https://sense-act.eu/

CLIMIT SUMMIT,
7-9 February 2023, Larvik

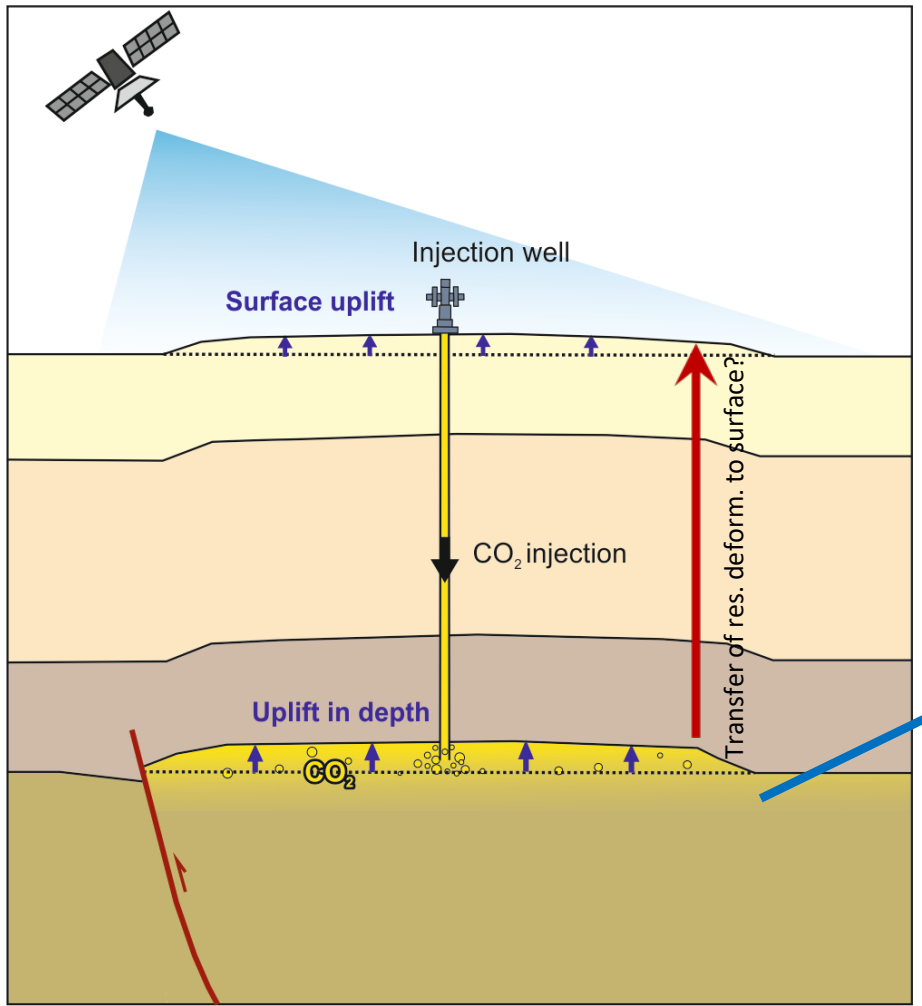
Value of ground deformation for monitoring CO_2 storage sites (SENSE project)

Bahman Bohloli (Norwegian Geotechnical Institute -NGI)

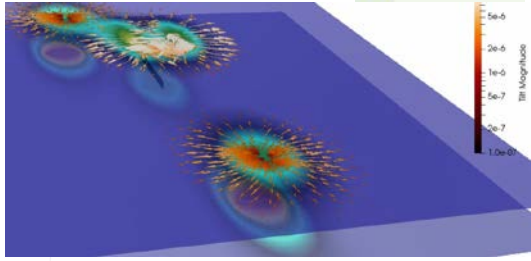
With contribution from: Joonsang Park, Tore I. Bjørnarå, Per M. Sparrevik, Malte Vöge, Regula Frauenfelder, Jean-Remi Dujardin, Henrik Meland, Nazmul H. Mondol, Ola Eiken, Christian Berndt, Jens Karstens, Sarah Bouquet, Audrey Estublier, Andre Fourno, Jeremy Frey, Yeon-Kyeong Lee, Yong-Chan Park, Ceri Vincent, Joshua White, Ziqiu Xue

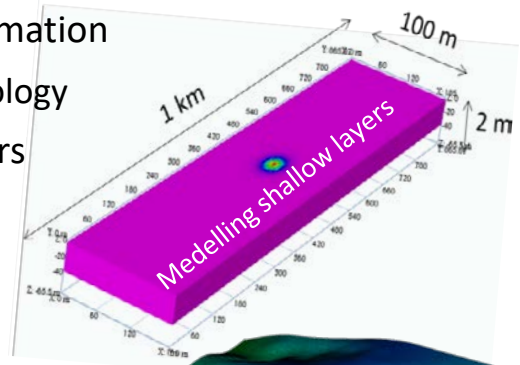
SENSE project narrative

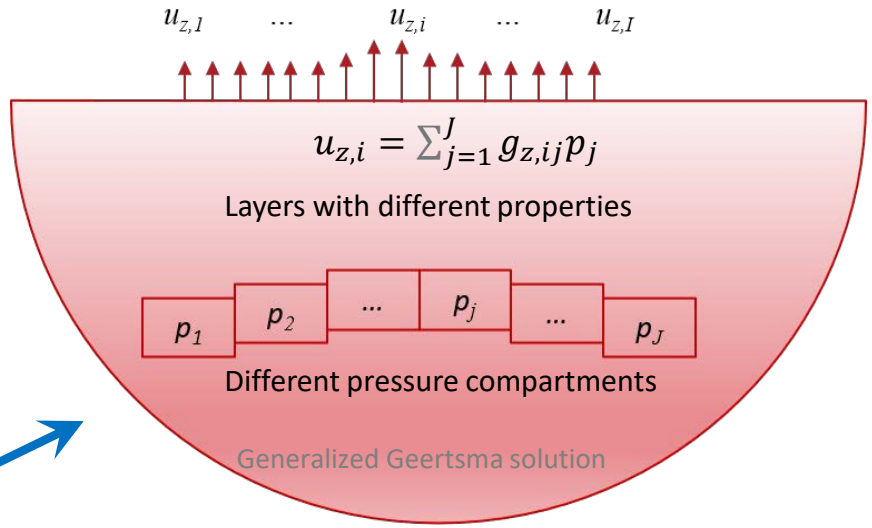
- **Objective**: use ground uplift as a parameter to monitor performance and integrity of storage complex.



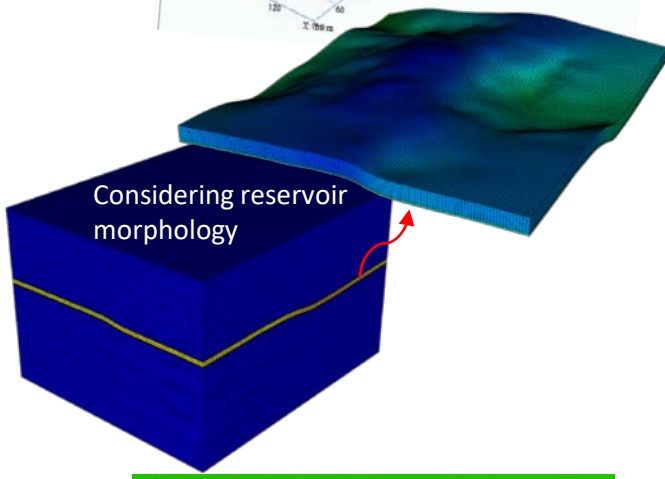
- **Methodology and Achievenments**
  - **Introduced a new analytical solution** for ground deformation
  - **Modelling uplift** with/without faults, considering morphology
  - **Developed** & **tested DSS fiber optics** & pressure sensors
  - **Developed InSAR data processing wokflow**.

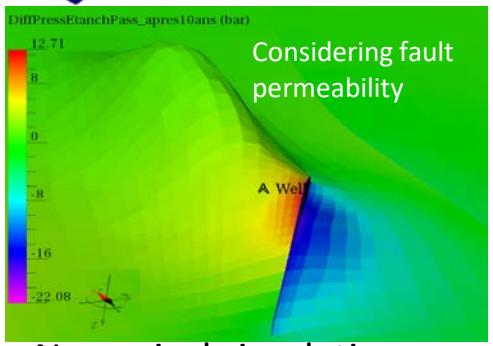






Geertsma Generalized Solution (Park et al. 2021) *for first-order, fast calculation of ground uplift*





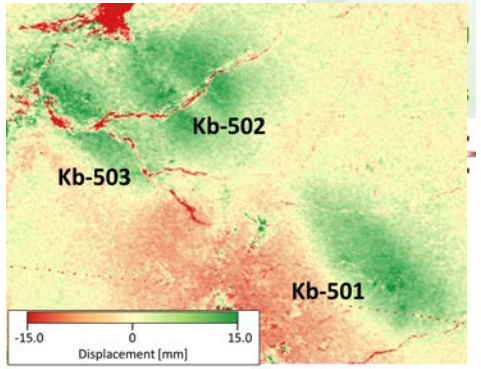
Numerical simulations

SENSE project narrative (Cont'd)

- **Methodology and Achievements**
  - **Introduced a new analytical solution** for ground deformation
  - **Modelling uplift** with/without faults, considering morphology
  - **Developed** & **tested DSS fiber optics** & pressure sensors
  - **Developed InSAR data processing wokflow**.

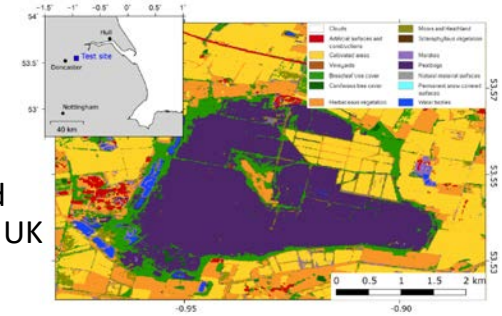
InSAR

In Salah

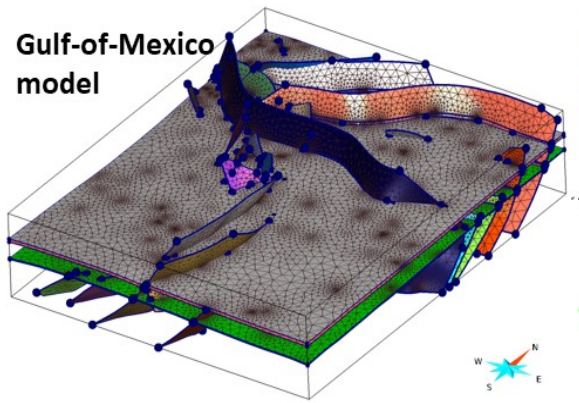


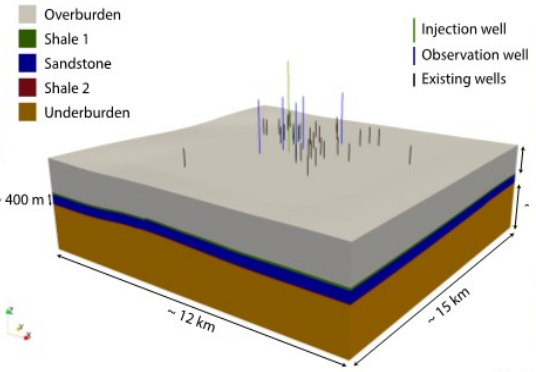
InSAR

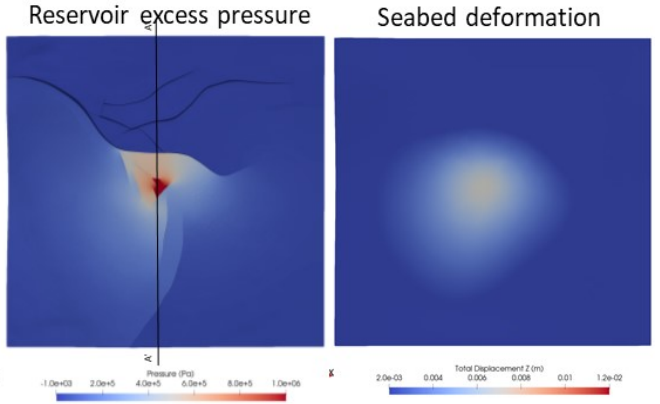
Hatfield Moors, UK



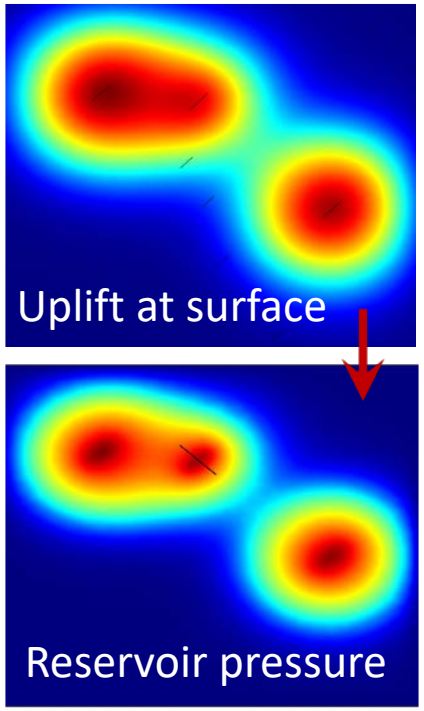
Ground uplift estimation





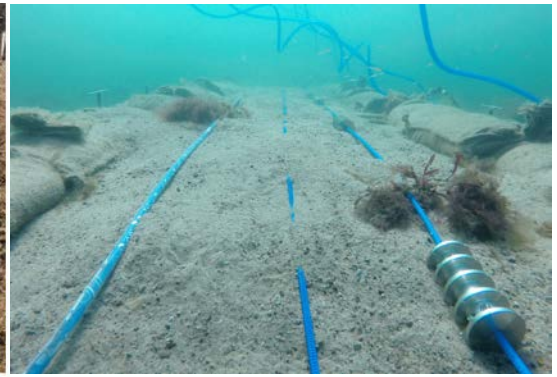


Machine learning



Large scale lab tests

Field scale



Offshore tests

Testing DSS fiber optics

Conclusions

- We suggest first-order estimation of ground uplift using the Generalized Geertsma solution (accounts for reservoir geometry, thickness, anisotropy). If considerable uplift → perform numerical simulations.

- Geomechanical modelling of real-life and synthetic cases shows the shape of deformation reveals sealing & draining behaviour of faults in reservoir/caprock.

- Experiments shows Distributed Strain Sensing (DSS) fiber optic cables:

- Provide good coupling with soil when embedded about 40 cm underground-no anchors
- Can detect deformations of ca. 1µ strain across cables
- Can work well for monitoring deformation hotspots.

Thank you!

https://sense-act.eu/

SENSE (Assuring integrity of CO_2 storage sites through ground surface monitoring) project No. 299664, has been subsidized through ACT (EC Project no. 691712) by Gassnova, Norway, United Kingdom Department for Business, Energy and Industrial Strategy, Forschungszentrum Jülich GMBH, Projektträger Jülich, Germany, The French Agency for the Environment and Energy Management, The United States Department of Energy, and State Research Agency, Spain. Additional support from Equinor and Quad Geometrics and permission to use data from the Krechba Field by In Salah Gas JV are appreciated.