Carbon Dioxide Capture and Sequestration

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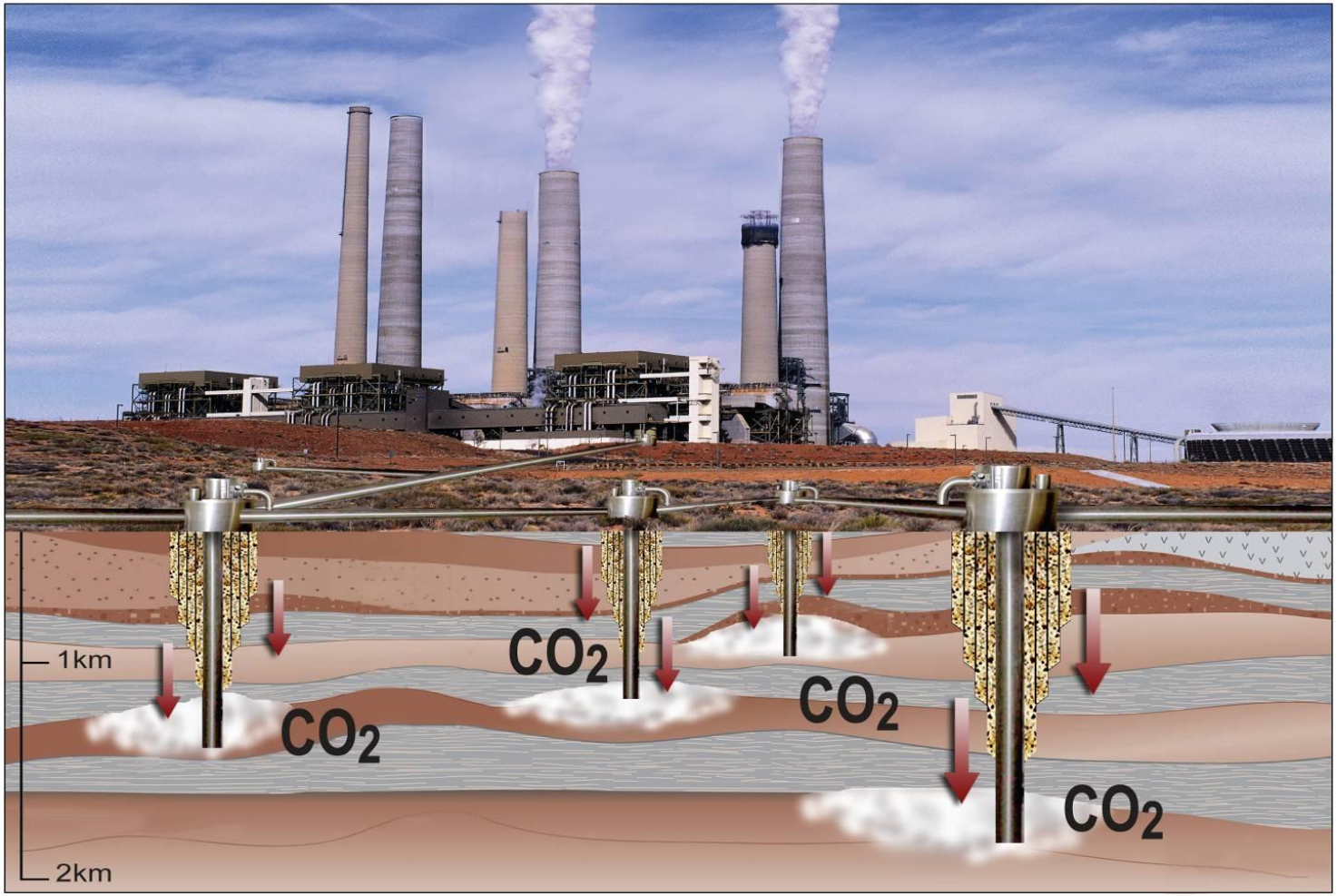
GLOBAL CHALLENGES – GLOBAL SOLUTIONS – GLOBAL OPPORTUNITIES

Why CCS?
(Carbon Capture and Sequestration)

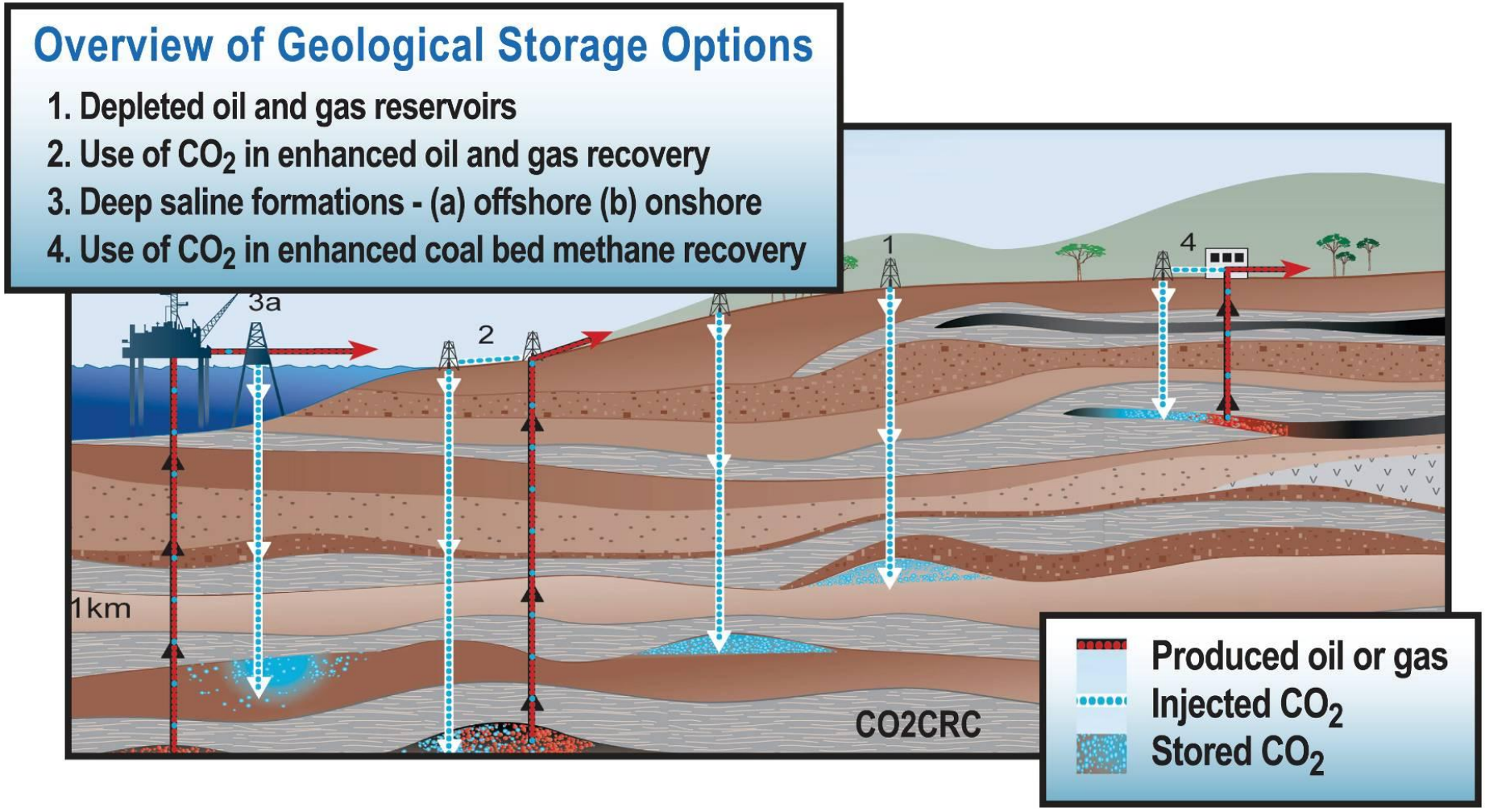
1. Applicable to 60% of global emissions
2. Achieve 65-85% lifecycle emissions reduction
3. Provide low carbon base-load and load-following electricity
4. Essential technological component for a global emissions reduction strategy
5. Negative emissions by combining biomass energy with CCS
6. Facilitate political consensus to address the climate problem

Carbon Dioxide Capture and Sequestration Involves 4 Steps



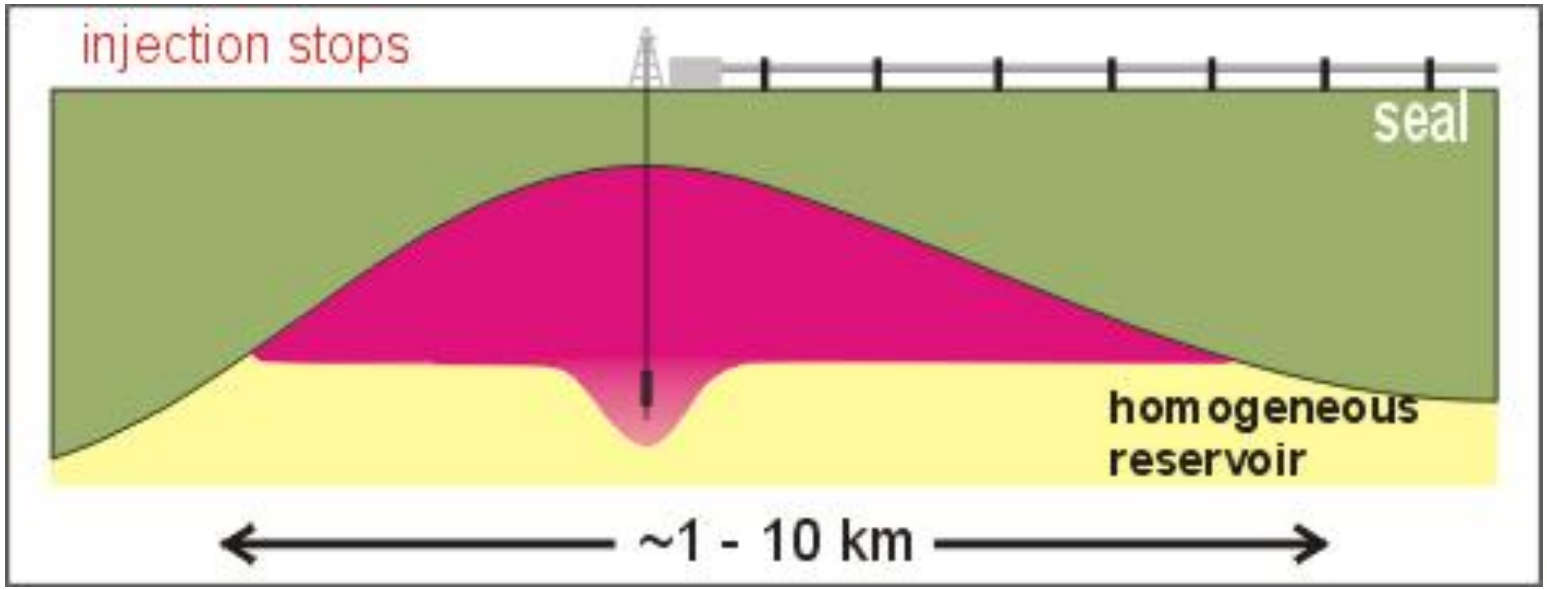
Capture → **Compression** → **Pipeline Transport** → **Geological Sequestration**

Options for Geological Storage



Basic Concept of Geological Sequestration of CO_2

- Injected at depths of 1 km or deeper into rocks with tiny pore spaces
- Primary trapping
  - Beneath seals of low permeability rocks



Courtesy of John Bradshaw

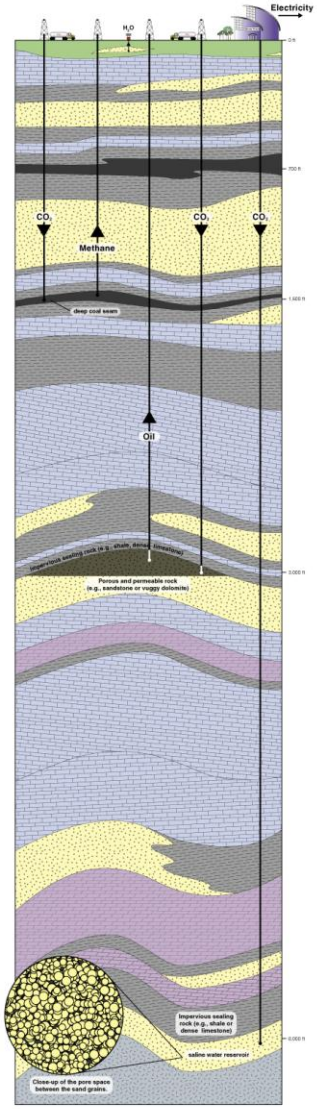
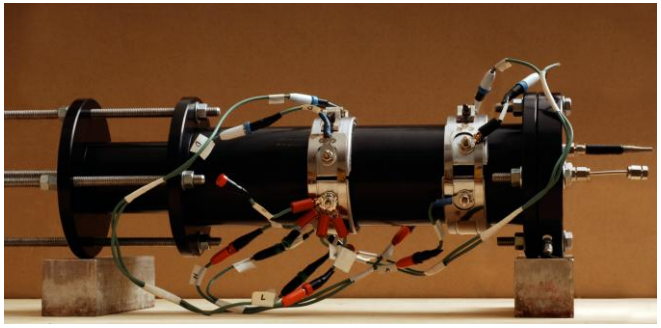


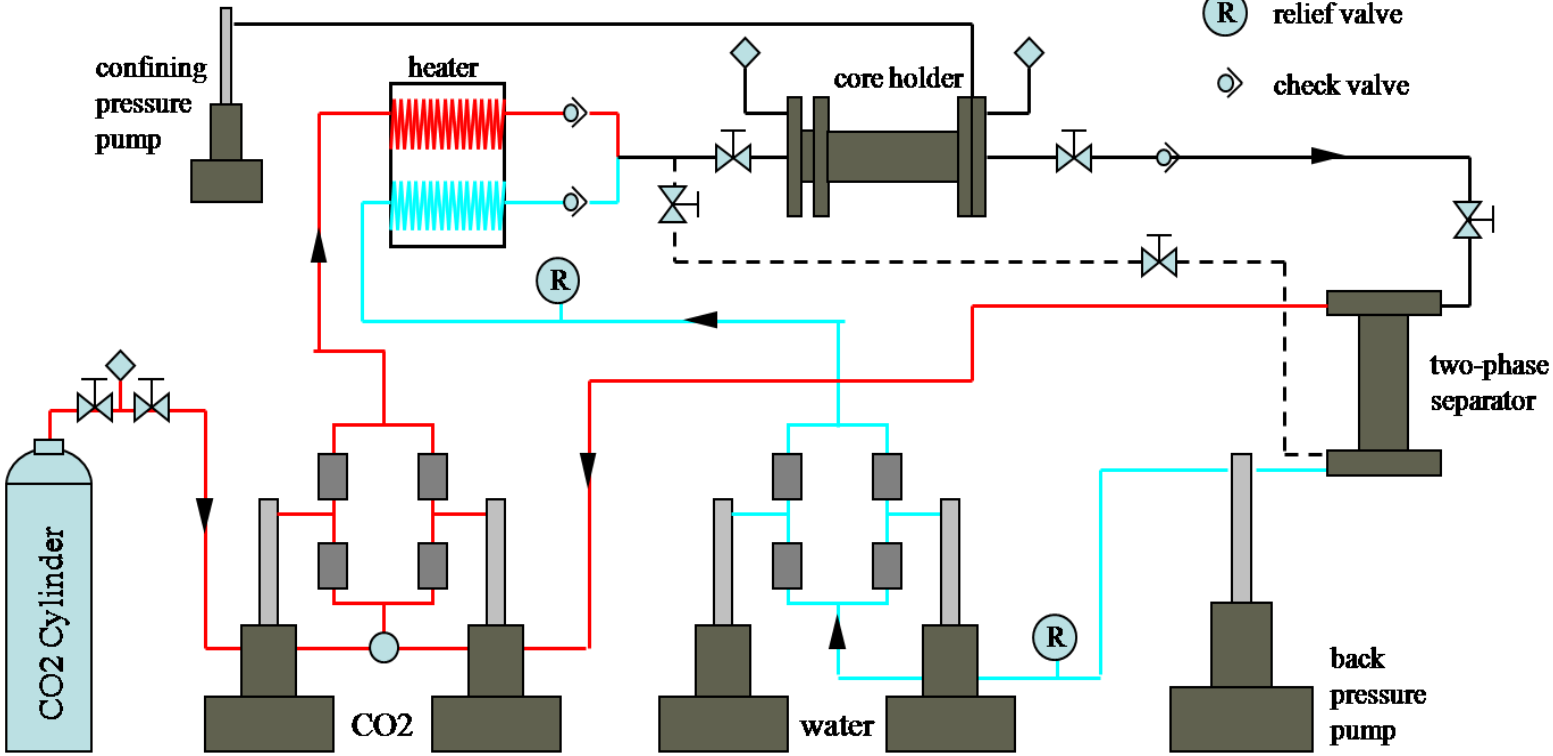
Image courtesy of ISGS and MGSC

Major Research Questions

- What makes a good seal?
- How fast can CO_2 be pumped underground?
- How far and how fast will the CO_2 plume move underground?
- What methods of monitoring can be used – and how accurate are they?
- What can be done if something goes wrong?

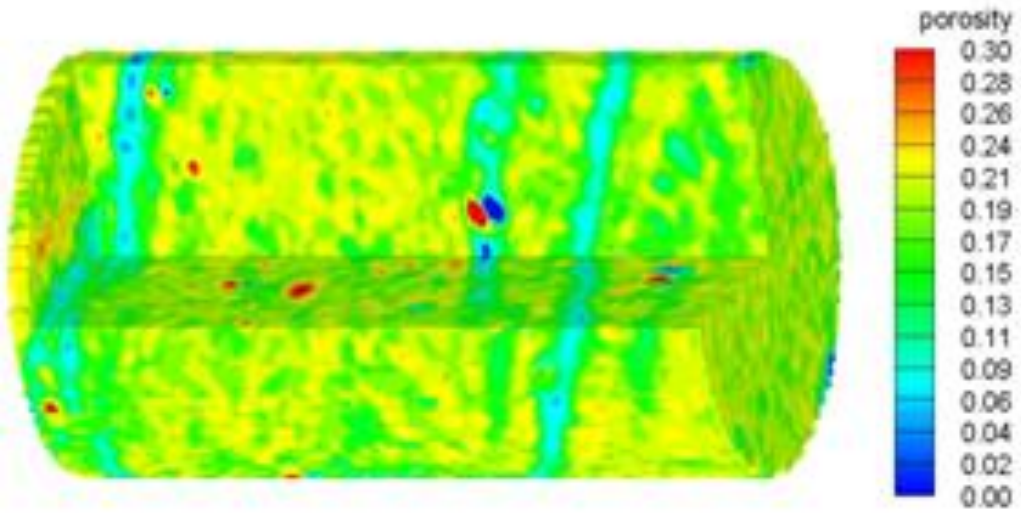
Core-Flood Visualization Lab



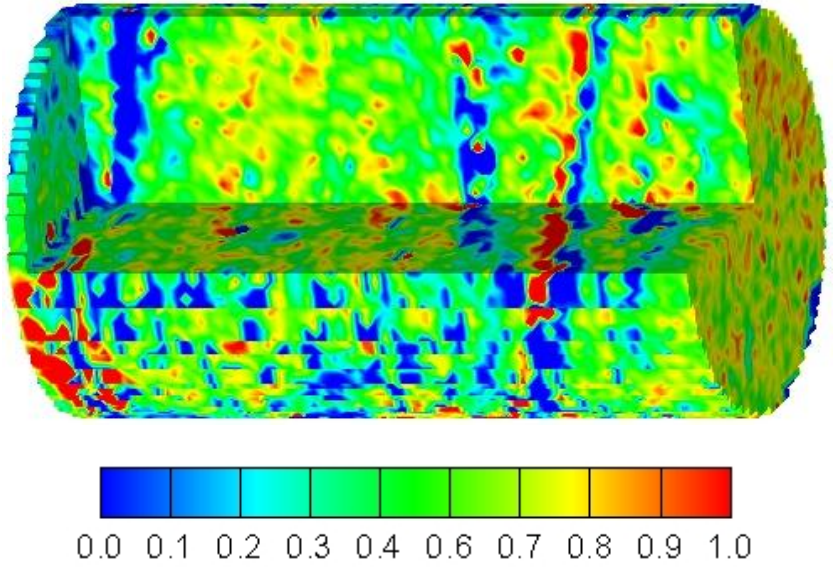


X-Ray CT Imaging of Rocks

Porosity Map



CO_2 Saturation Map

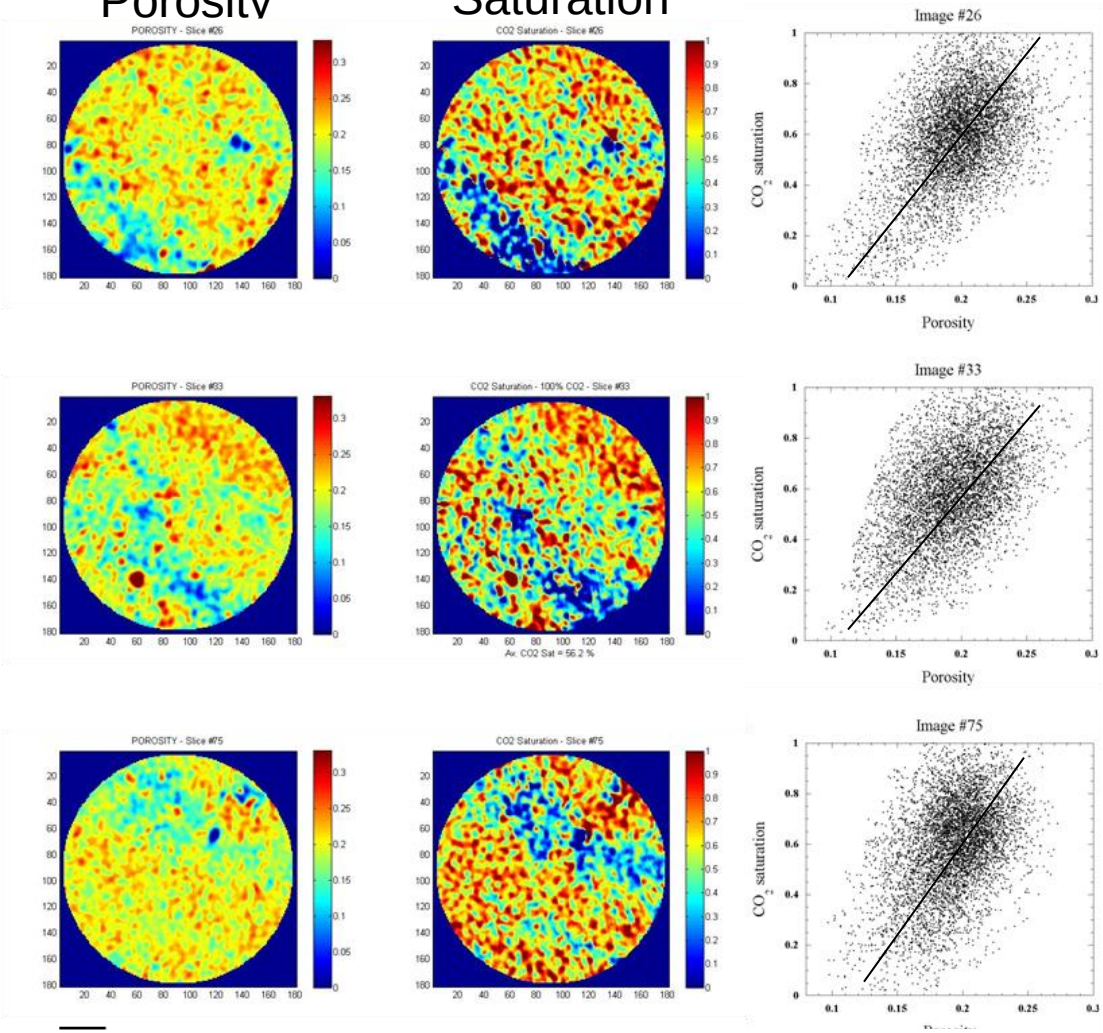


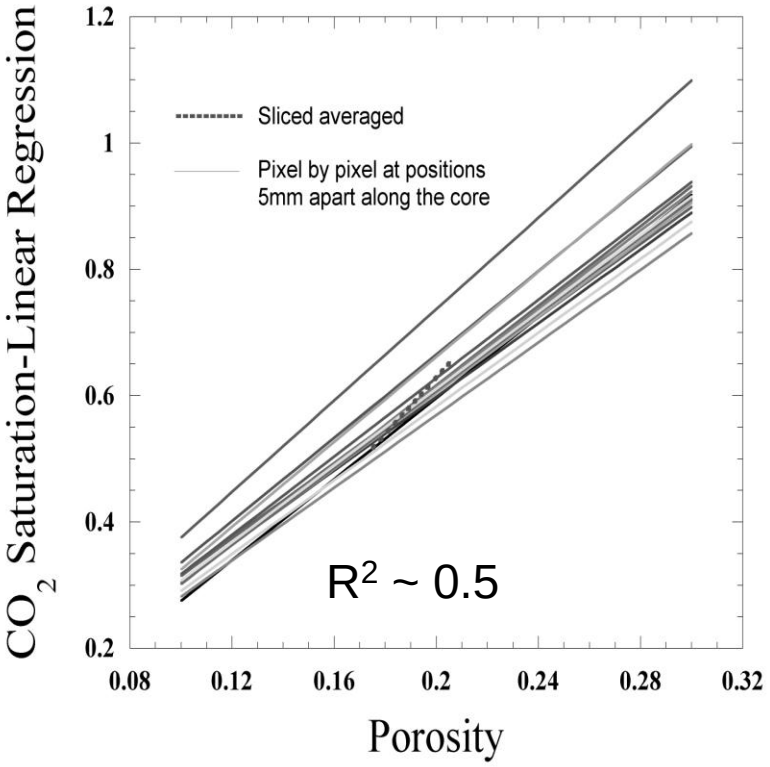
Perrin and Benson, 2009. An Experimental Study on the Influence of Sub-Core Scale Heterogeneities on CO_2 Distribution in Reservoir Rocks, *Transport in Porous Media*.

Correlation of Saturation Distribution with Porosity

Porosity

Saturation



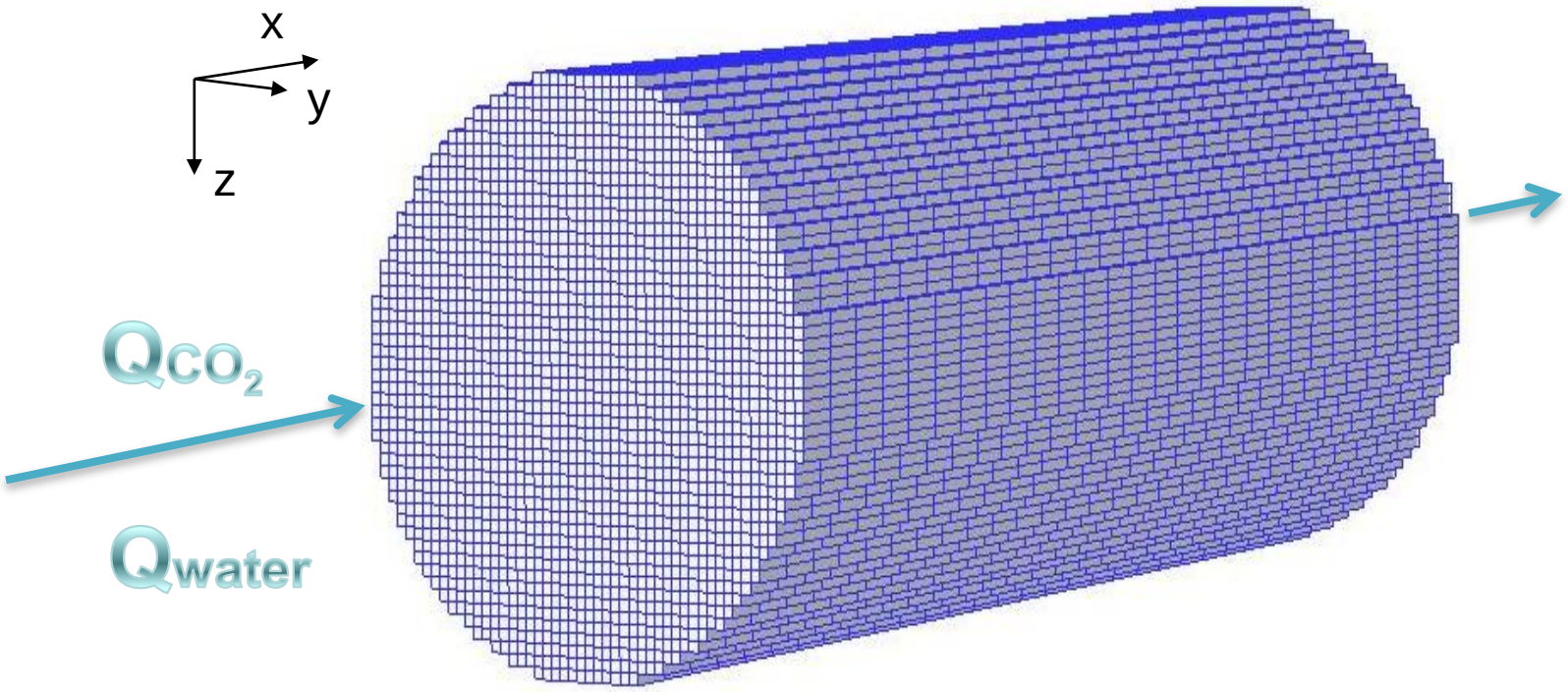


Data illustrate weak but significant correlation between porosity and saturation.

1 cm

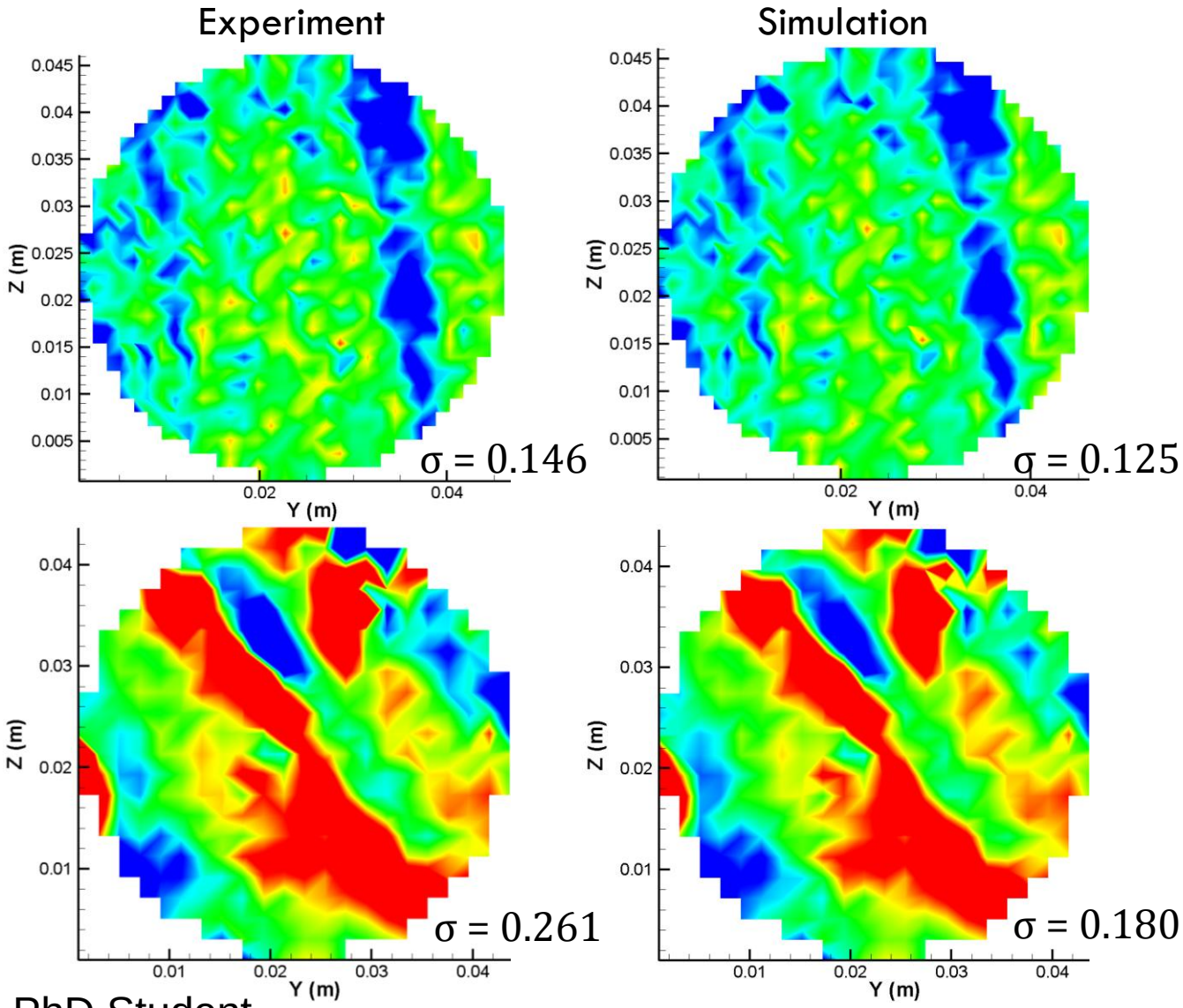
Perrin and Benson, 2009. An Experimental Study on the Influence of Sub-Core Scale Heterogeneities on CO_2 Distribution in Reservoir Rocks, *Transport in Porous Media*.

Simulation of Sub-core Scale Flow of CO_2 and Brine



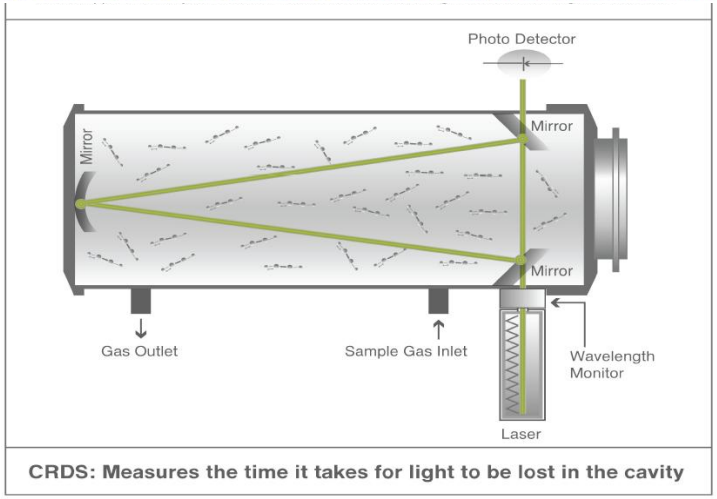
Kuo, C.-W., Krause, M. Perrin, J.C., and S. M. Benson, 2009. Effect of Small Scale Heterogeneity on Multiphase Flow of CO_2 and Brine, 8th Annual NETL Carbon Sequestration Conference, Pittsburg, PA, May 5-8, 2009.

Comparison Between Theory and Experiments



Mike Krause, PhD Student

CO_2 and ^{13}C Isotopic Anomalies for Monitoring Leakage



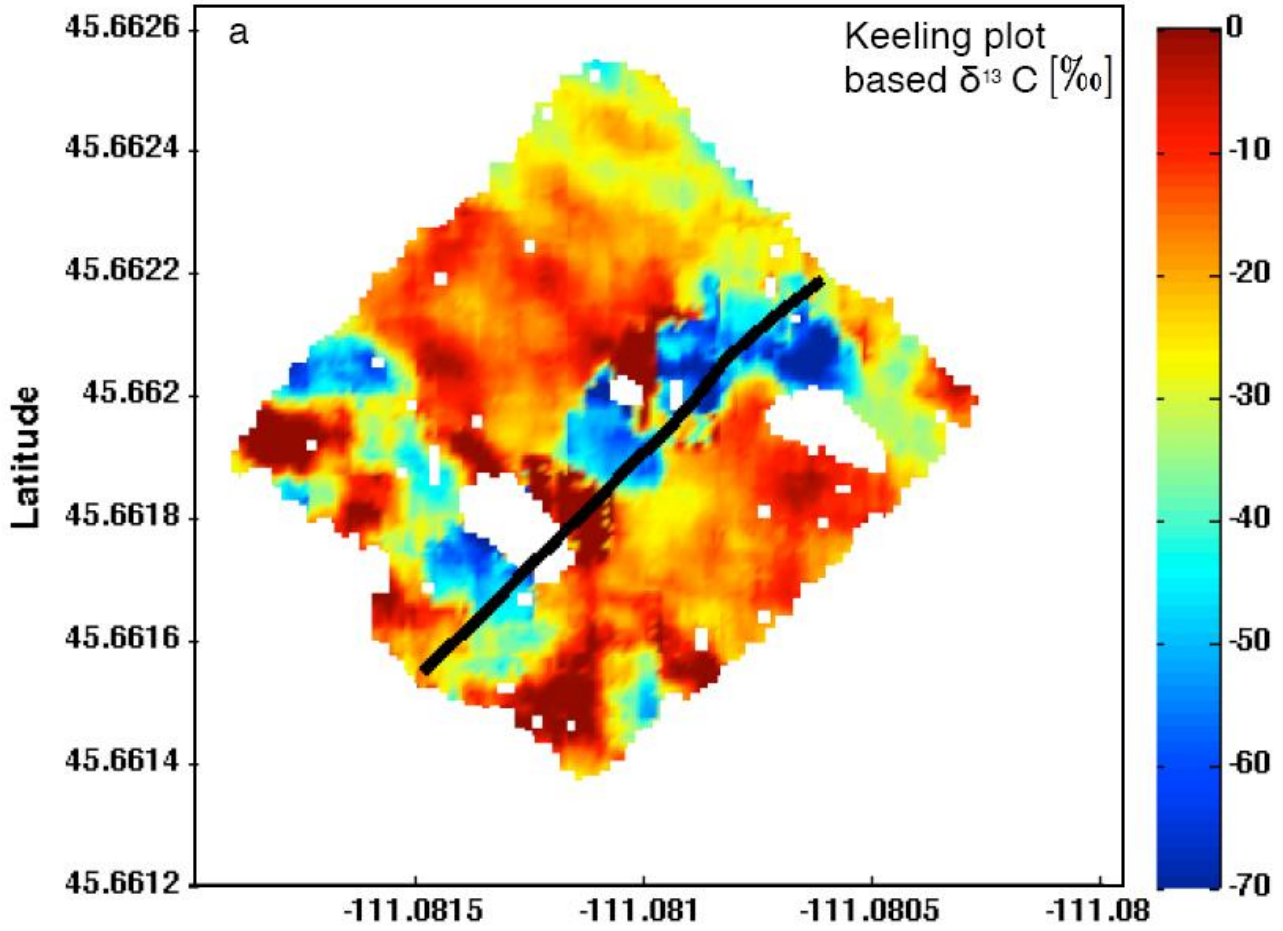
CRDS: Measures the time it takes for light to be lost in the cavity

High precision isotopic ^{13}C analyzer:
Picarro Instruments cavity ring down spectrometer

Krevor et al., 2010. , International Journal of Greenhouse Gas Control Technology

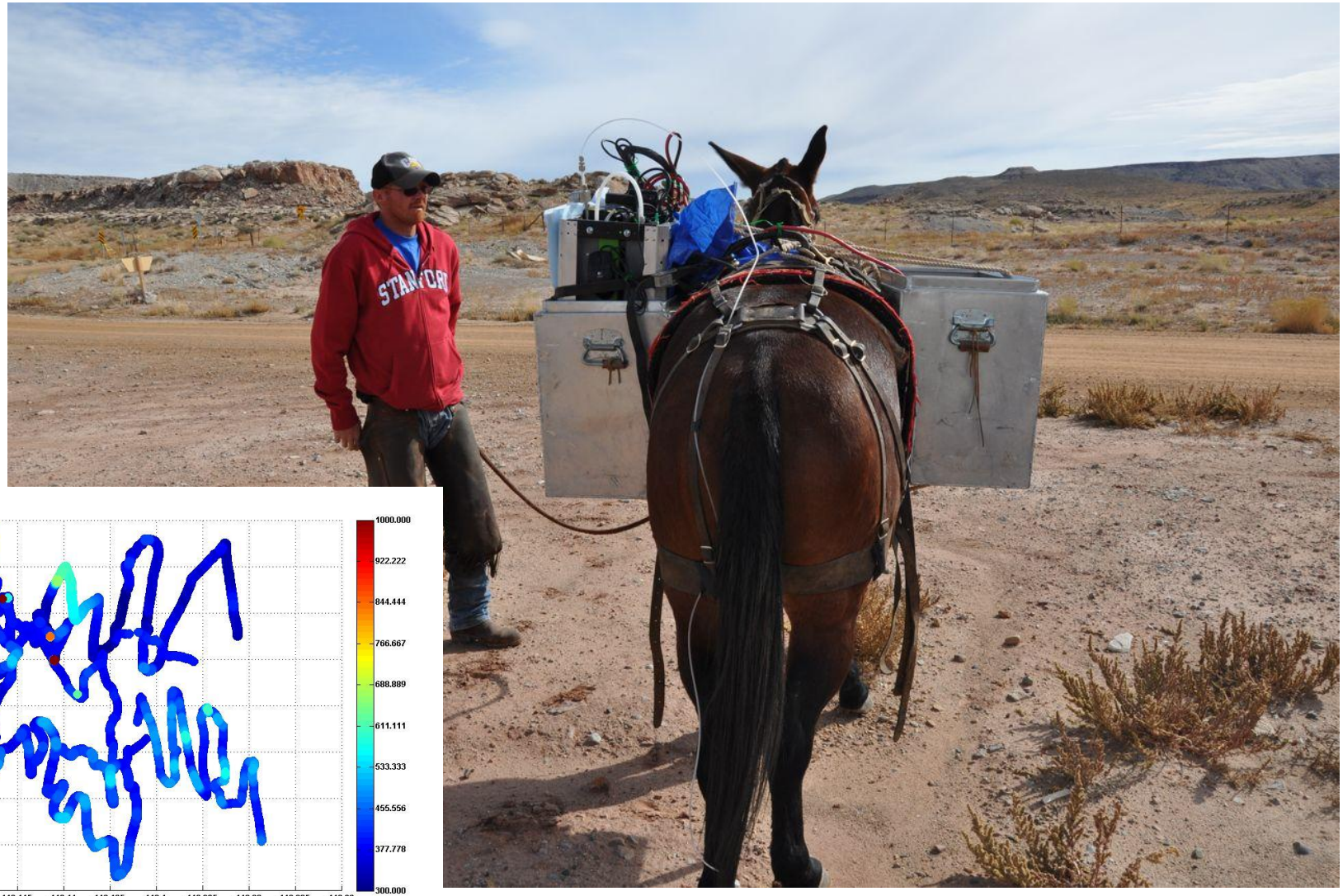
Successful Leak Detection and Attribution

Leak Rate = 200 kg/day (73 tonnes/year!)



From Krevor et al., 2010, International Journal of Greenhouse Gas Control Technology

Scaling Up Isotopic Monitoring



Teaching

- ENERGY 153/253: Carbon Capture and Sequestration (Fall)
- ENERGY 201: Laboratory Measurements for Multiphase Flow (Winter)
- ENERGY 104: Transition to a Sustainable Energy System (Spring)
- Energy Seminar: Fall, Winter and Spring