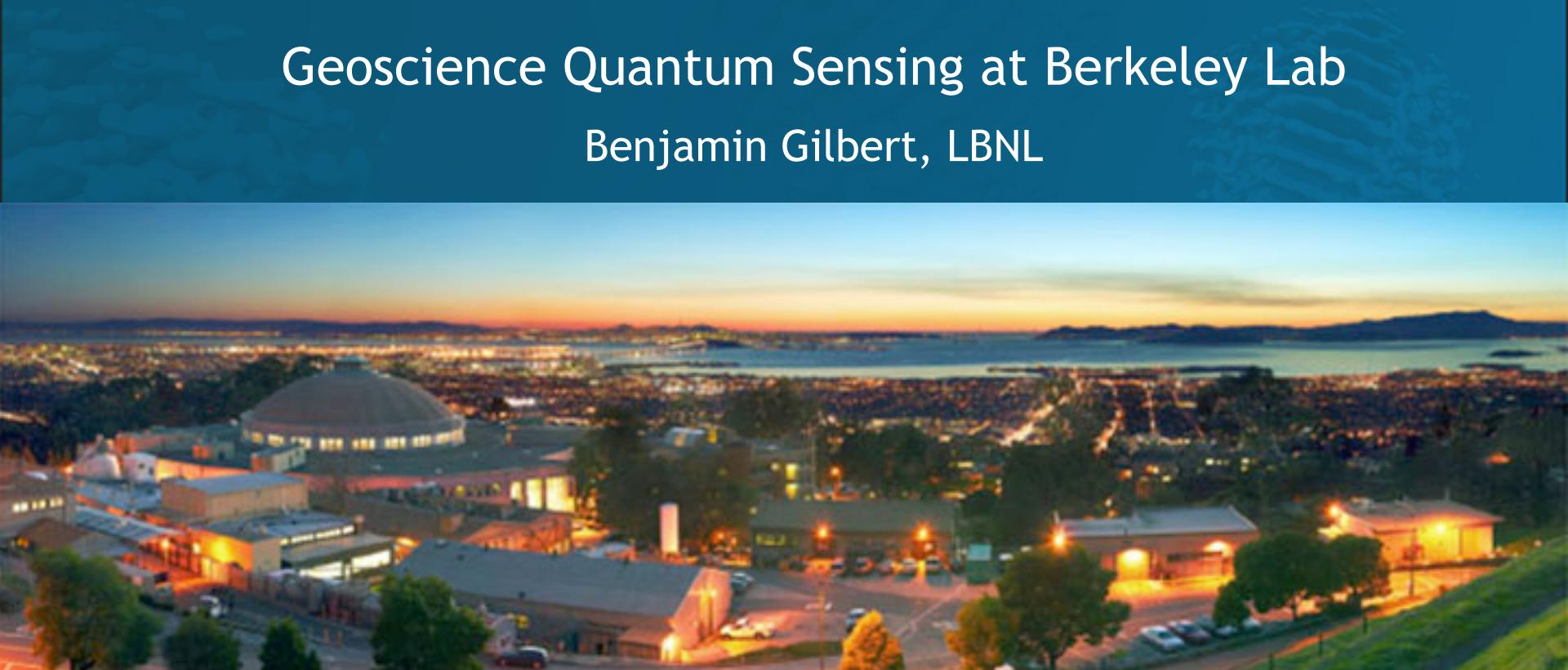
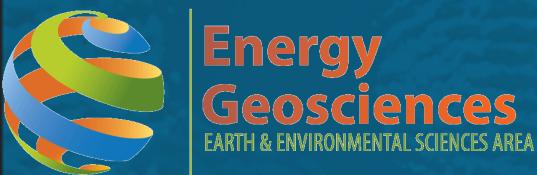
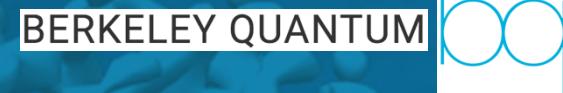


# Geoscience Quantum Sensing at Berkeley Lab

## Benjamin Gilbert, LBNL



NETL, Pittsburgh, PA  
19<sup>th</sup> November 2019



BERKELEY LAB



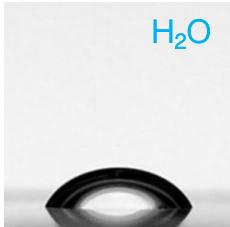
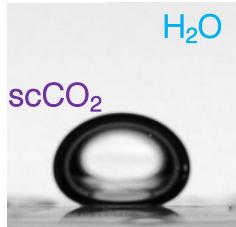
U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

# Chemistry and Rheology of Interfaces

## Interface Type

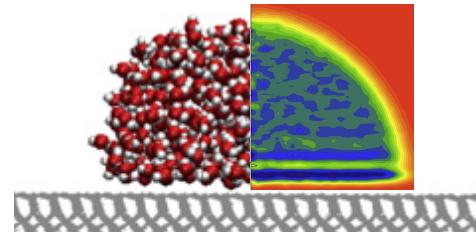
### Bulk Mineral-Fluid Interfaces



Fresh mica

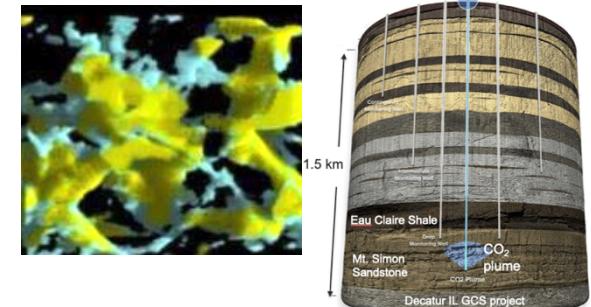
Reacted mica

## Current Model

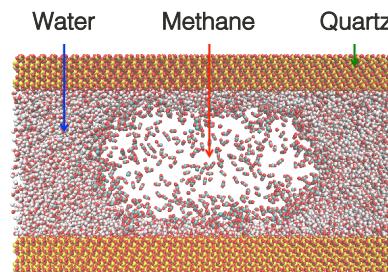
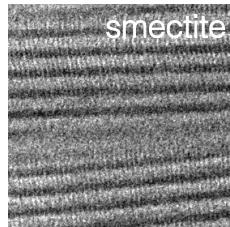
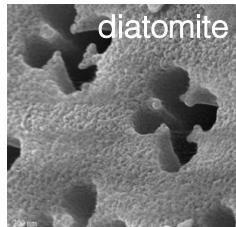


## Field-Scale Impact

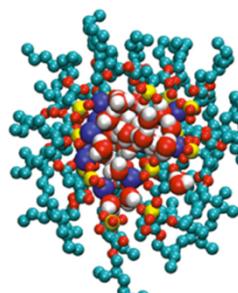
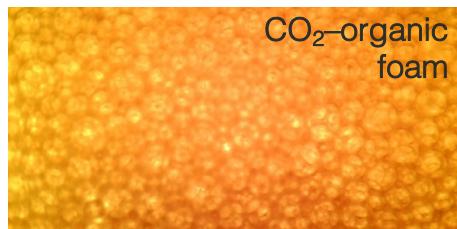
Oil extraction or CO<sub>2</sub> sequestration



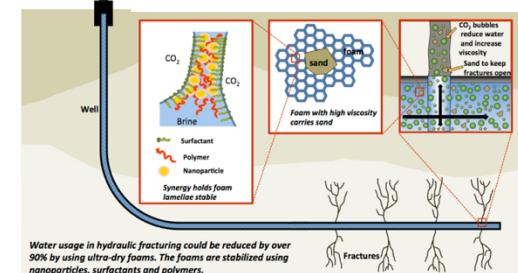
### Nanopore-Fluid Interfaces



### Fluid-Surfactant-Fluid Interfaces

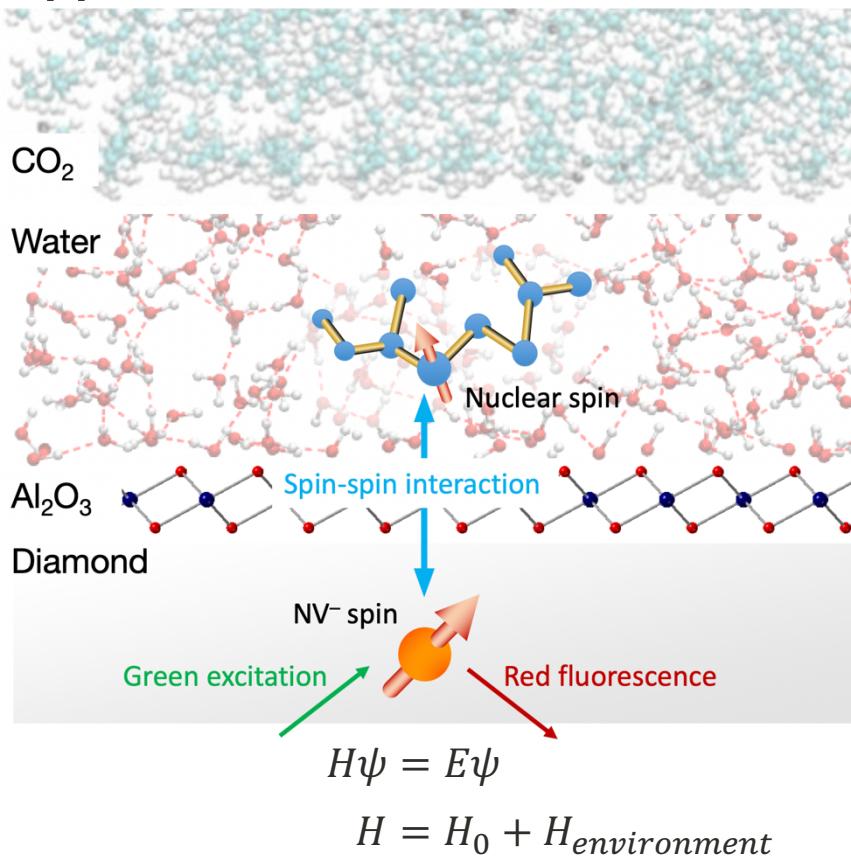


## Reduced water use in HF



# Interface Science with Diamond NV<sup>-</sup> Centers

## Application to Interface Science



## Physical and Chemical Measurements

- Viscosity from solvent <sup>1</sup>H NMR relaxometry
- Solute speciation from (<sup>13</sup>C, <sup>31</sup>P ...) NMR
- Pressure and strain

## Laboratory Capabilities

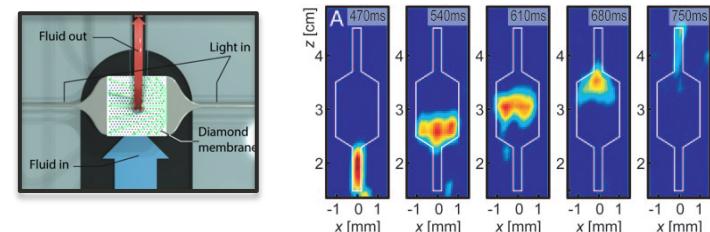
### In Situ Experiments

- 1 bar – GPa
- 0°C – supercritical water

## Extensions

### Nuclear hyperpolarization

- Optical manipulation and NMR spectra/imaging
- Microfluidics → cores → field



## Nanodiamonds

- Surfactant interfaces
- Functionalization

