Effects of Added Chemicals on Expansion of Oil Volume with CO_2 Injection: Experimental Studies with High Pressure Optical cell (HPOC) and In-situ Raman Spectroscopy

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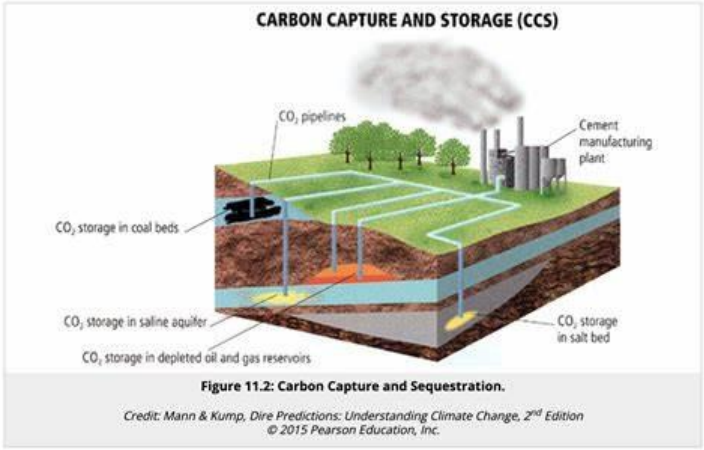
1. Background

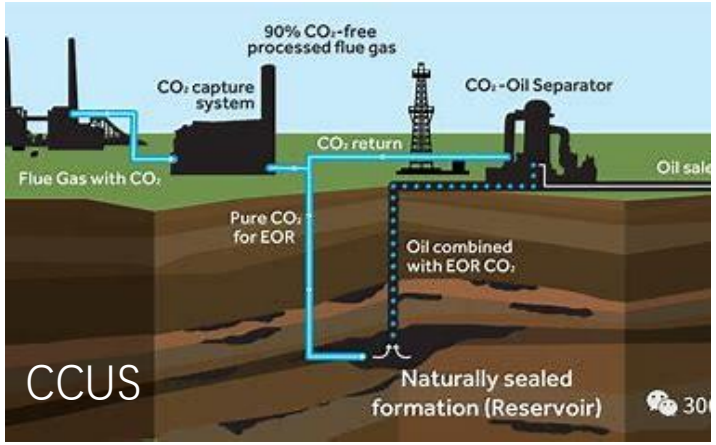
A collage of events related to climate and weather: loss of glacial ice, wildfires, hurricanes, floods, and drought. (Image credit: NOAA)

CO_2

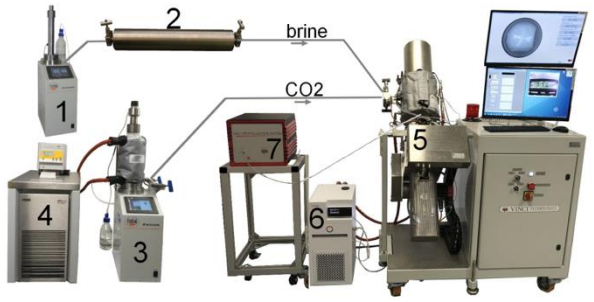
The foundational technology to ensure a zero-carbon future for humanity - Carbon Capture, Utilization, and Storage (CCUS)

Oil & Gas Industry





2. Method



1. Brine transfer pump
2. Brine accumulator
3. CO2 transfer pump
4. Thermostatic bath
5. PVT cell
6. Thermostatic bath
7. Salt detection system

Fluid Eval 300HC- PVT cell

Good, but expensive system

Capillary Threshold Pressure apparatus

CO2_brine dissolution apparatus

Innovative system

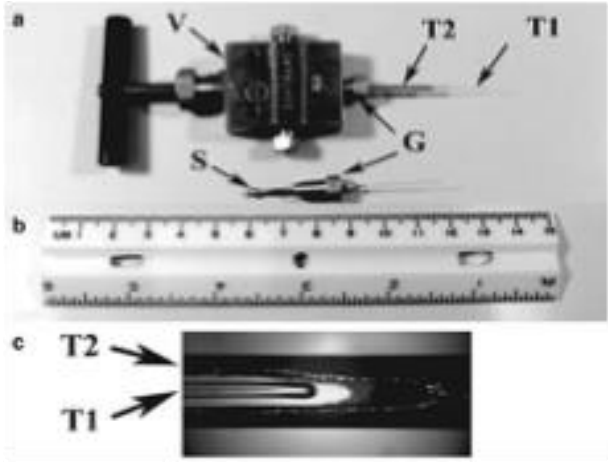


Fig. 1. Photograph of a high-pressure optical cell (HPOC).

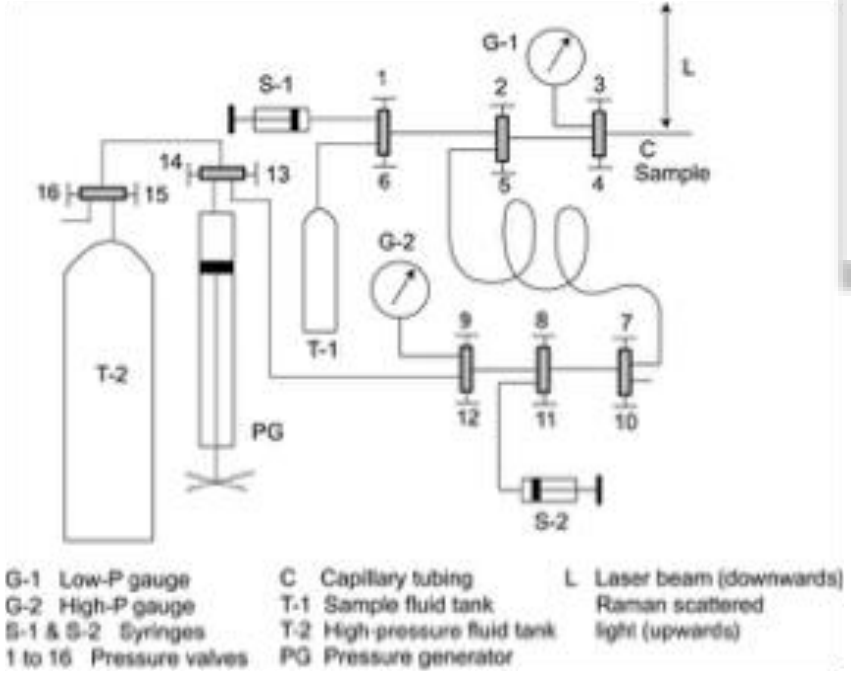
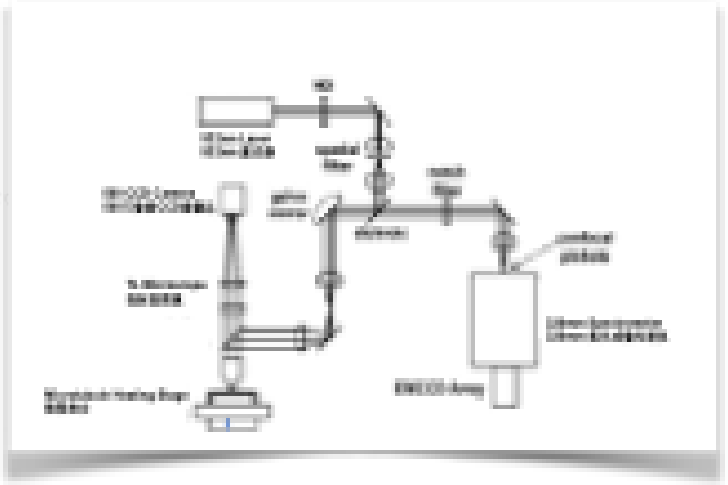


Fig. 2. Schematic diagram showing the sample loading and pressurization system for Raman spectroscopic analysis of fluid samples.



Schematic diagram of GeoRaman Microprobe.

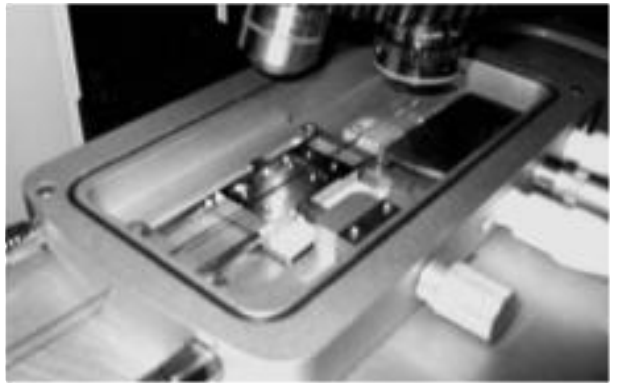


Fig. 9. Photograph of the sample chamber of the Linkam CAP 500 heating-cooling stage.

EMU Notes in Mineralogy, Vol. 12 (2012), Chapter 6, 227–247

Optical cells with fused silica windows for the study of geological fluids

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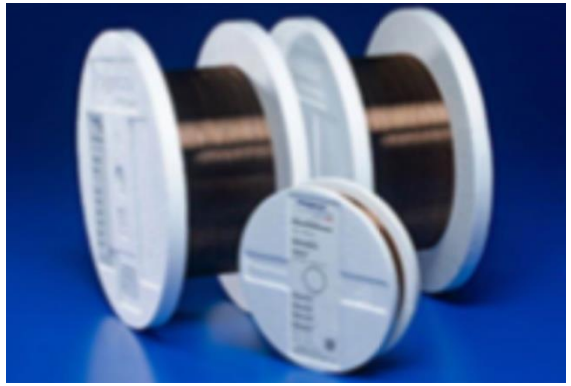
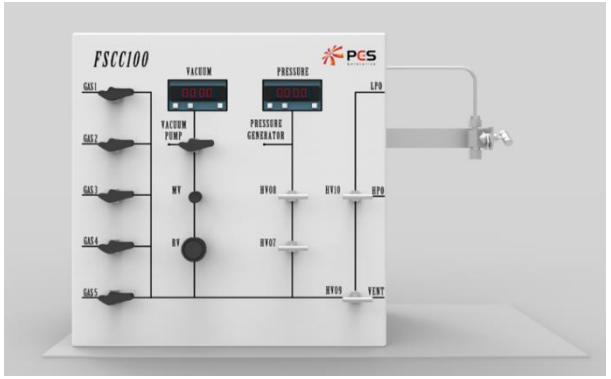
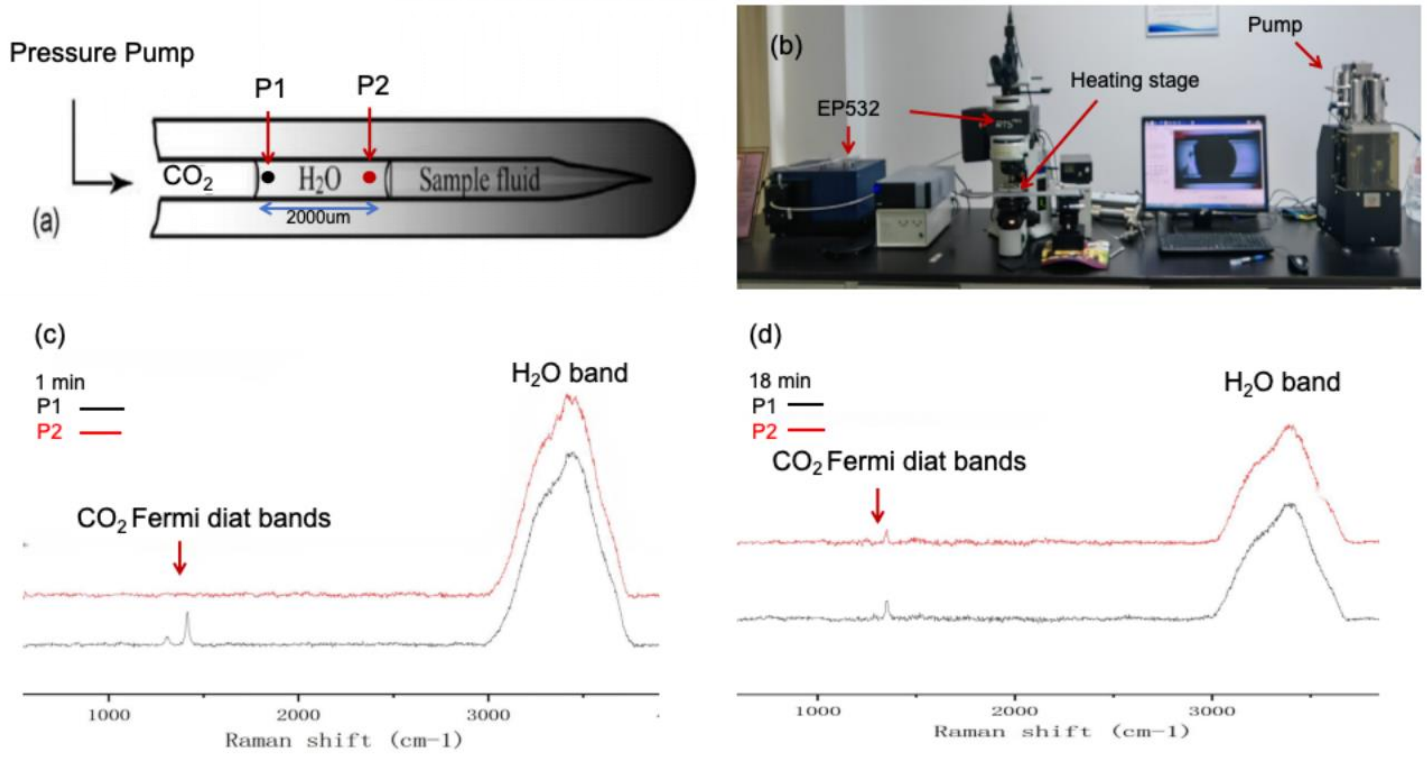
Innovative system



Commercial system

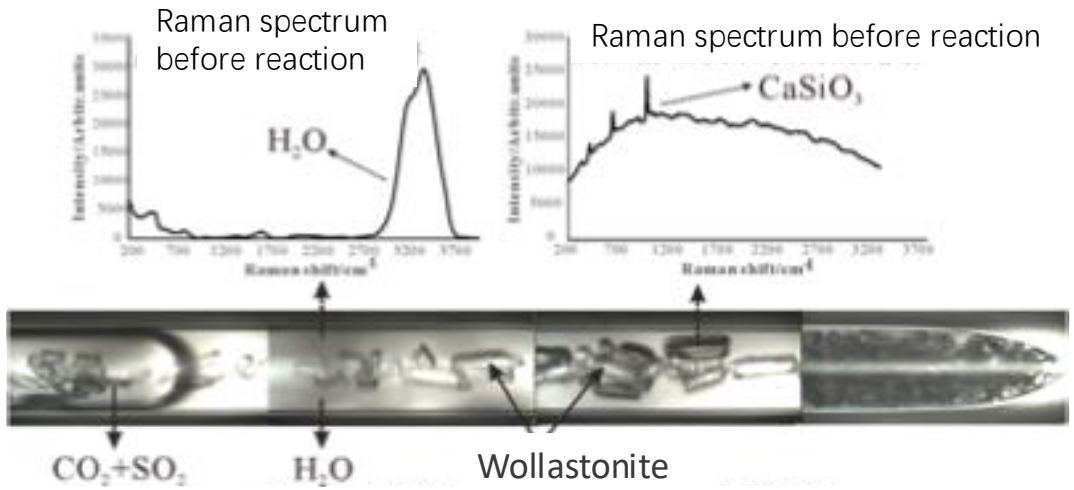


Innovative system

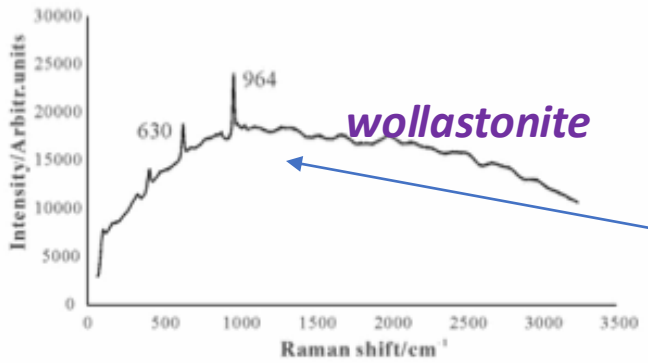


The configuration of experimental system and collected Raman spectra of dissolved CO_2 in H_2O in HPOC. (a) Schematic diagram of the HPOC setup. Raman spectra were collected at points P1 and P2, they were located 100 µm away from the gas-water interface and 100 µm from the water-oil interface, respectively; (b) Compact EP532 Laser GeoRaman Microprobe with Linkam CAP500 stage and CF30 pump; (c) and (d) Raman spectra collected at 44.7℃ at P1 (black lines) and P2 (red lines) 1 and 18 min after 14 MPa of CO_2 was applied to the system, respectively.

Application on CO_2 Storage

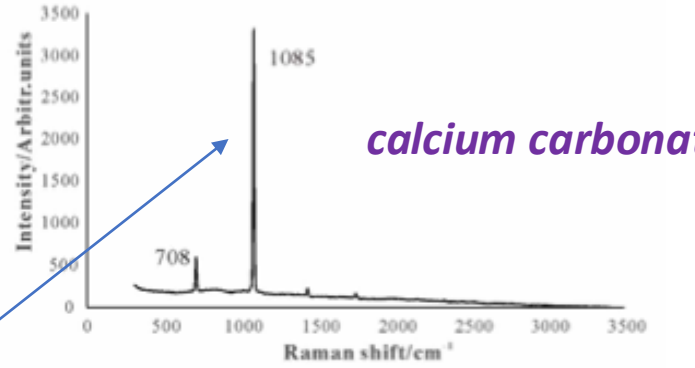


Cell image and Raman spectrum before reaction

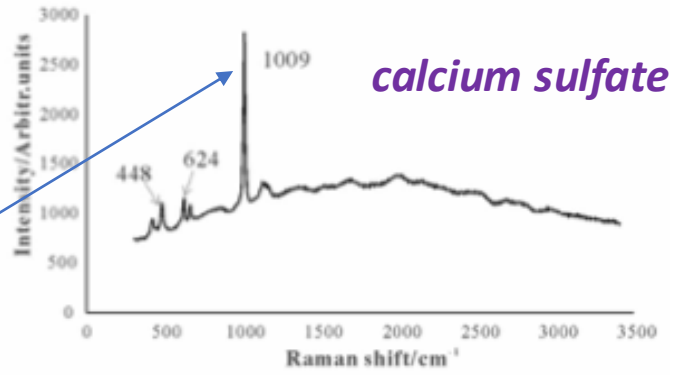


Raman shifts are 964 cm^{-1} for wollastonite

Comparing of Raman shifts on wollastonite and deposit before and after reaction.



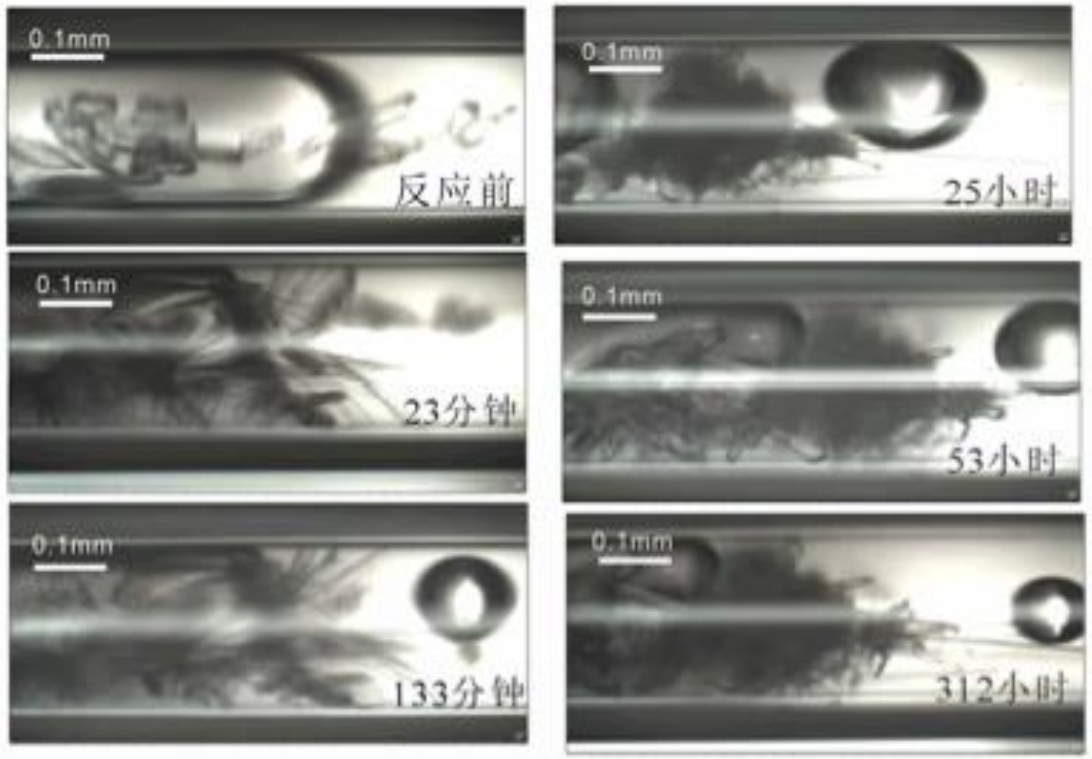
Raman shifts are 1085 cm^{-1} for calcium carbonate

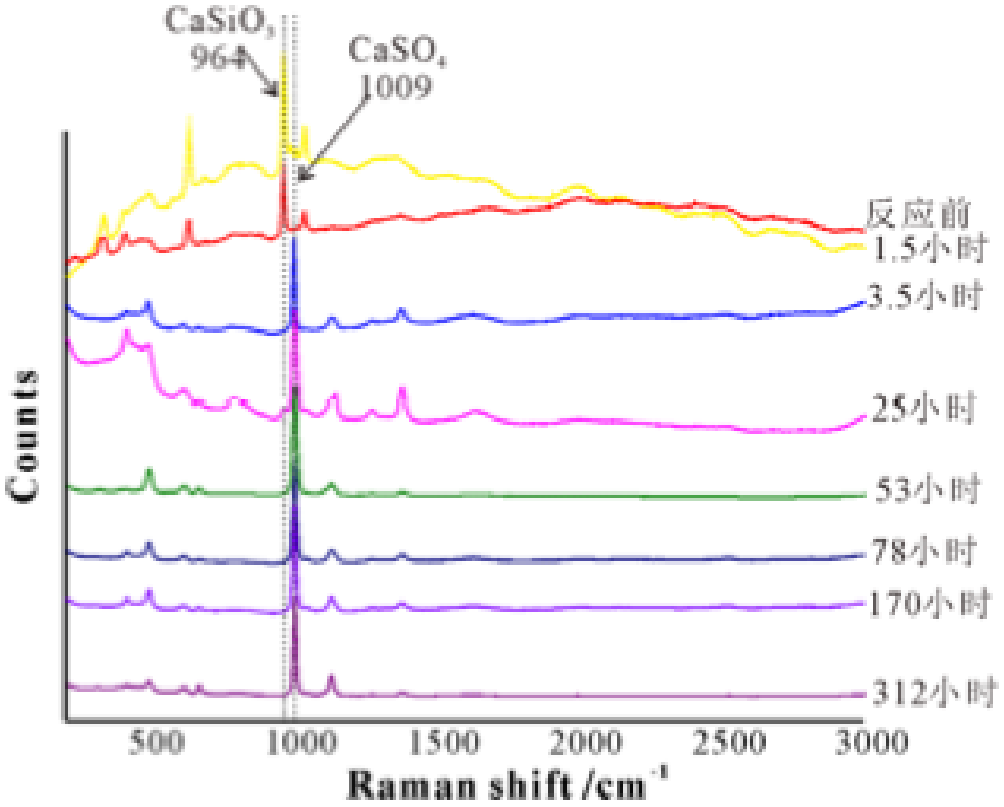


Raman shifts are 1009 cm^{-1} for calcium sulfate.

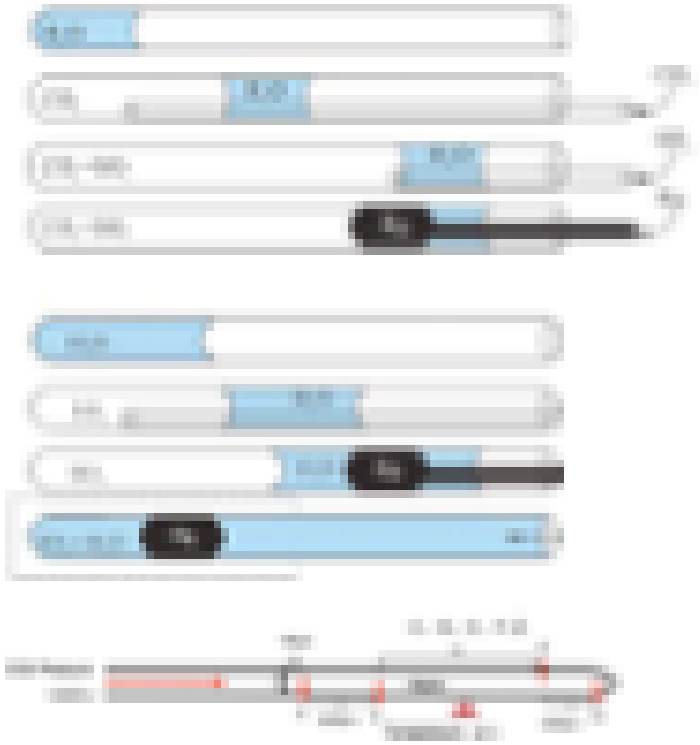
2021, by Ms. Qing Zhou

Application on CO_2 Storage

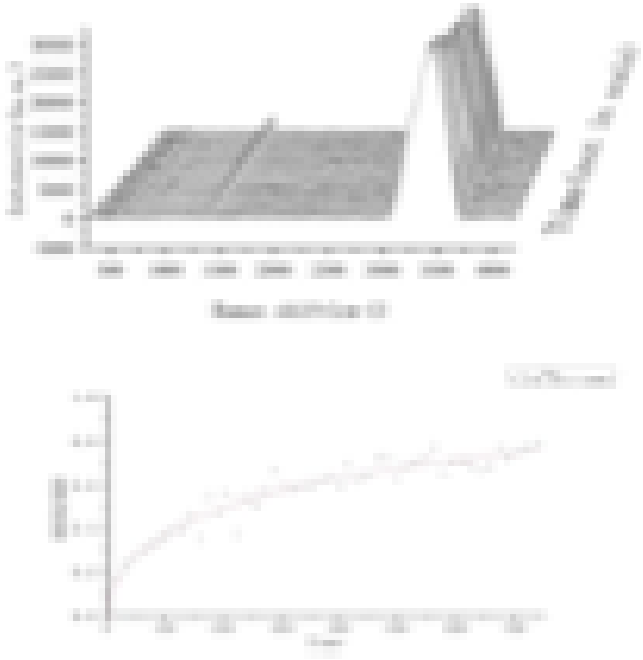




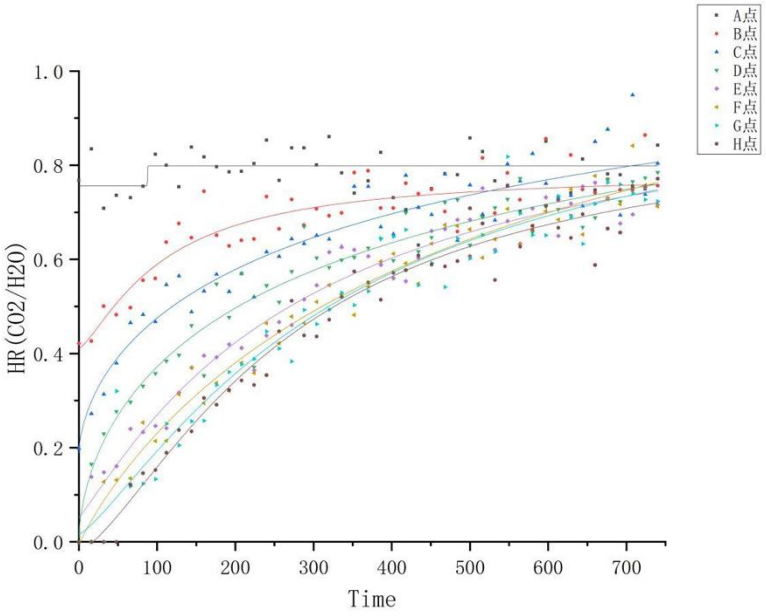
Application on CO_2 Storage



Loading different samples in HPOC



Diffusion trend on point D with time, CO2 in water，with HT/HP Optical Cell GeoRaman Microprobe

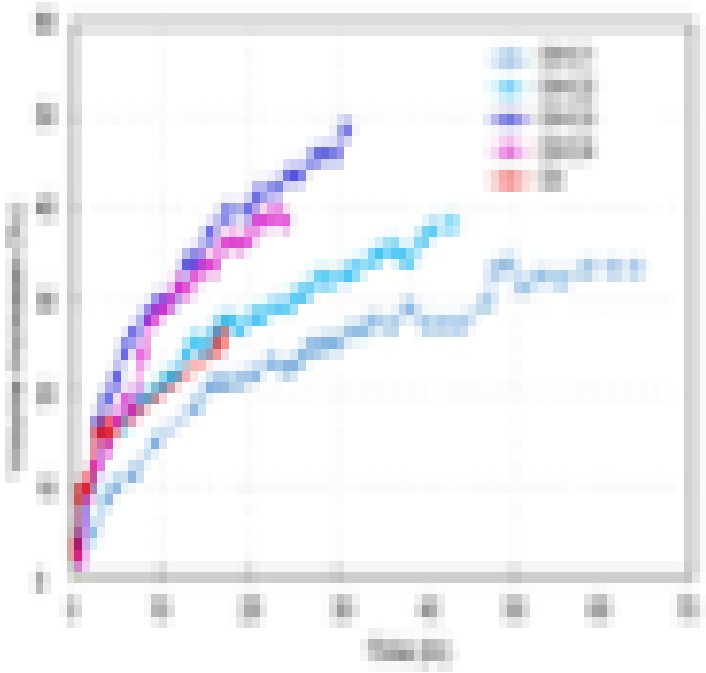


Diffusion trend on different point from A to D with time, CO2 in water，with HT/HP Optical Cell GeoRaman Microprobe

Application on CO_2-driven EOR Study

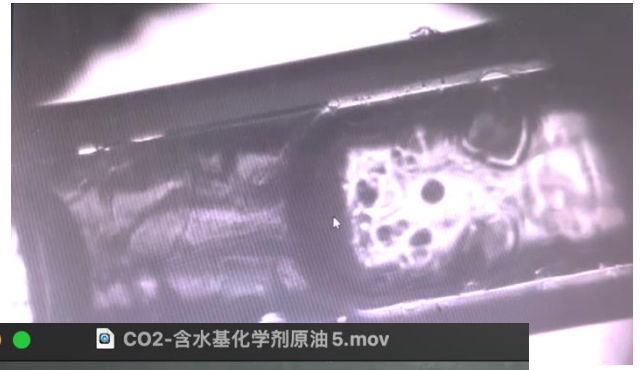
Under Stereo Microscope

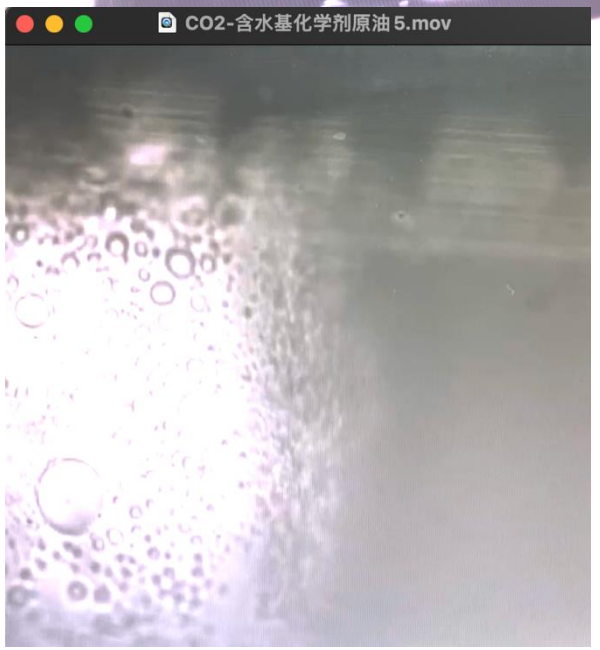
Chemical oil expansion test with different time under microscope at high pressure 50MPa.



he relative expansion of oil volume (%) over time (hours) after the application of CO2 to oil with or without chemical additives in HPOC under 14MPa.

Under IR Specific Microscope





Video of chemical oil with CO2

Many thanks for your attention