laboratory experiments for geological CO2 storage. (CNRS, Luquot)
16:15 – 16:30	Wrap up

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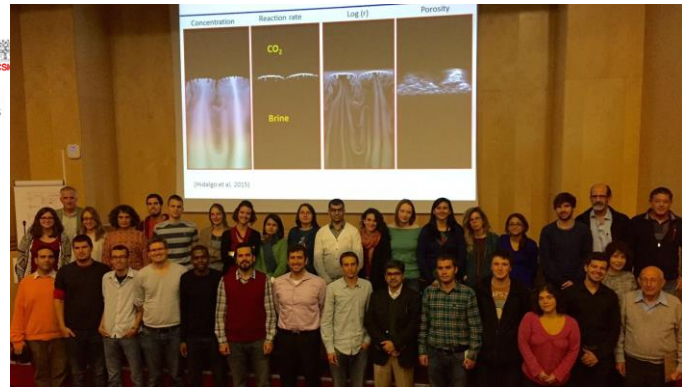
Montpellier, France, October 2015

Advanced Course on CO_2 Sequestration in Deep Geological Formations

19-21 October 2015
Montpellier, France
www.trustco2course.wordpress.com



PROGRAMME

19 October 2015

8:30 – 9.00	Registration
9:00 – 9:45	Introduction to geological storage of CO_2 and examples of field projects (Auli Niemi, University of Uppsala, Sweden)
9:45 – 10:30	Experiences from natural analogues (Alfons van der Kerhof, University of Göttingen, Germany)
10:30 – 11:00	*Coffee break*
11:00 – 11:45	Capacity estimates of CO_2 geological storage sites (Jesús Carrera, CSIC, Spain)
11:45 – 12:30	Approaches to large scale problems (Auli Niemi, Uppsala University, Sweden)
12:30 – 13:30	*Lunch*
13:30 – 15:00	Mathematical models for CO_2 spreading and related processes (part 1; two-phase flow; part 2, non-isothermal transport, deformable porous media) (Jacob Bear, Technion, Israel)
15:00 – 15:30	*Coffee break*
15:30 – 17:00	Numerical Modeling of Geological Storage – part 1; Methodologies, part 2; Results and examples. Hontomín example (Jesús Carrera, CSIC, Spain)
17:00 – 17:30	Public perception and societal challenges associated with CCS (Meritxell Martell, Merience, Spain).

20 October 2015

9:00 – 9:45	Laboratory experiments for CO2 geological characterization and leakage risks (Linda Luquot, CSIC)
9:45 – 10:30	Scale effects and upscaling (Marco Dentz, CSIC, Spain)
10:30 – 11:00	*Coffee break*
11:00 – 11:45	Fractured rock hydrology and implications for carbon storage / sequestration (Robert Zimmerman, Imperial College, UK)
11:45 - 12:30	Advanced methods for fracture propagation modeling (Adriana Paluszny, Imperial College, UK)
12:30 – 13:30	*Lunch*
13:30 – 14:15	Injection well-reservoir interaction (Myra Kitron-Belinkov, Technion, Israel)
14:15 – 15:00	Fluid mechanics and resulting geological response of sequestration (Herbert Huppert, University of Cambridge, UK)
15:00 – 15:30	*Coffee break*
15:30 – 16.15	Hydro-mechanical processes (Henry Power, Geo-Energy Research Centre, UK)
16: 15 – 17:00	Geophysical monitoring of CO2 geological storage sites, Ketzin case study (Fengjiao Zhang, Uppsala University, Sweden)

21 October 2015

9:00 – 9:45	Characterization and monitoring of an injection experiment – Example from Heletz, Israel (Jacob Bensabat, EWRE, Israel)
9:45 – 10:30	Hydro-geophysical monitoring methods: lessons from shallow injection experiments at Maguelone (Philippe Pezard, CNRS, France)
10:30 – 11:00	*Coffee break*
11:00 – 11:45	Risk assessment in geological storage of CO_2 (Jacob Bensabat, EWRE, Israel)
11:45 – 12:15	Closure of the course

14: 00 – 18:00 FIELD TRIP!!
A bus will leave from the meeting to the Maguelone experimental site at 12:30 and will take us back at 18:00. The trip will be organised by CNRS.

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Montpellier, France, October 2015

Advanced Course on CO_2 Sequestration in Deep Geological Formations

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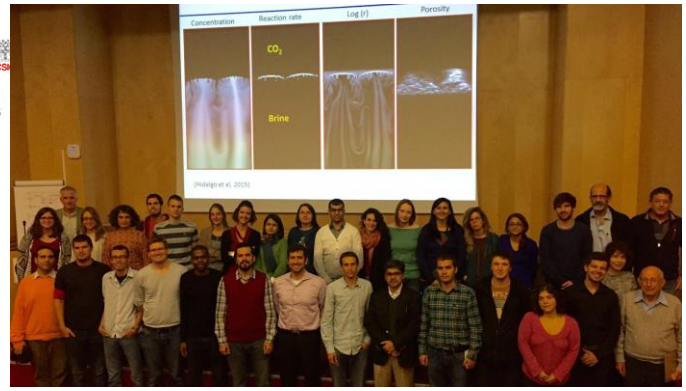

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Barcelona, Spain, September 2017

AUDIENCE

This course is intended for graduate students and post-doctoral researchers, including M.Sc. and Ph.D. students in the fields of engineering (civil, chemical, mechanical and petroleum engineering), geology, and geophysics, as well as professionals who wish to gain a greater understanding of current research findings, modeling and planning elements of CCS projects.

13 September 2017

8:30 – 9.00	Registration
9:00 – 10:00	Introduction to geological storage of CO_2 and examples of field projects (Auli Niemi, University of Uppsala, Sweden)
10:00 – 11:30	Mathematical models for CO_2 spreading and related processes: flow, two phases, non-isothermal, reactive transport, deformable porous medium (Jacob Bear, Technion, Israel)
11:30 – 12:00	*Coffee break*
12:00 – 13:00	Mathematical models for CO_2 spreading and related processes: flow, two phases, non-isothermal, reactive transport, deformable porous medium (Jacob Bear, Technion, Israel) – continuation
13:00 – 14:00	*Lunch*
14:00 – 15:00	Numerical Modeling of Geological Storage – part 1; Methodologies, part 2; Results and examples. (Jesús Carrera, CSIC, Spain)
15:00 – 15:30	*Coffee break*
15:30 – 16:30	Approaches to large scale projects (Auli Niemi, University of Uppsala, Sweden)
16:30 – 17:30	Hydro-mechanical processes (Jesús Carrera, CSIC, Spain)

14 September 2017

9:00 – 10:00	Characterization methods for geological reservoirs – Part 1 (Jesús Carrera, CSIC, Spain)
10:00 – 11:00	Characterization methods for geological reservoirs – Part 2 (Auli Niemi, University of Uppsala, Sweden)
11:00 – 11:30	*Coffee break*
11:30 – 12:30	Laboratory testing of properties relevant to CO_2 injection and spreading (Philippe Gouze, CNRS, France)
12:30 – 13:30	*Lunch*
13:30 – 15:30	Characterization, monitoring and field experiments of an injection site – the Heletz case, Israel (Jacob Bensabat, EWRE, Israel)
15:30 – 16:00	*Coffee break*
16:00 – 17:00	Interactive exercise: public perception and societal challenges associated with CCS (Meritxell Martell, Merience, Spain).
17:00 – 17:30	Evaluation of the workshop and closure

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Educating PhDs – TRUST (2012-2018) project only

- Uppsala Univ, Sweden: 4+2 =6 completed, 2 underway
- CSIC, Spain: 1 completed, 4 underway
- Göttingen Univ, Germany: 2 completed, 2 underway
- ETH, Switzland: 1 completed
- Cambridge Univ, UK: 1 completed

Total: 11 completed, 8 underway

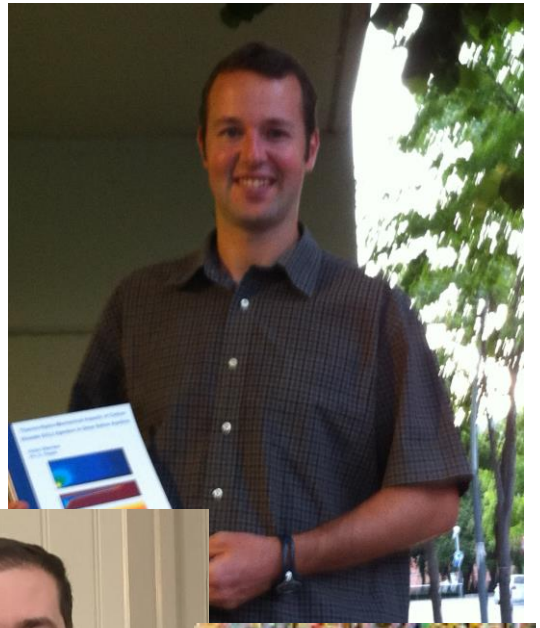
Post-Docs and MSc students - TRUST project (2012-2018) only

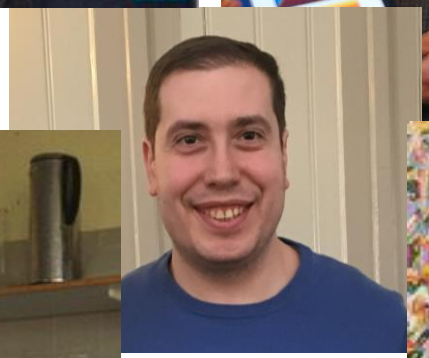
Post Docs:

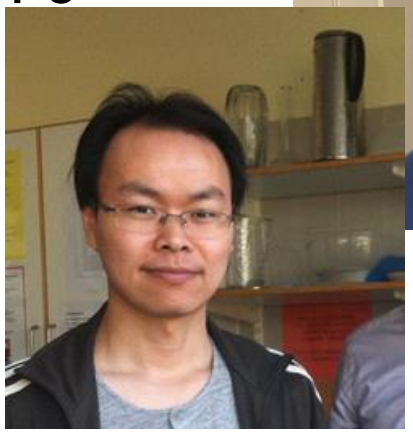
Uppsala University: 5
CSIC: 6
Imperial College: 1
Cambridge University: 1

MSc Theses:

- Göttingen University: 9
- Imperial College: 3

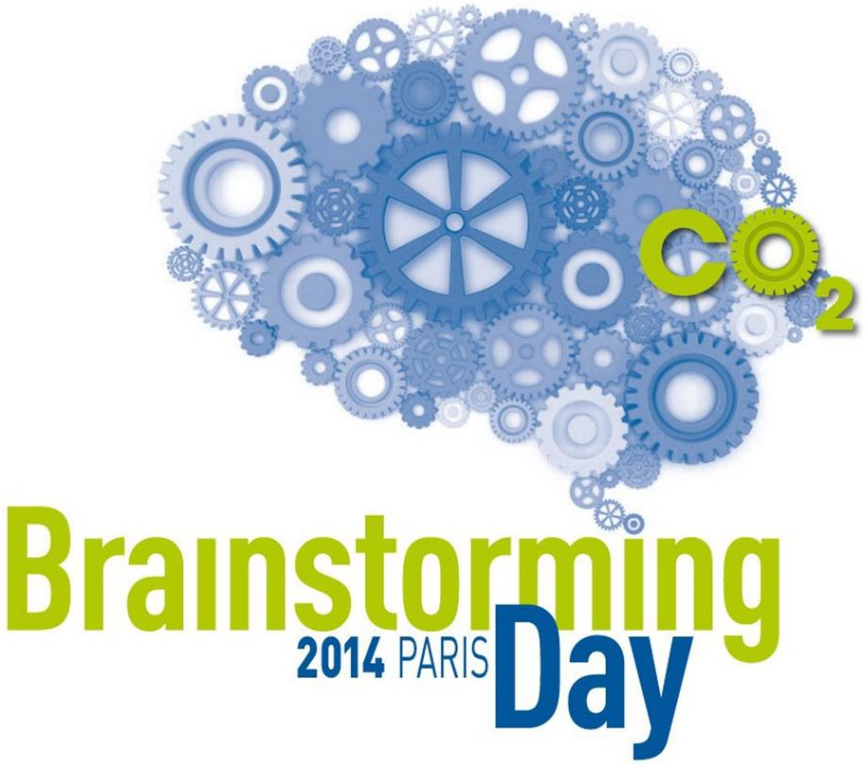






Examples of other training activities

- Brainstorming Day on *'The long term fate of geologically stored CO2'* in 2013, Trondheim, Norway (jointly organized by MUSTANG, ULTIMATECO2, CO2CARE, CARBFIX and PANACEA projects) and in 2014, Paris, France.
- Organizing a session on CO2 (Field testing) at European Geosciences Union (EGU) meeting regularly since 2011
- Incorporating the learnings to regular curriculum courses



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A comprehensive text book

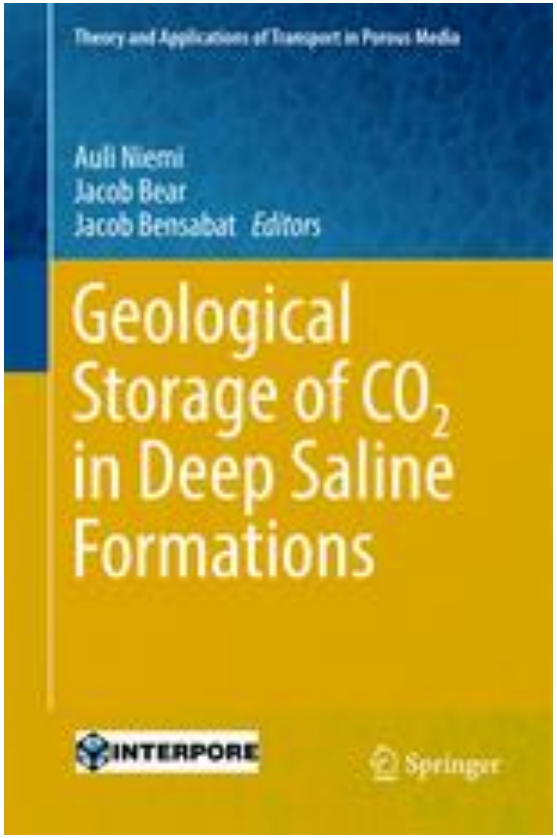

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Table of Contents (Niemi et al. (eds) 'Geological...)

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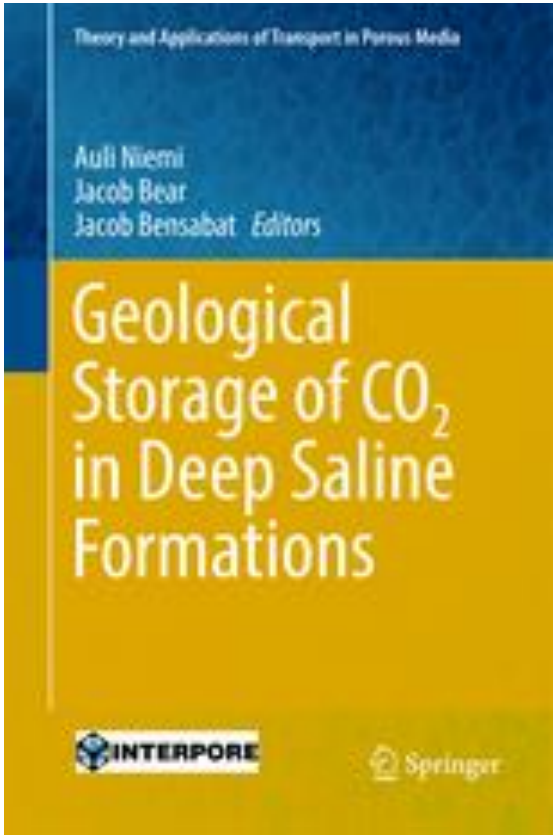

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Thank you for your attention!

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by EU FP7 projects MUSTANG, PANACEA and TRUST

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CO_2QUEST