

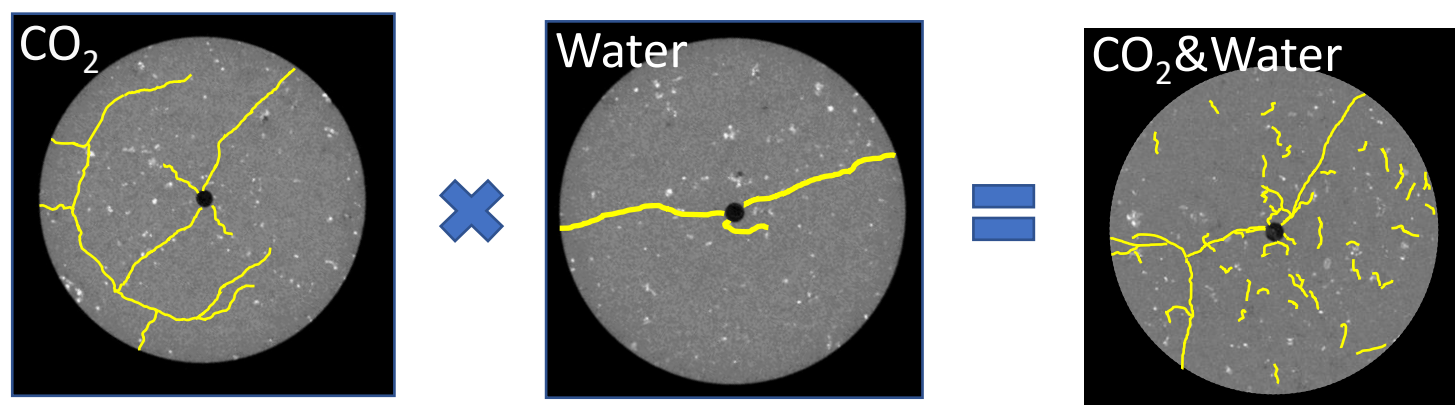


We conducted various research in energy resources, environmental sciences, and engineering. They include environmental risk assessments, geosciences and geoengineering in light of energy resource production, and geo-informatics for a sustainable future. Recently, our work has focused on the sustainable and profitable production of petroleum and geothermal energy, as well as CO<sub>2</sub> sequestration and mineralization.

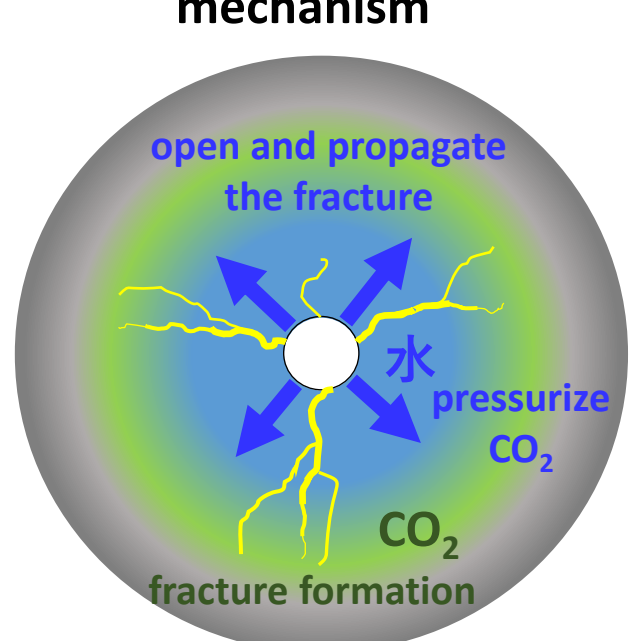


## Carbon Recycle CO<sub>2</sub> Geothermal Power Generation

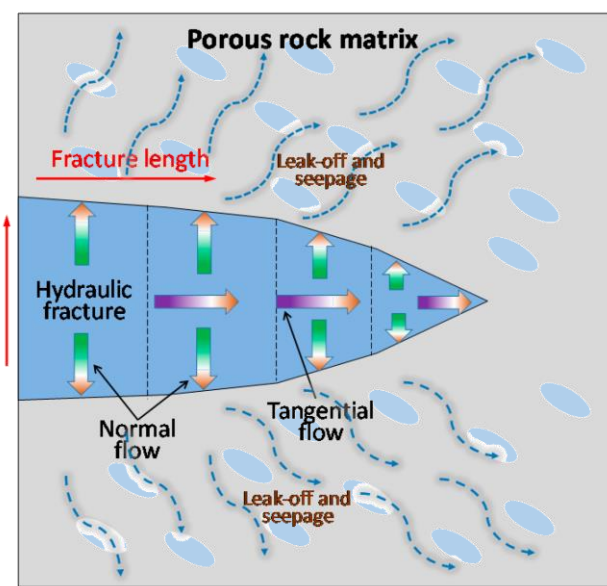
### New fracturing method combining CO<sub>2</sub> & water injection



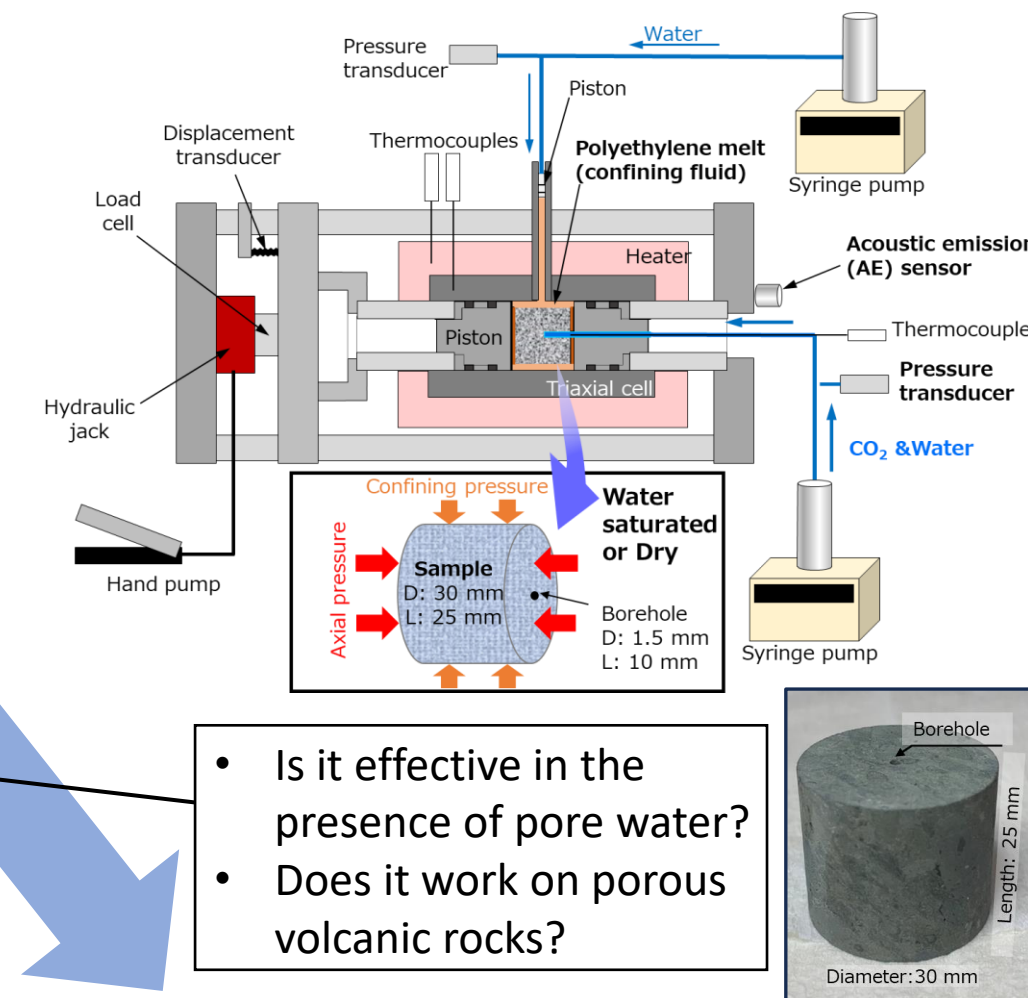
#### CO<sub>2</sub> & water fracturing mechanism



pore water in rocks inhibits fractures opening and propagation

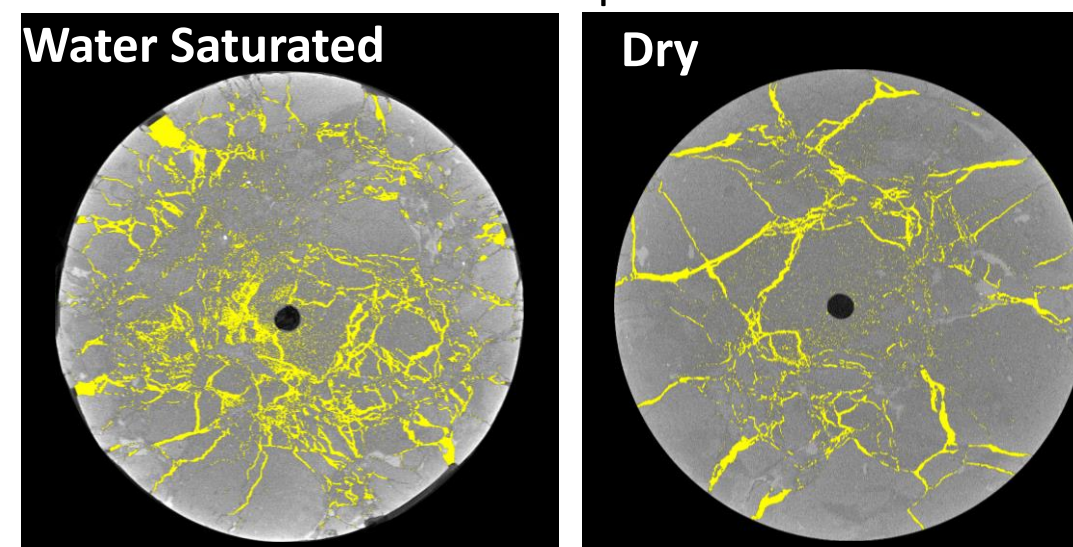


CO<sub>2</sub> & water fracturing is still effective with the pre-existing pore water and is particularly effective in porous volcanic rocks.



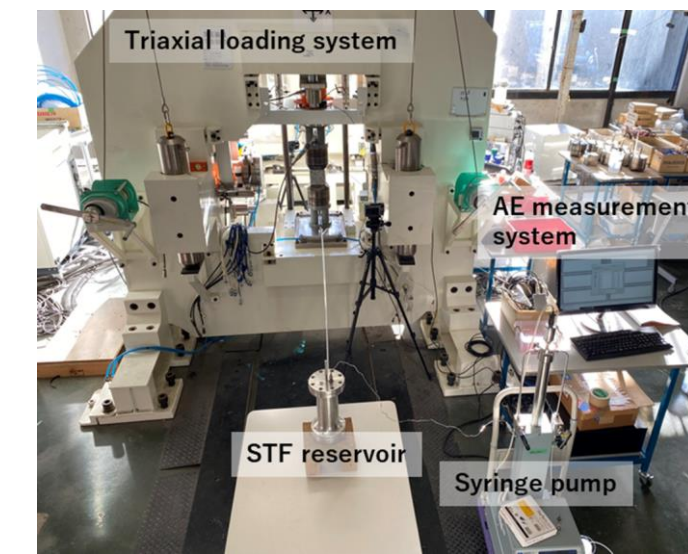
- Is it effective in the presence of pore water?
- Does it work on porous volcanic rocks?

andesitic lapilli tuff



## Multidirectional fracturing of rock using shear thickening fluid

### Experiment System

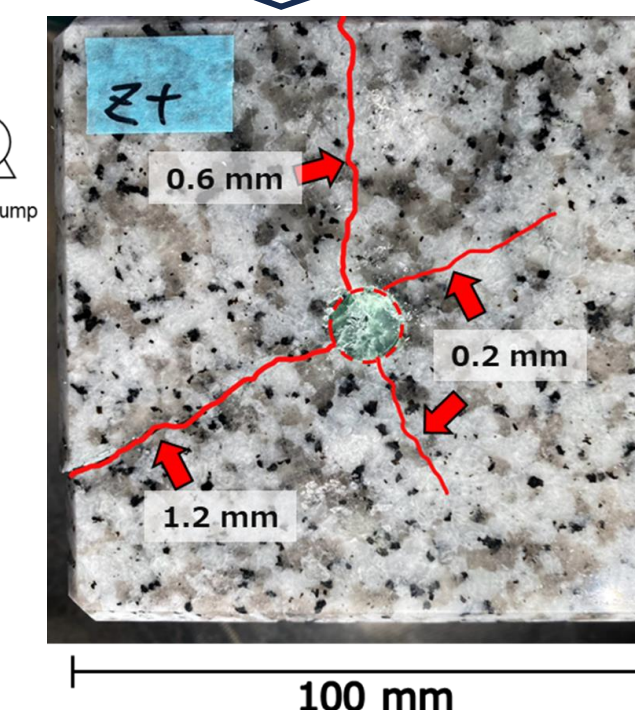
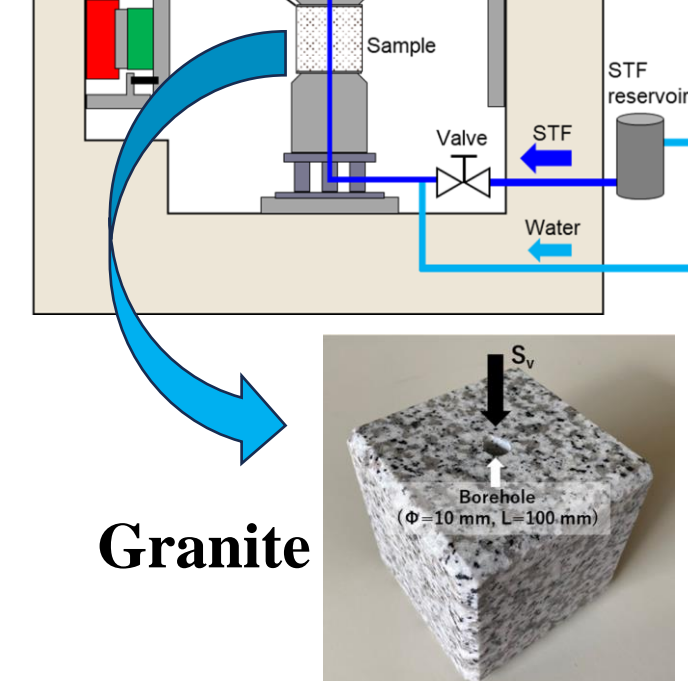
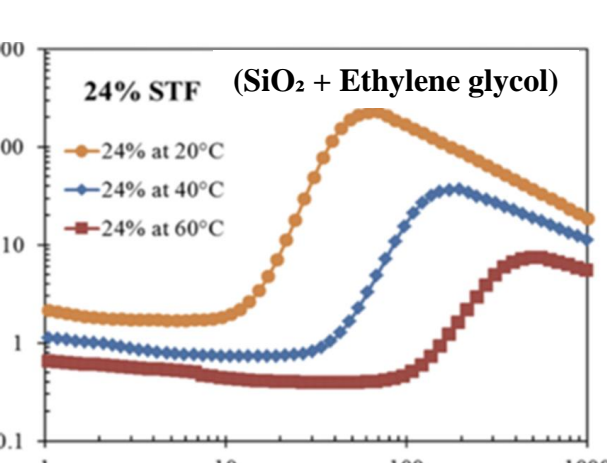
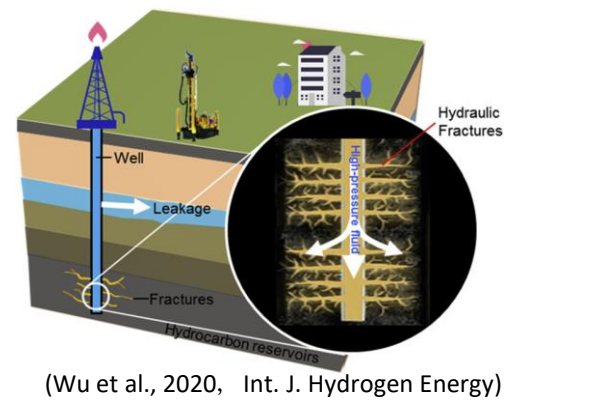


### Hydraulic fracturing

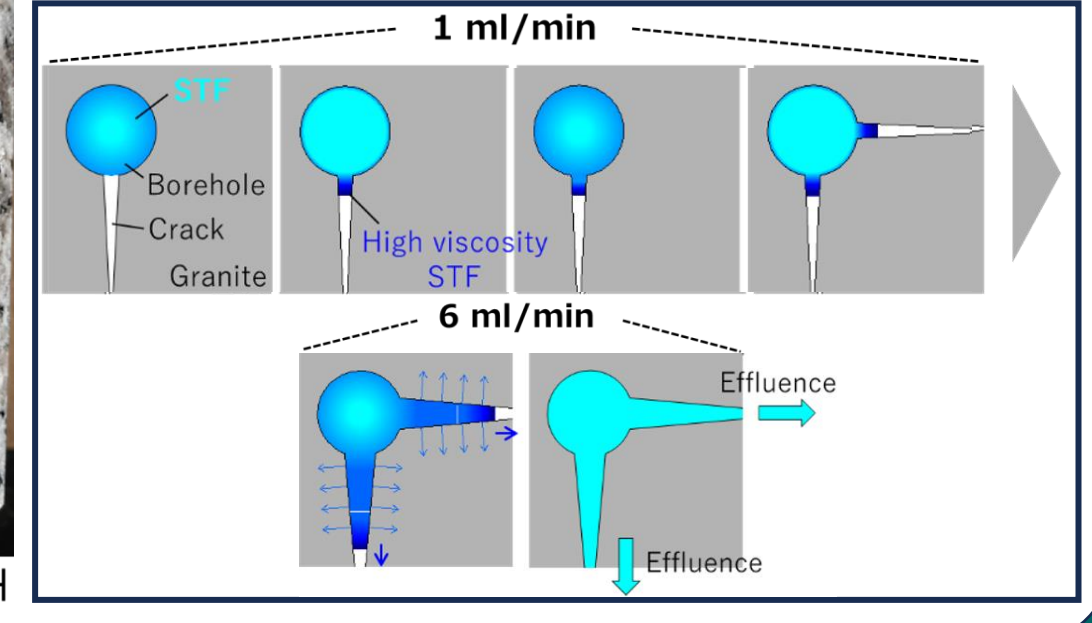
Fracture nucleation improves the permeability only in a certain direction.  
➡ How does the fracturing manner change by the **shear thickening fluid (STF)**?

**High flow rate and narrow fracture width**  
➡ **Increase in viscosity**

We have produced **multidirectional fractures and larger aperture fractures**, which improve rock permeability.

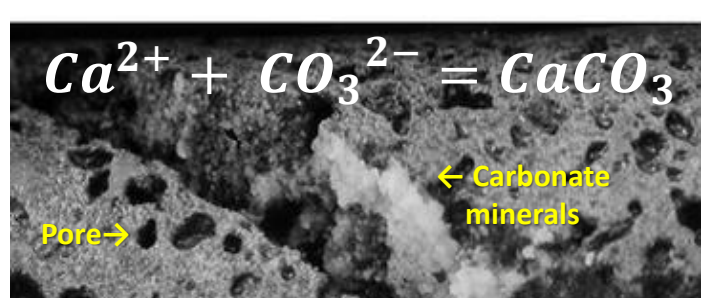


### Possible mechanism of STF fracturing



## Enhanced CO<sub>2</sub> geological storage and mineralization using biodegradable chelating agents

CCS, in which CO<sub>2</sub> is injected into underground rocks and fixed as a carbonate mineral, has been attracting attention in recent years.



In order to utilize reservoirs in the most efficient, safe, and secure manner, we invented a method to promote CO<sub>2</sub> geological storage and mineral fixation.

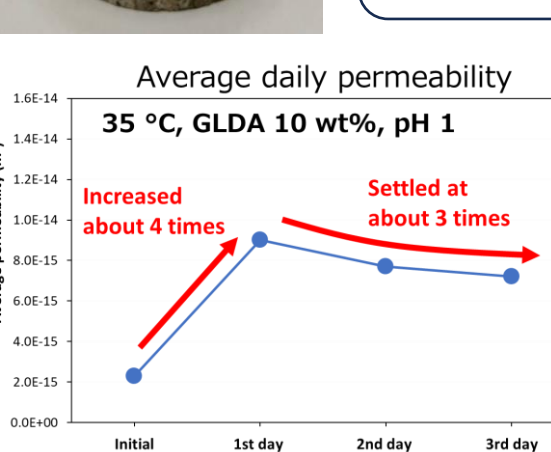
[patent application 2023-51335]

What is the applicability to basaltic volcanic sandstone containing clay minerals?

**Challenge: Clay minerals clogging channels and poor permeability**

Rocks that have undergone clayey alteration and oxidative alteration  
Contains the clay mineral montmorillonite

**Biodegradable chelating agent GLDA dissolves minerals to improve permeability**



Permeability UP!

Aids in the dissolution of minerals!

Settled at about 3 times

Increased about 4 times

Initial

1st day

2nd day

3rd day

4th day

5th day

6th day

7th day

8th day

9th day

10th day

11th day

12th day

13th day

14th day

15th day

16th day

17th day

18th day

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