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GASRIP: Geomechanical Assessment of CO_2 Storage Reservoir Integrity Post-closure

GASRIP URL

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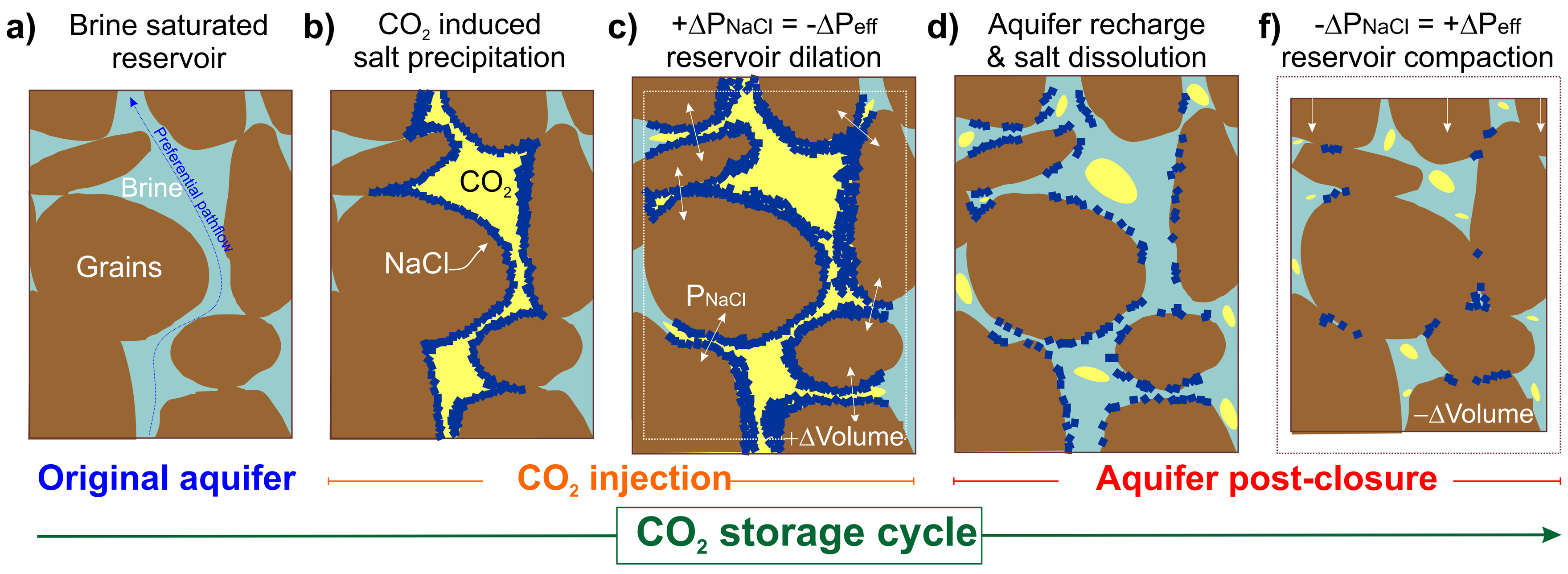
Summary

Geomechanical Assessment of CO_2 Storage Reservoir Integrity Post-closure **(GASRIP)** is a project primarily designed to study how CO_2-brine induced-salt precipitation/dissolution affects geomechanical integrity of CO_2 storage reservoirs. (i) By looking at changes in the elastic, mechanical and transport properties of natural (clean) sandstones in the laboratory, GASRIP will assess variations in the geomechanical properties in saline siliciclastic reservoirs post-CO_2 injection. (ii) By analysing carbonate-rich sandstones, GASRIP will determine the mechanical and chemical post-CO_2 injection effects on chemically reactive reservoirs. This information is needed for the potential use of salt precipitation in a controlled manner to improve the transport properties and the viable production of oil and gas from tight reservoirs (EOR alternative).

Research hypothesis

Geological reservoirs are complex systems. Their geomechanical integrity can be affected by CO_2-fluid-rock interactions associated with the injection of CO_2. Following the interruption of CO_2 injection, pressure decreases, the CO_2 plume migrates (and dissolves in the resident brine) and natural imbibition leads to aquifer recharge. However, **CO_2 injection is a drying process** that triggers complex salt precipitation phenomena in brine saturated formations.

Several studies have reported risks associated with porosity and permeability reduction with respect to injection efficiency and storage capacity. A less appreciated fact is that salt crystals growing under confinement have the potential to damage the rock by exerting enormous pressures (**haloclasty**). After ceasing the CO_2 injection, the aquifer recharge leads to salt dissolution and reservoir compaction.



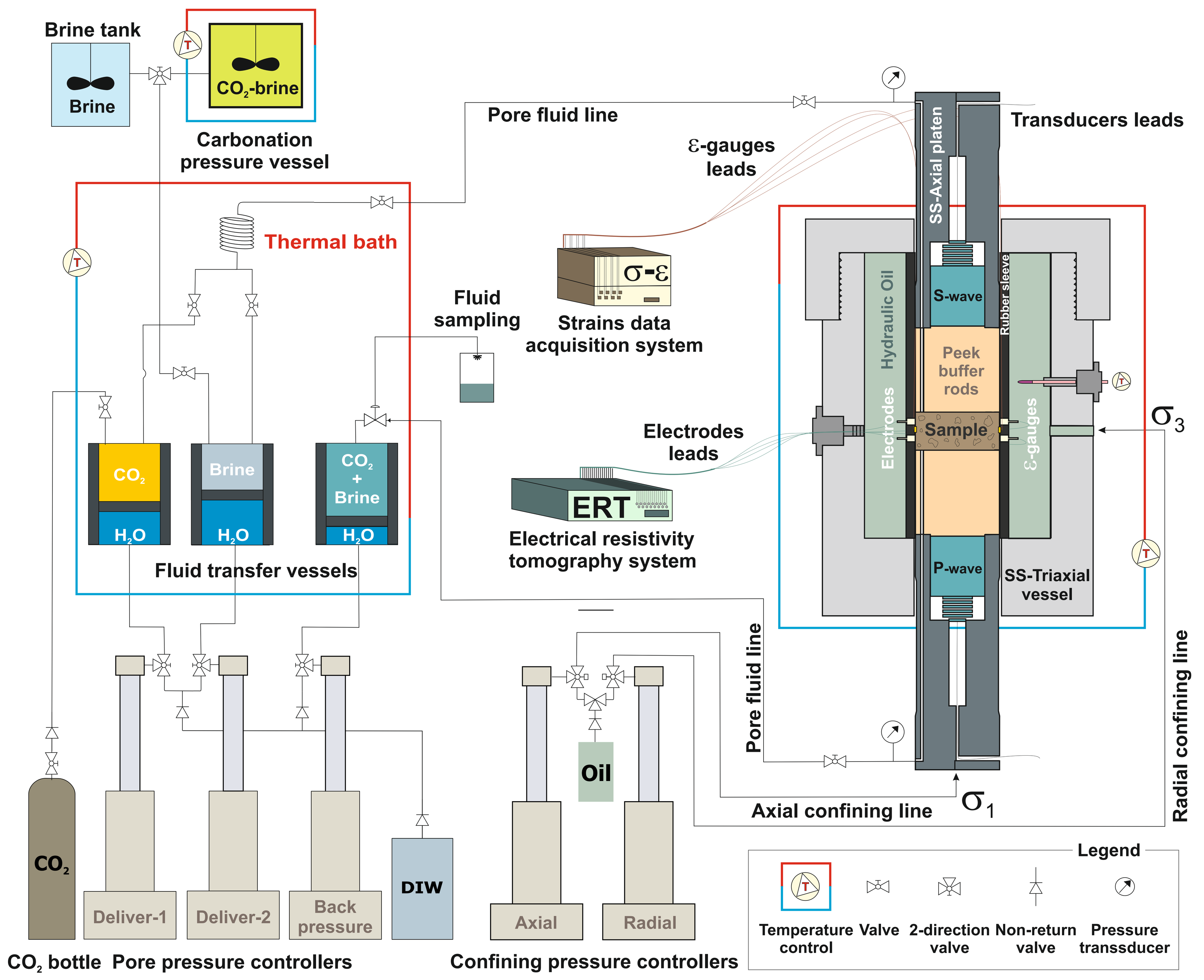
GASRIP aim

Which phenomena affect reservoir integrity during the natural aquifer recharge post-CO_2 injection? Can we control them? The energy industry is transforming as we move to a lower carbon world. CCS and EOR-CCS are becoming essential practices for the oil and gas industry, a vital sector for the UK economy. The major objective of GASRIP is to fill the lack of research regarding the **geomechanical integrity** of **CCS and EOR-CCS reservoirs post-closure**, from a comprehensive laboratory programme and state-of-the-art data analysis and interpretation.

Experimental setup

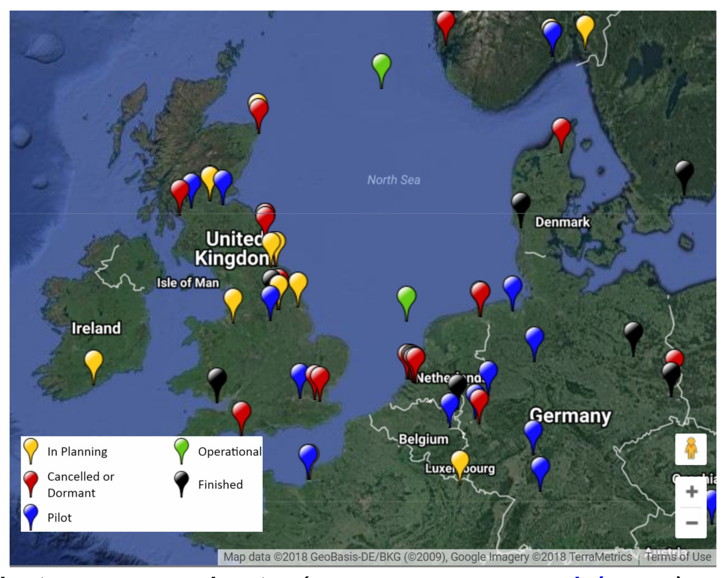
The experimental work will be carried out in the rig for CO_2 storage multi-flow tests at the **Rock Physics laboratory** in the **NOCS**. The setup is configured to measure simultaneously ultrasonic P- & S-wave velocities and attenuations, electrical resistivity, axial and radial strains, and permeability, during the co-injection of up to two pore fluids (under flow and pressure control). *See the experimental procedure in the video...*

Rig video



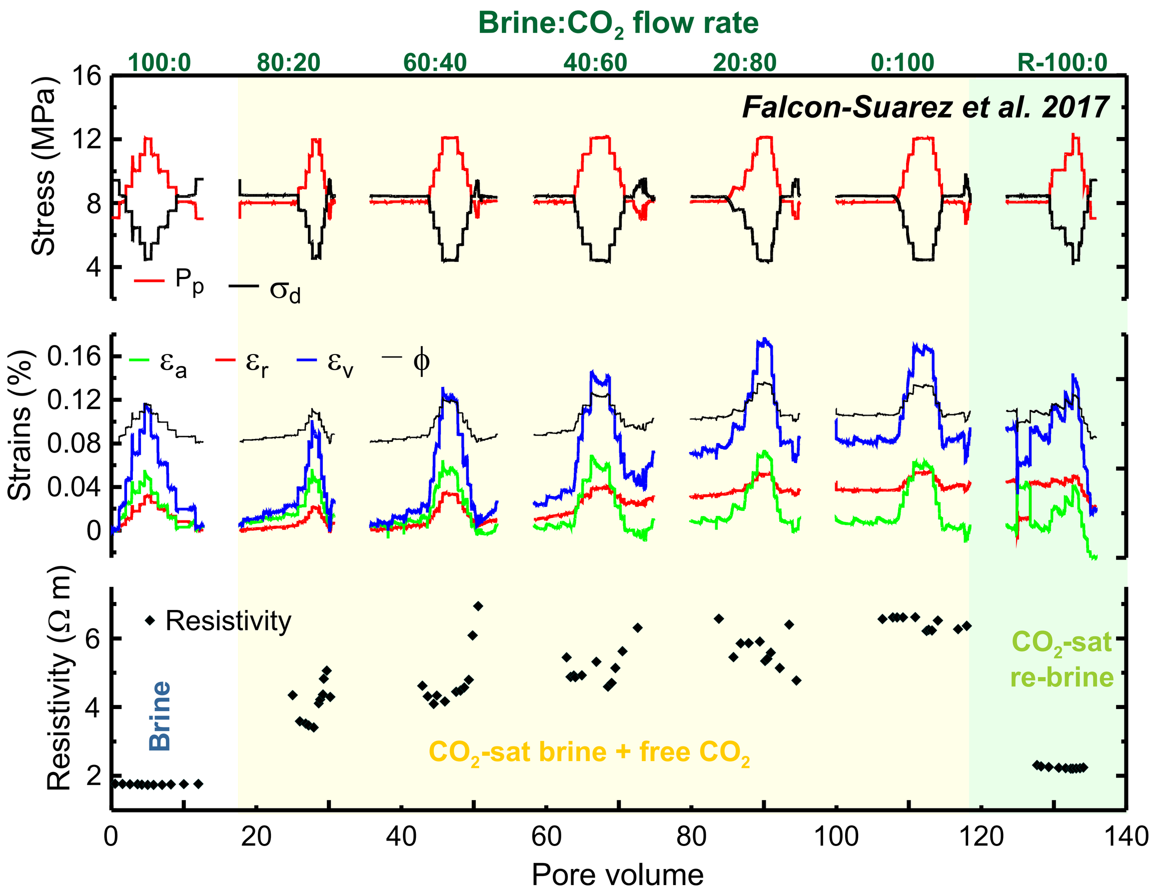
Context

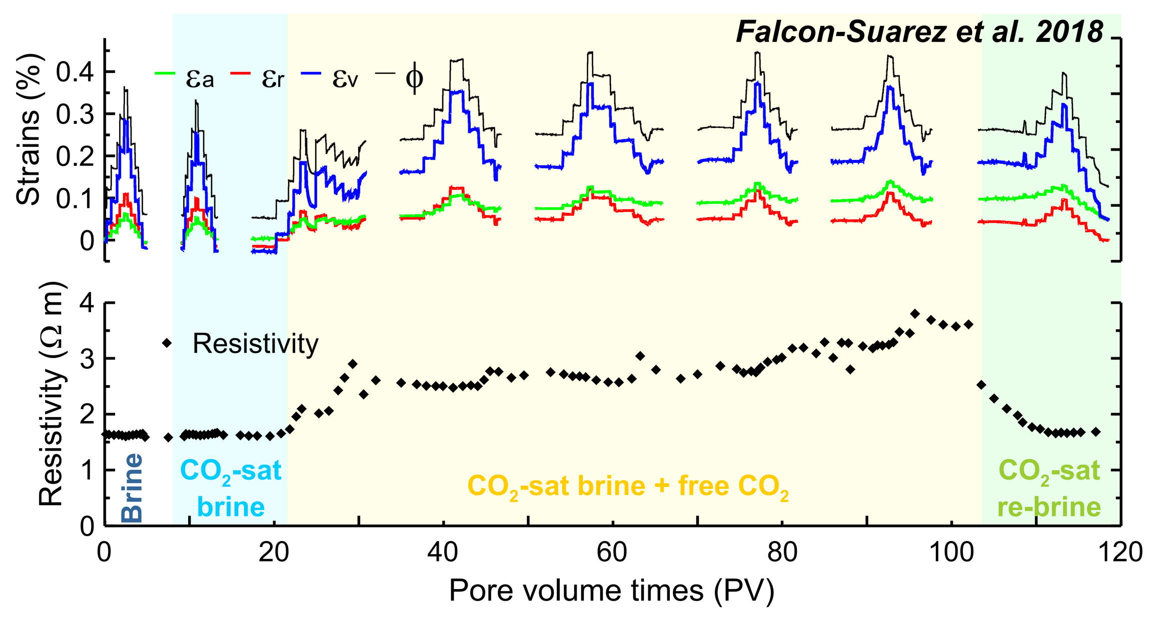
Injecting carbon dioxide (CO_2) into deep geological formations is recognized worldwide as the only realistic mitigation technology that can reduce current anthropogenic CO_2 emissions to meet national targets by 2050. European countries, including the UK, have considered depleted oil and gas fields and saline aquifers for CO_2 storage (e.g. Sleipner field, North Sea), while a number of projects in the United States have focused on CO_2 injection for enhanced oil recovery (EOR) in depleted or unconventional hydrocarbon reservoirs.



Scottish CCS' interactive world map of carbon capture and storage projects (www.sccs.org.uk/map)

Inflation/deplation traces during CO_2-brine flow tests





Our results indicate permanent **inflation** in non-reactive (siliciclastic) brine saturated reservoir analogues, when CO_2 was being injected, later **recovered** when brine was forced to flow through the sample. This process simulates the imbibition mechanisms of aquifer recharge **after ceasing** the **CO_2 injection**. The strains recovery associated with the recharge occurs abruptly, and carries some degree of shrinking with respect to the original state (prior to CO_2 injection). All this suggests that this mechanism is capable of triggering significant reservoir instability.

See how strains drop from the CO_2-brine (yellow band) stage to re-brine (green band), in both tests.

Ongoing tests

Our tests involve (i) the study of the elastic and transport properties of sandstones prior contact with CO_2, (ii) the analysis of the **hydro-mechano-chemical coupled phenomena** taking place during CO_2-brine flow-through tests (including drainage and imbibition), and (iii) the assessment of sample damage post-CO_2 by repeating the elastic/transport properties analysis test.

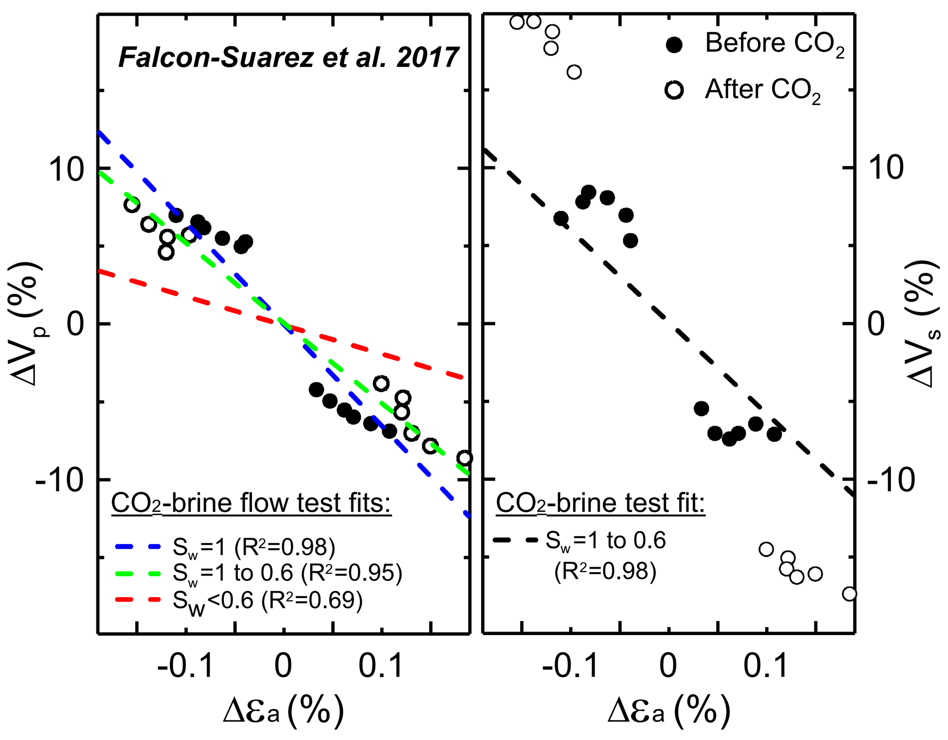
Test sequence

1. Elastic and transport properties before CO_2 injection
2. CO_2-brine flow-through test
3. Elastic and transport properties after CO_2 injection

Measured parameters

$V_{P,S}$, $Q_{P,S}^{-1}$, $k_{abs,rel}$, Ω, $\varepsilon_{a,r}$, ϕ

Experimental observations: Changes in elastic properties due to CO_2



Acknowledgements

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References

Falcon-Suarez I, et al. 2017, 2018. *Int J Greenh Gas Con*