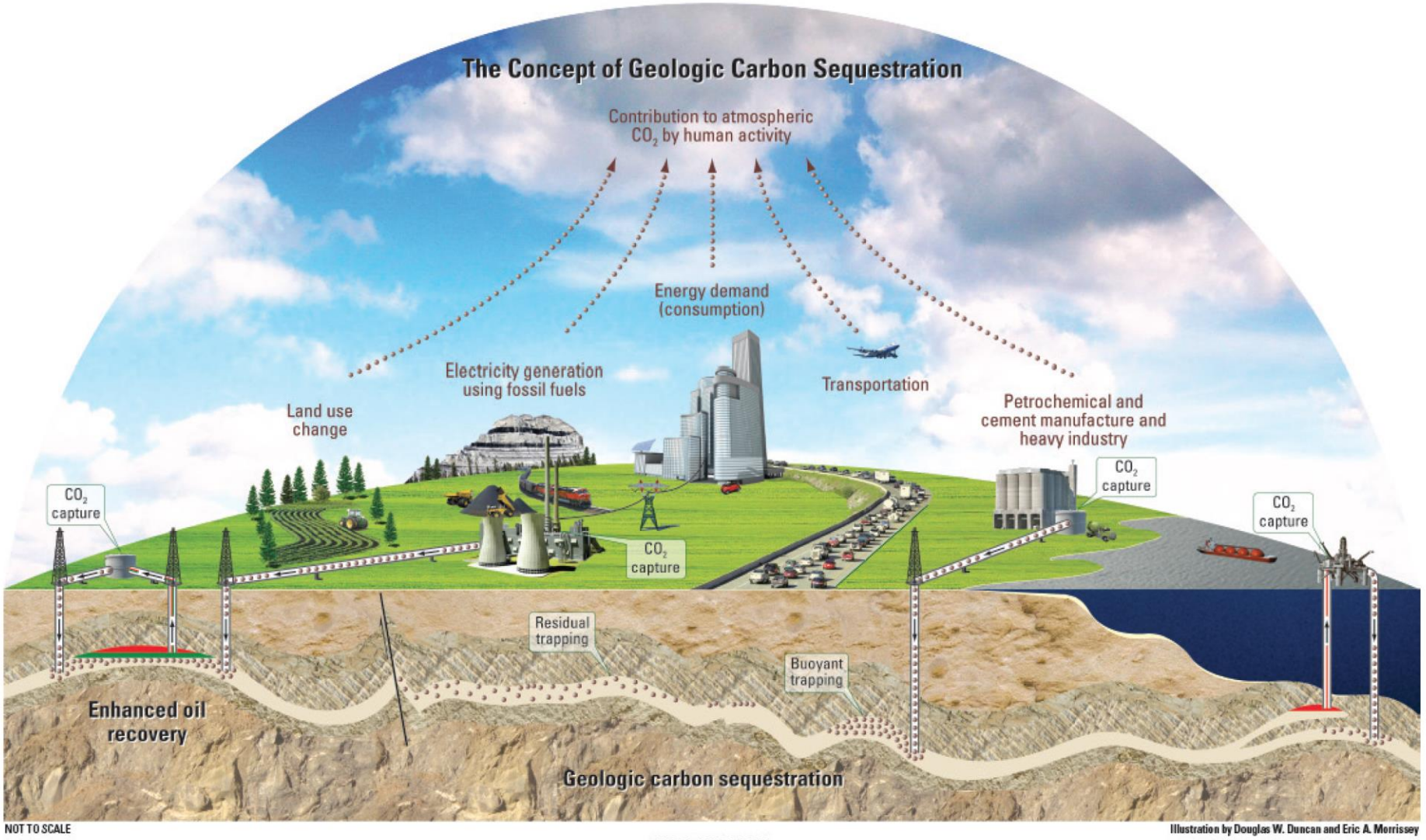
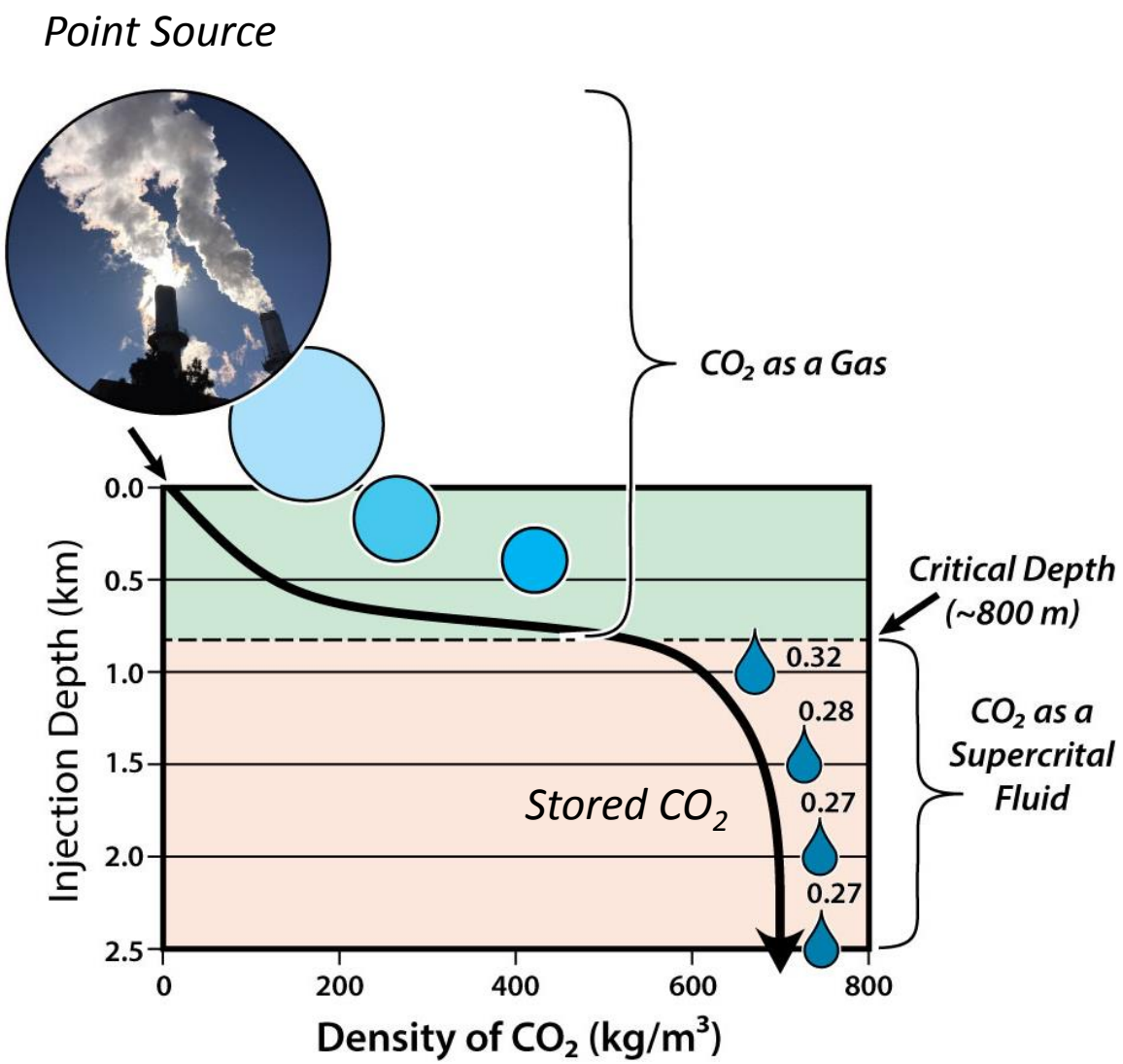
Carbon Capture and Storage



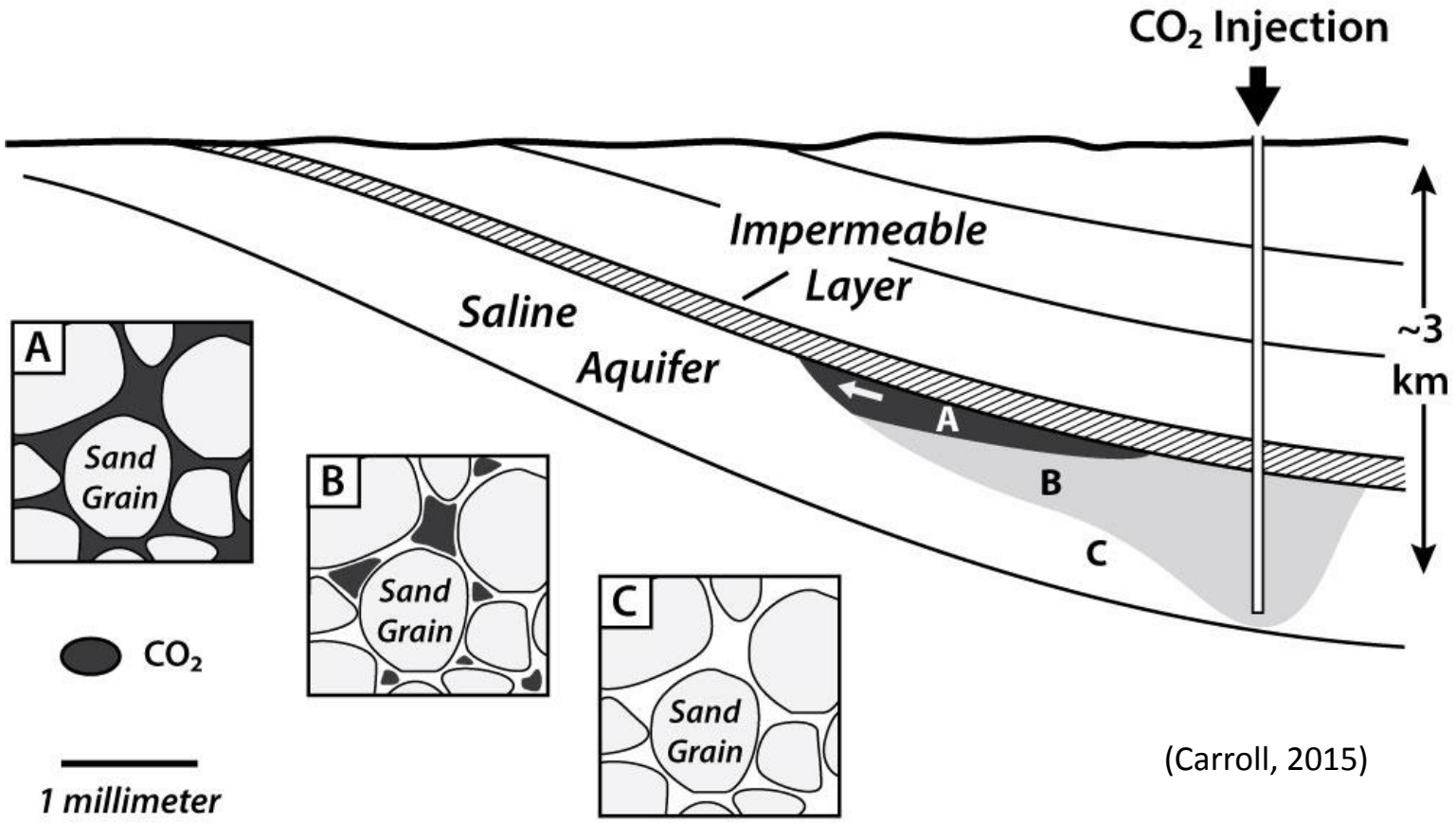
U.S. Geological Survey

What is it?



- CO_2 from fossil fuels combustion or cement production captured, and injected into rocks underground
- Best accomplished with a concentrated point source of CO_2 (such as coal-fired power plant)
- CO_2 injected below freshwater aquifers (saline aquifers OK)
- Injected at depths greater than 800 m, where CO_2 is a supercritical fluid.
- Over time the CO_2 may form solid minerals in the subsurface
- Currently a number of pilot projects underway

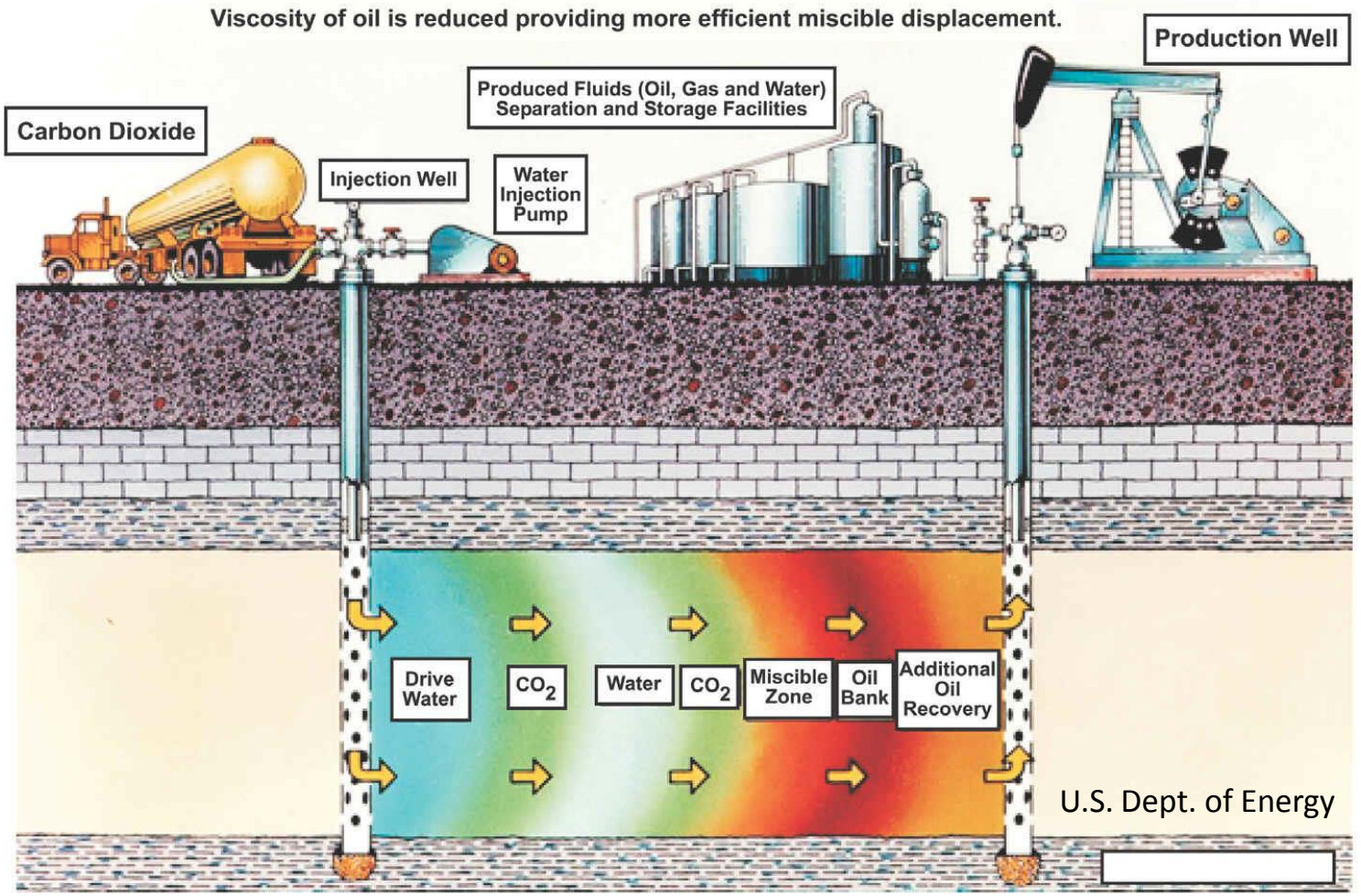
Fate of Injected CO_2



(Carroll, 2015)

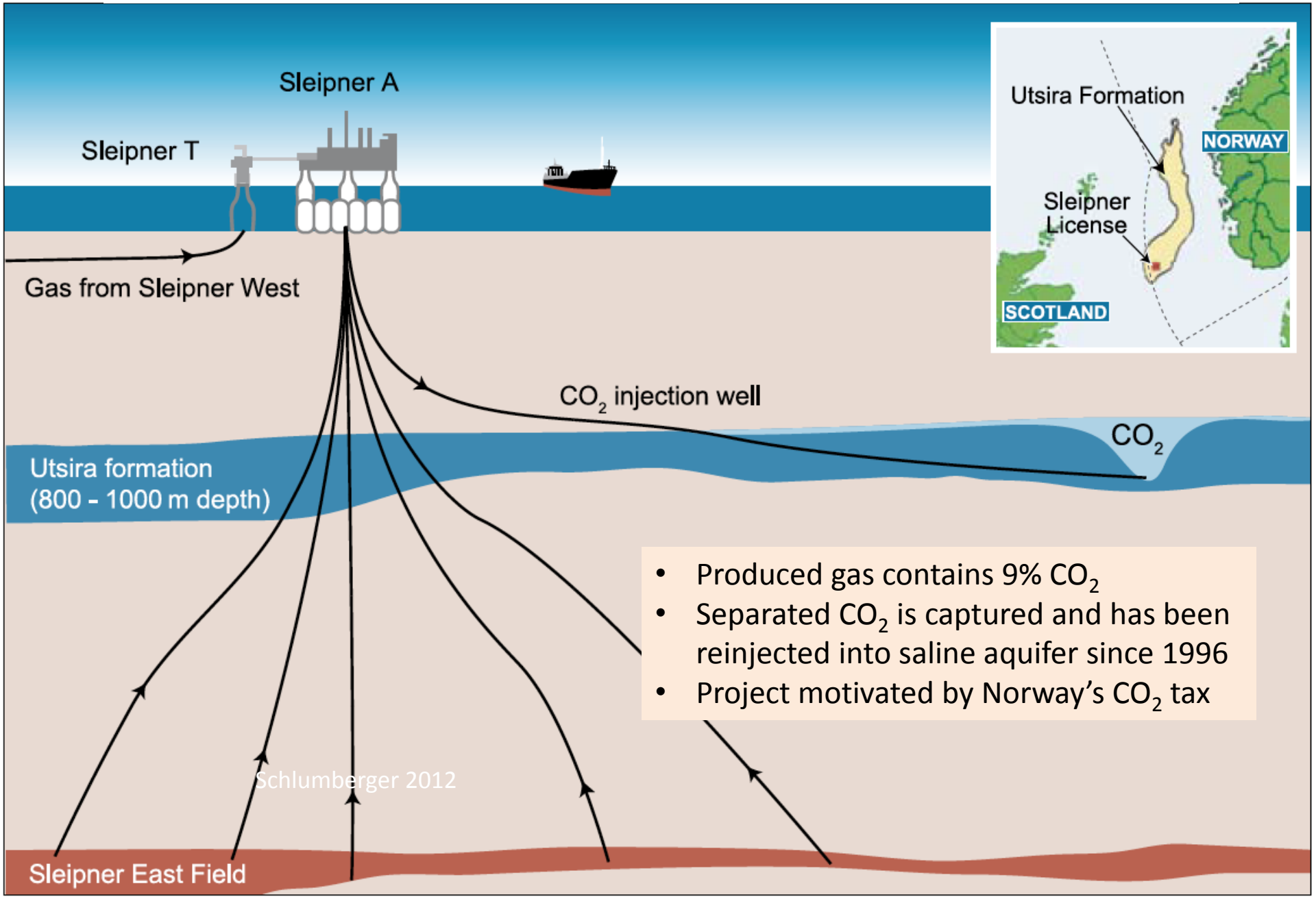
- Supercritical CO2 is less dense than water, therefore migrates upward
- Initially saturates reservoir (A), then breaks into droplets (B), then dissolves (C)
- Eventually may precipitate as solid carbonate minerals

CO_2 Injection to Enhance Oil Recovery



- CO_2 injection used for decades in petroleum industry
- Ironically, the limiting factor is the cost of CO_2!
- Most CO_2 used is geological, produced from other wells

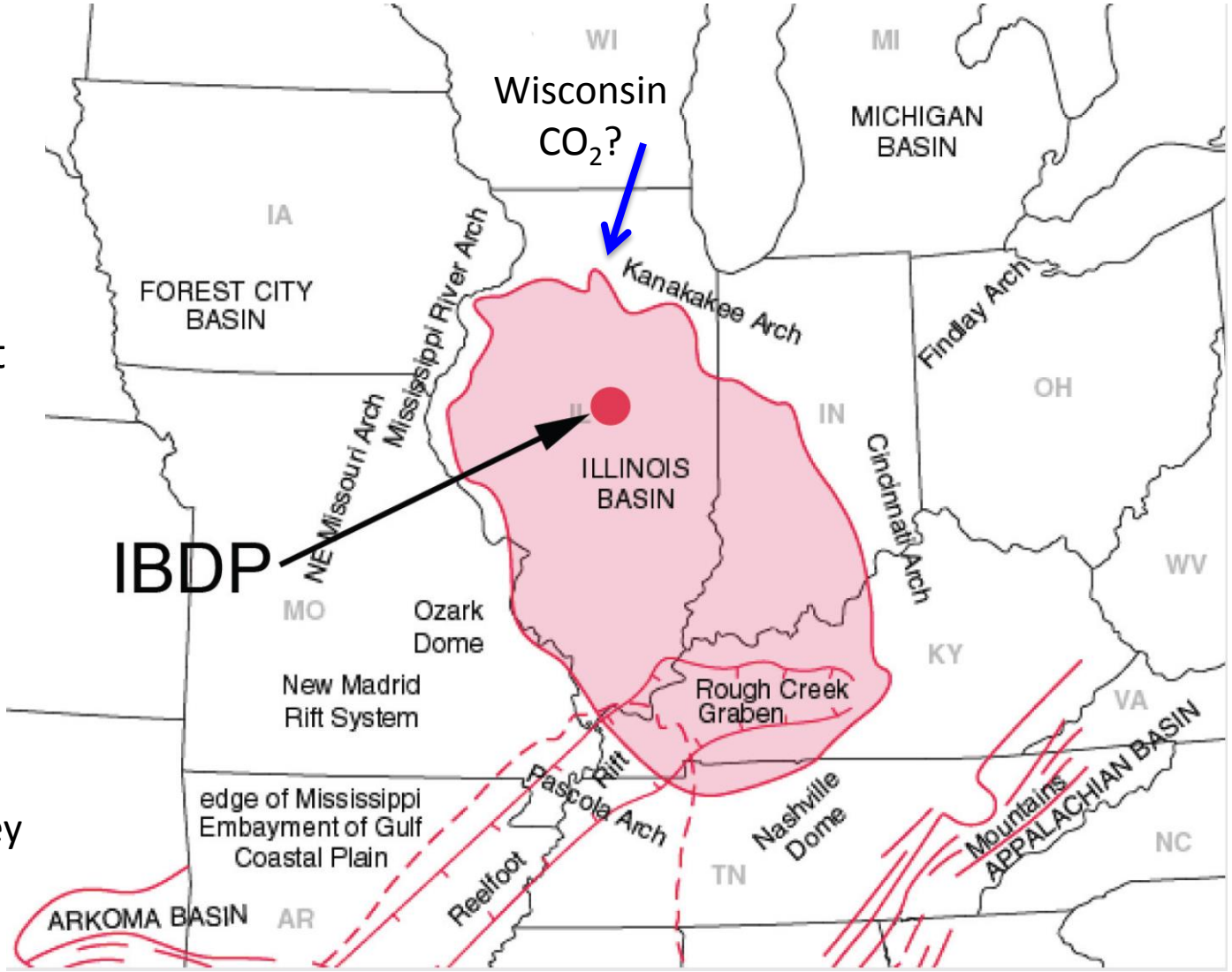
CCS Pilot Project, Sleipner Field, Norway



- Produced gas contains 9% CO_2
- Separated CO_2 is captured and has been reinjected into saline aquifer since 1996
- Project motivated by Norway's CO_2 tax

CCS Pilot Project, Illinois Basin, U.S.

- Experiment to test geologic carbon sequestration
- Injecting 1 million tones of supercritical CO_2 at depth of 7,000 ft., starting in 2011



Illinois Geological Survey

Unresolved Issues

- Point sources only account for about 50% of CO_2 emissions; need to capture more?
- Cost not well known, but commonly estimated to add 50% to 100% of energy generated
- Most economically feasible where used for enhanced oil recovery, due to value of oil recovered (but burning that oil creates more CO_2…)
- Depleted oil and gas fields provide existing infrastructure, but the volume of suitable fields is limited
- Deep saline aquifers offer much larger volume to store CO_2, but are largely undrilled. Large infrastructure investment required.
- Induced seismicity (earthquakes) likely? (volume of injection required to effectively mitigate atmospheric CO_2 concentrations very large)
- Potential for leakage of CO_2 back to surface (small risk?)
- Other environmental effects not well known

For More Information

- Report: Intergovernmental Panel on Climate Change (IPCC): https://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf
- Report: International Energy Agency (IEA): http://www.iea.org/topics/ccs/
- Video: Julio Friedmann, Deputy Assistant Energy Secretary for Clean Coal: http://www.c-span.org/video/?323368-1/discussion-coal-us-energy-policy