CEMENTEGRITY

Testing and developing improved wellbore sealants for CCS applications.

ACT Knowledge Sharing Workshop, Paris, 2023-10-05

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The Cementegrity Team

www.cementegrity.eu

IFE

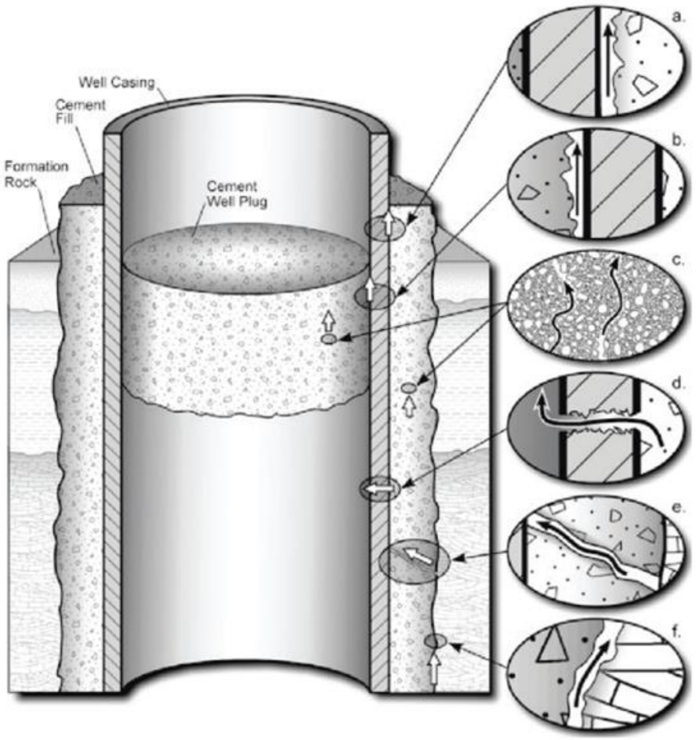
Cementegrity – Challenge

How can we ensure wellbore seal integrity over the full duration of CO_2-storage, when leakage pathways can form:

- during emplacement, or
- during subsequent operation.

- along interfaces (a, b, f),
- along fractures (d, e), or
- through the sealant body (c).

Due to chemical, mechanical and/or thermal effects.



Schematic illustration of a plugged wellbore, showing potential leakage pathways.

From: Celia et al. (2005) Quantitative estimation of CO2 leakage from geological storage: Analytical models, numerical models, and data needs. GGCT1, 663-671.

Partners

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Department for Business, Energy & Industrial Strategy
Accelerating CCS Technologies

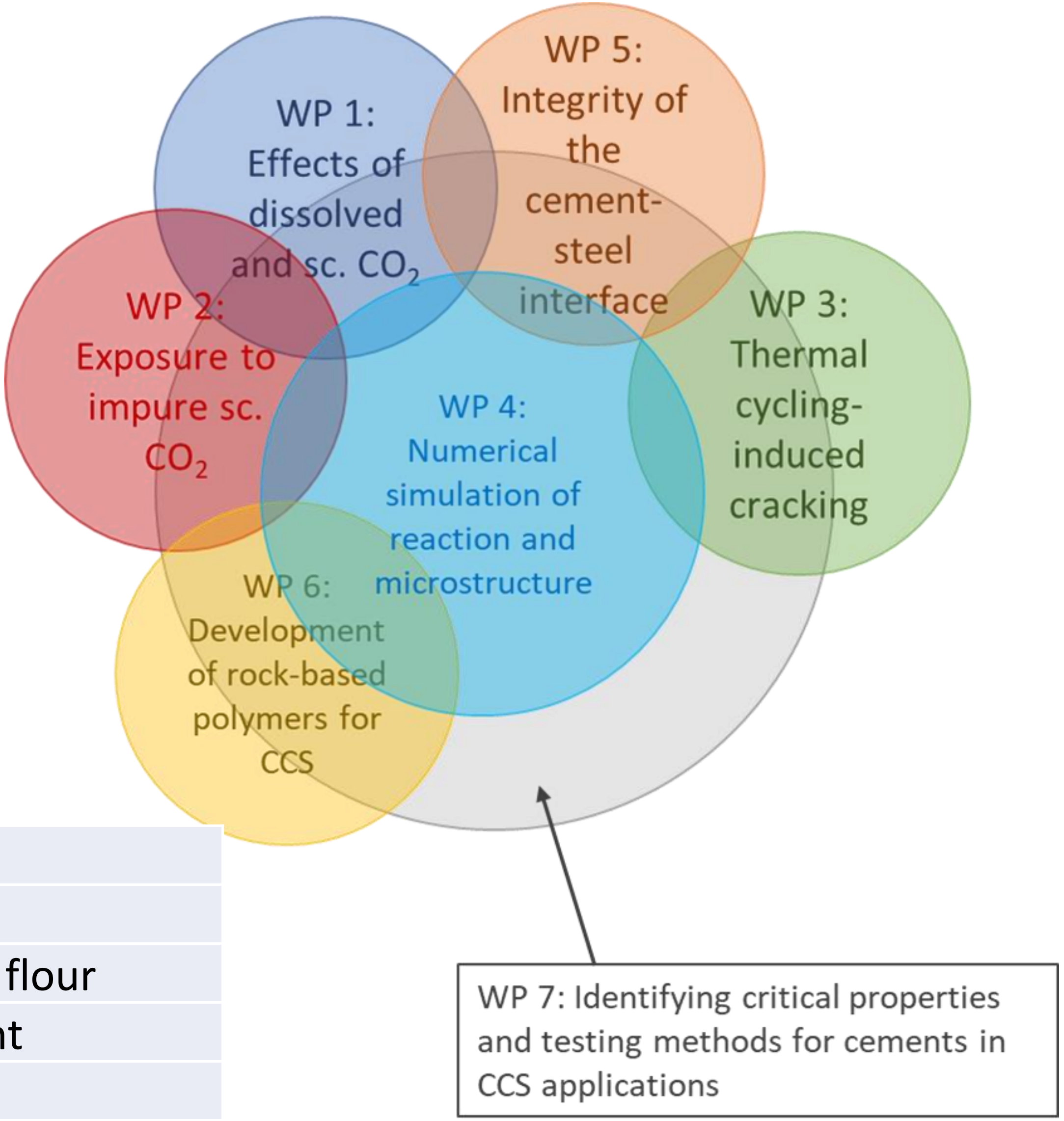
The *CEMENTEGRITY project is funded through the ACT program (Accelerating CCS Technologies, Horizon2020 Project No 691712).*
Financial contributions from the Research Council of Norway (RCN), the Netherlands Enterprise Agency (RVO), the Department for Business, Energy & Industrial Strategy (BEIS, UK), and Wintershall DEA are gratefully acknowledged.

Project structure

A multidisciplinary team to address this complex challenge, with seven WPs:

- That tackle chemical and thermal mechanisms;
- That impact mechanical and interface integrity;
- By collaborating closely.

- Central preparation of samples for all WPs by Halliburton
- Samples cured under water, at 150 °C and 30 MPa for 28 days to ensure full hydration



WP 1: Effects of dissolved and sc. CO_2

WP 5: Integrity of the cement-steel interface

WP 2: Exposure to impure sc. CO_2

WP 3: Thermal cycling-induced cracking

WP 4: Numerical simulation of reaction and microstructure

WP 6: Development of rock-based polymers for CCS

WP 7: Identifying critical properties and testing methods for cements in CCS applications

Five sealant compositions will be tested:

S1: Class G cement with 35% BWOC silica flour

S2: Ultra low permeability based on class G cement with 35% BWOC silica flour

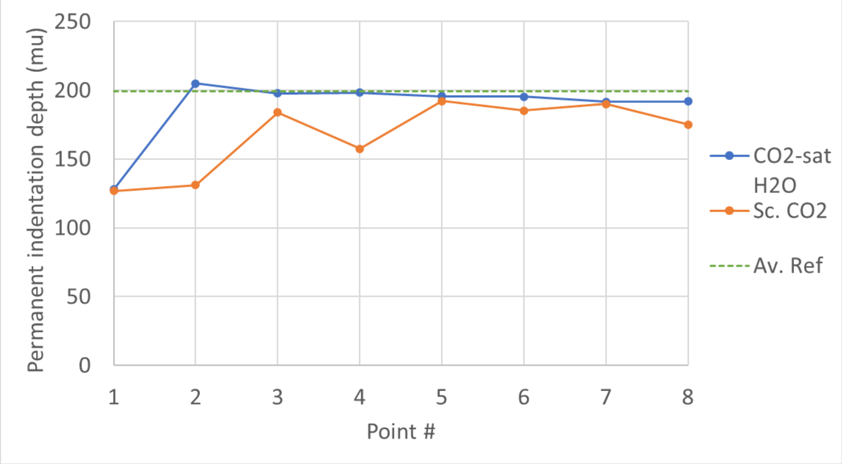
S3: Class G cement with 35% BWOC silica flour and CO_2-sequestering agent

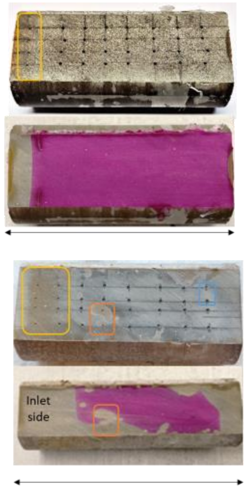
S4: Blend based on calcium aluminate

S5: Granite-based, 1-part geopolymer engineered for CCS

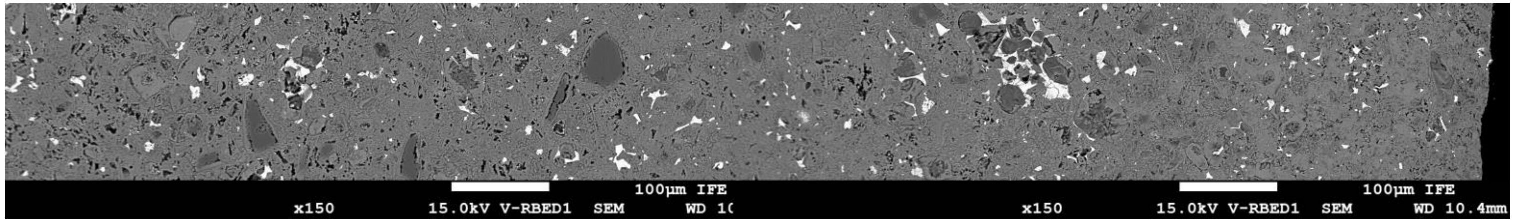
Chemical effects – WP1,2

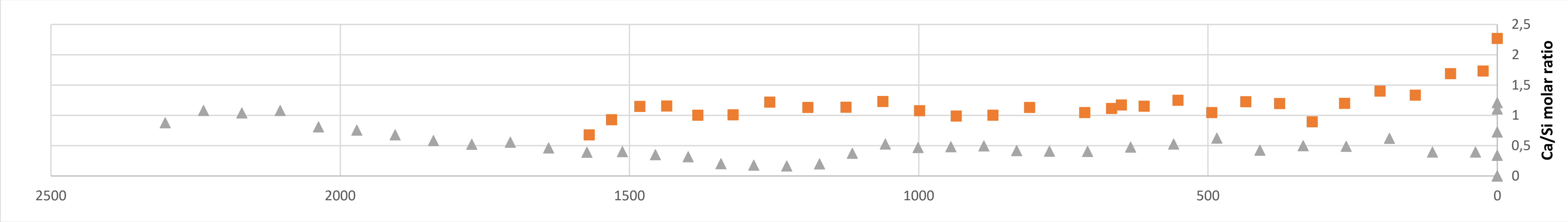
- Micro-indentations tracking impact of CO_2 on mechanical properties of sealant (here, S1 after 180 day exposure to CO_2-sat water and sc. CO_2.

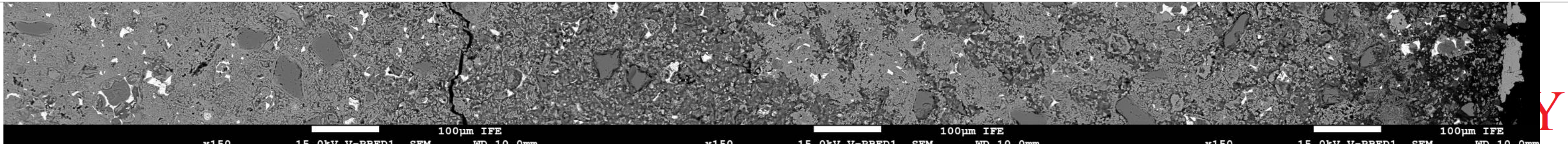




- Microstructural change due to CO_2-ingress in S1 after 16wk exposure to CO_2-sat. water, and to sc. CO_2

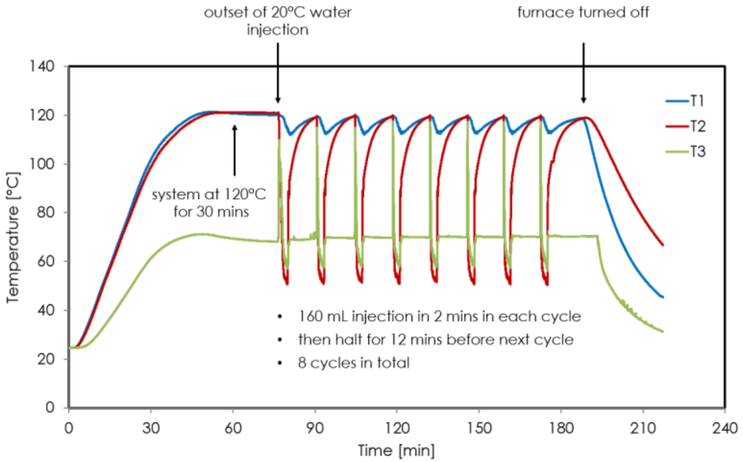


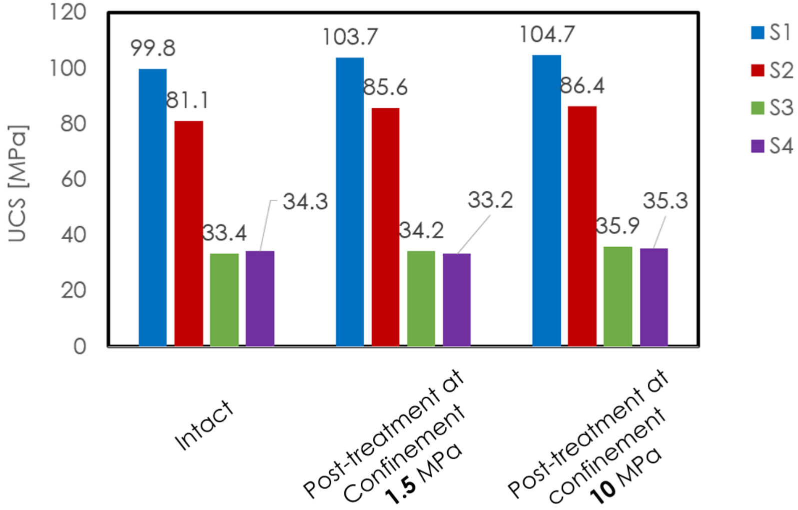




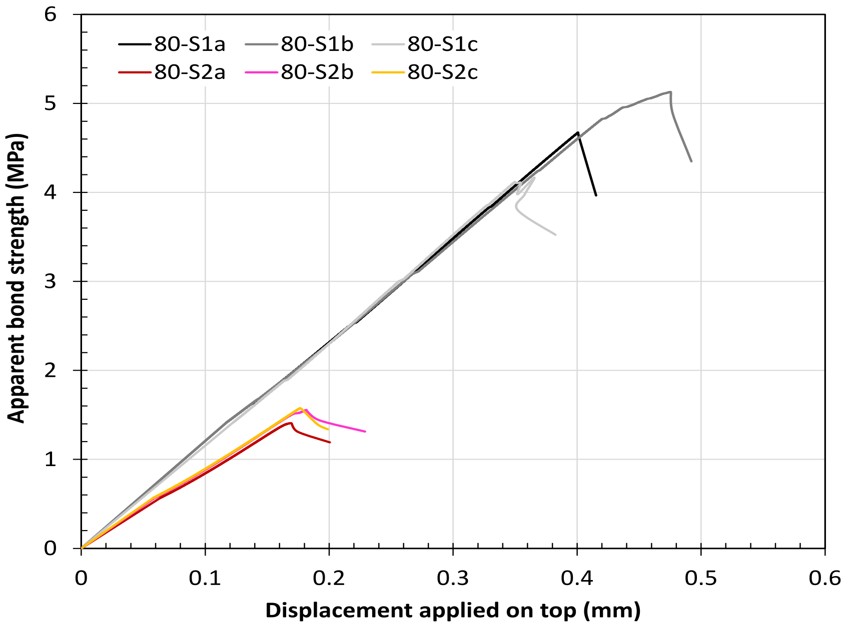
Thermal effects and interface integrity – WP3,5

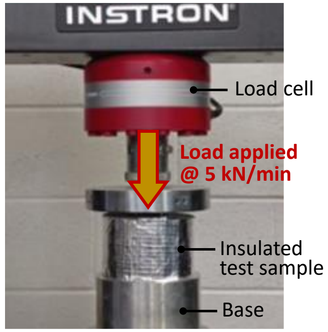
- Impact of thermal cycling under confined conditions on sealant strength (and microstructure).





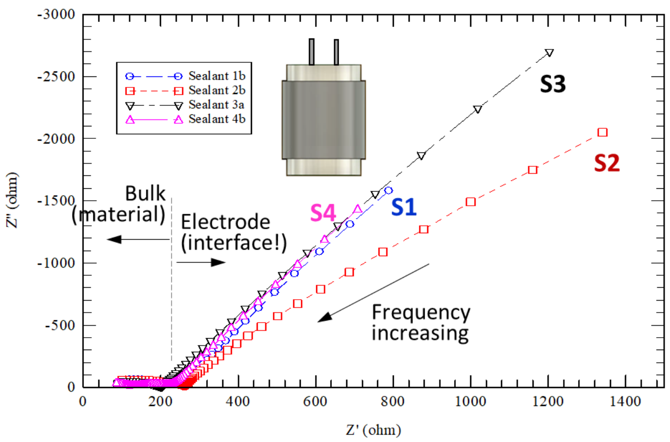
- Direct measurement of sealant-steel bond strength.



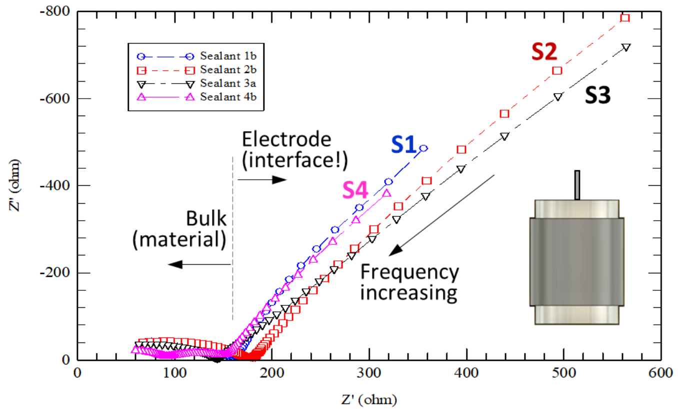


- Using impedance to monitor sealant body and interface integrity.

Impedance – 2pins (full data)



Impedance – coax (full data)



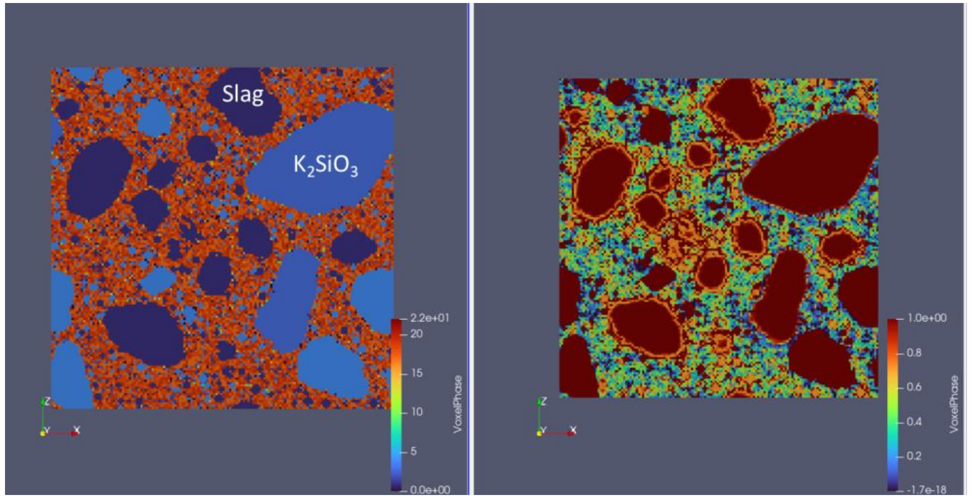
Geopolymer development and microstructure simulation – WP4,6

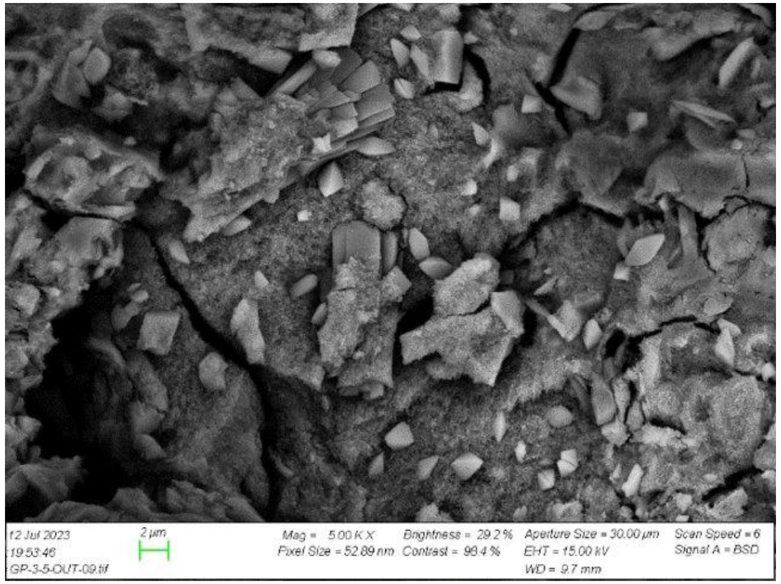
Microstructural simulation:

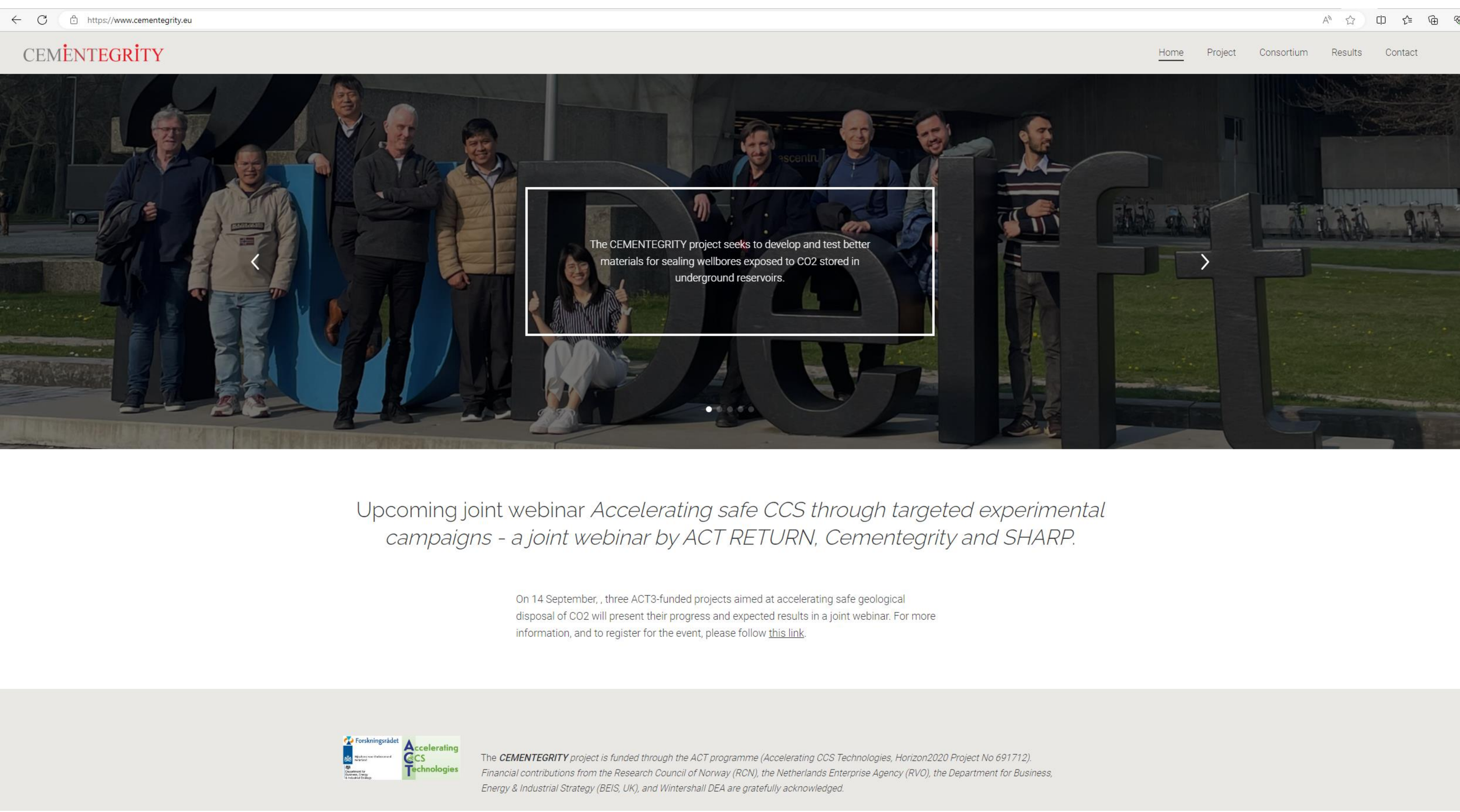
- Numerical simulation of reaction process (hardening), to build geopolymer microstructure from starting components:
- This as input for numerical simulation of volume stability of geopolymers when exposed to T-fluctuations and CO_2

Of rock-based GP developed in Cementegrity:

- Geopolymer based on granite, tailored for CCS applications
- To be tested as part of development in WP6,
- Also being tested in all other WP's







The CEMENTEGRITY project seeks to develop and test better materials for sealing wellbores exposed to CO2 stored in underground reservoirs.

Upcoming joint webinar *Accelerating safe CCS through targeted experimental campaigns - a joint webinar by ACT RETURN, Cementegrity and SHARP.*

On 14 September, , three ACT3-funded projects aimed at accelerating safe geological disposal of CO2 will present their progress and expected results in a joint webinar. For more information, and to register for the event, please follow this link.

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