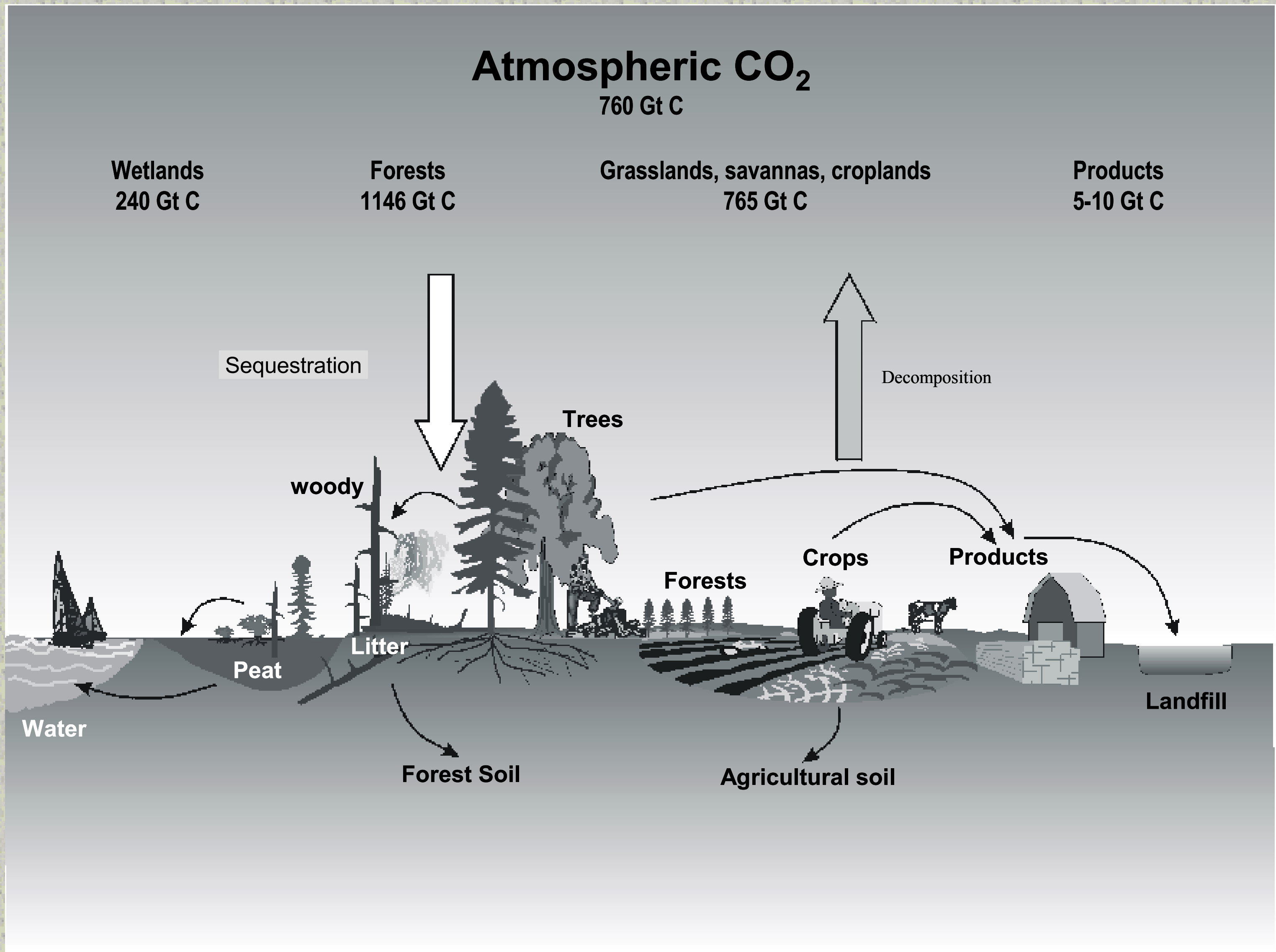
USDA's Role in the Development of Carbon Sequestration Technologies

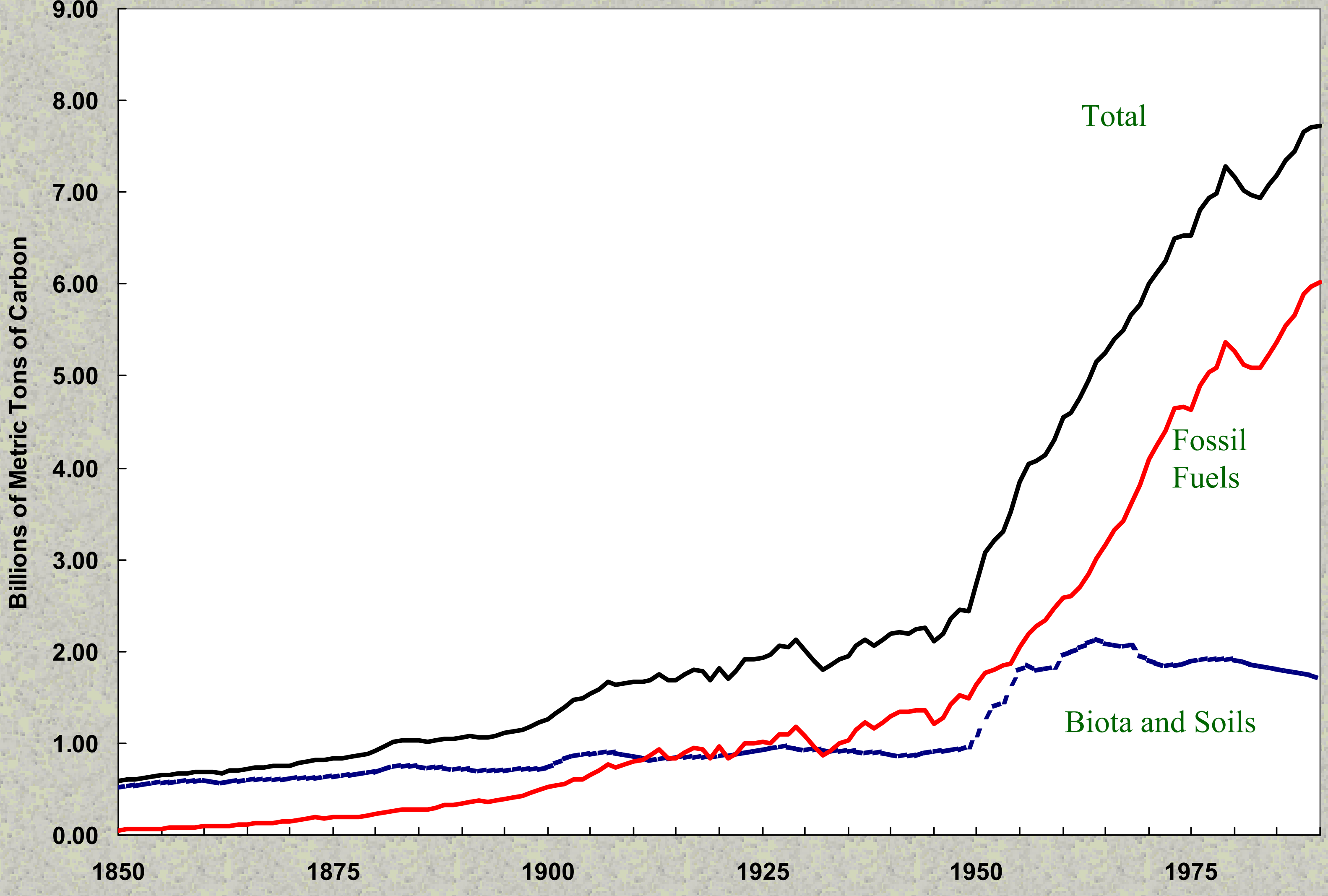
William Hohenstein
Global Change Program Office

May 8, 2003

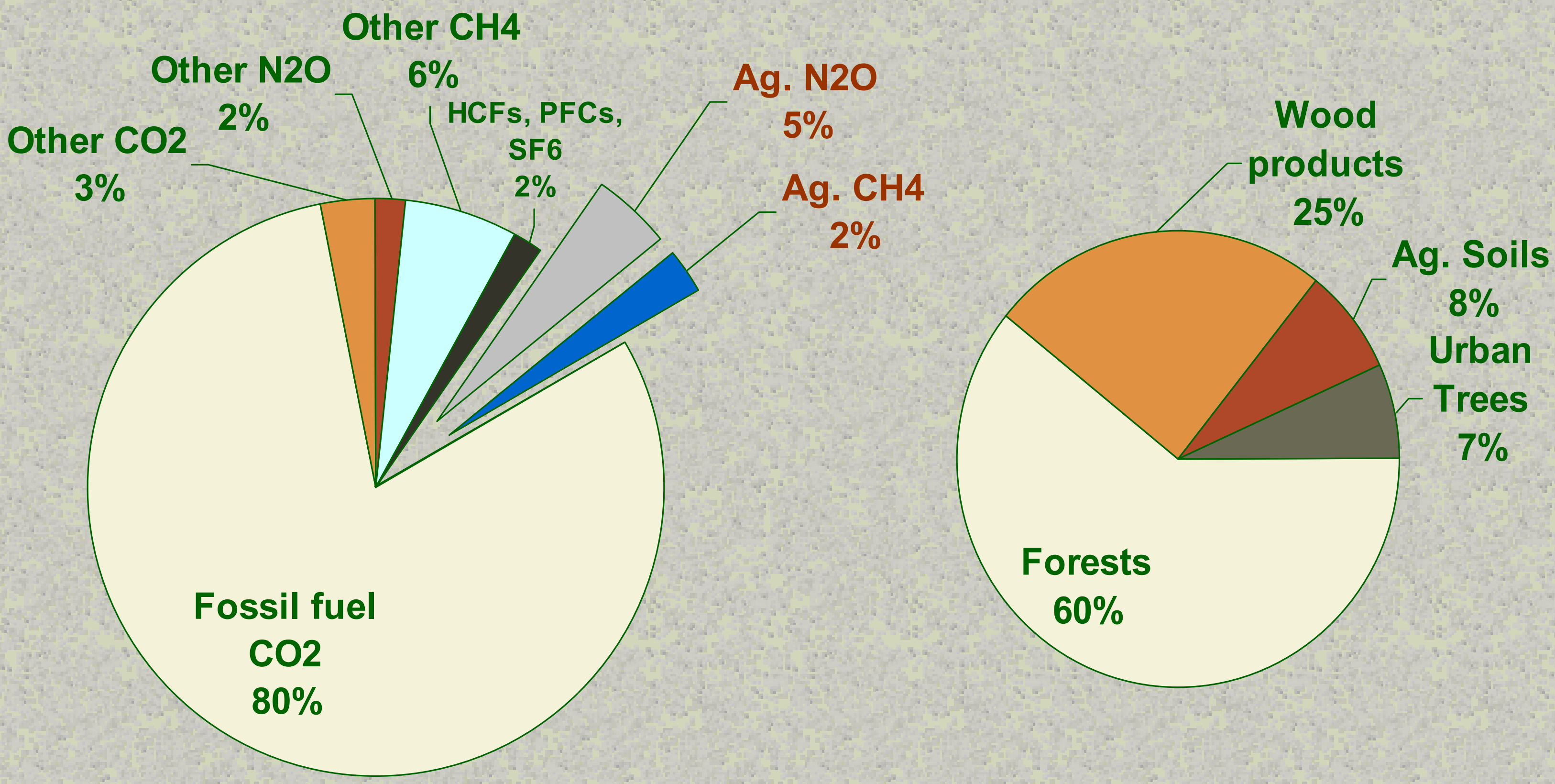
Terrestrial carbon stocks are on the order of 2,000-2,500 Gt Carbon



Global Annual Carbon Dioxide Emissions from Fossil Fuels and Land Use



2000 Contribution to U.S. Emissions of Greenhouse Gases from Agriculture and Forests



Total Emissions: 1901 Tg C eq.

Carbon Sequestration: 244 Tg C eq.

Opportunities for Greenhouse Gas Emission Offsets

Croplands . . .

- Less tillage
- Increasing cropping intensity
- Adding hay to the rotation
- Fertility and water management
- High biomass crops

Rangeland or Pasture . . .

- Restoring eroded lands
- Adding legumes
- Improved grazing management
- Fertility and water management

Forests . . .

- Tree planting
- Longer rotations
- Reduced impact logging
- Storage in wood-based products
- Fossil fuel offsets for energy and products
- Increased recycling

Animal Agriculture. . .

- Improved feed and forage
- Methane capture

Technical and economic potential of carbon offsets for major land uses within the U.S. and globally (TgC/yr)

Land Base	US Potential	Global Potential	Source
Cropland	55-164 52-60	460-900	Lal, McCarl, DOE
Grazing Land	30-110	1,700	Follett, DOE
Forests	210	1,200-1,600	Forest Service, IPCC
Biomass Energy	91-152 0-26	500-800	ORNL, McCarl, DOE

Reported in NCCTI Terrestrial Sequestration White Paper

McCarl estimates assume $10-$50 per metric ton of carbon

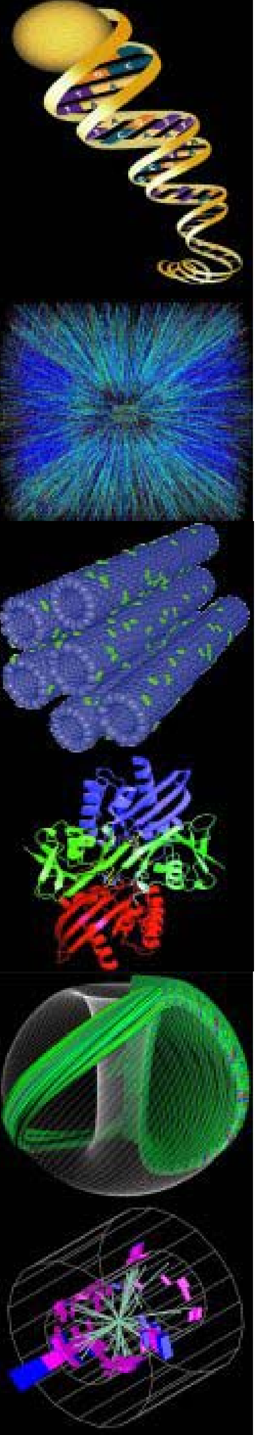
Roles of the USDA Agencies

- **ARS:** Assess potential impacts and vulnerabilities to agriculture; identifying opportunities to respond and adapt; develop technologies and practices to mitigate greenhouse gases
- **Forest Service:** Assess and manage potential impacts on forest productivity, health, disturbance processes, and species distributions; improve the information on carbon cycling and inventories, provide landowner assistance.
- **CSREES:** Support the national UV-B monitoring network; provides competitive grants to assess impacts; oversee major soil carbon study.
- **NRCS:** Provide technical assistance to farmers; help farmers plan and implement conservation systems; maintain soil survey and associated databases.
- **ERS:** Assess the economics of mitigation options and impacts of climate change on well-being of global and US agricultural producers and consumers.
- **Others with roles**: FSA, RUS, International Forestry, FAS, NASS

USDA Climate Change Basic Research Priorities

Pursuing Technological Solutions

Improving Carbon Measurement and Observation Systems



Office of Science
U.S. Department of Energy

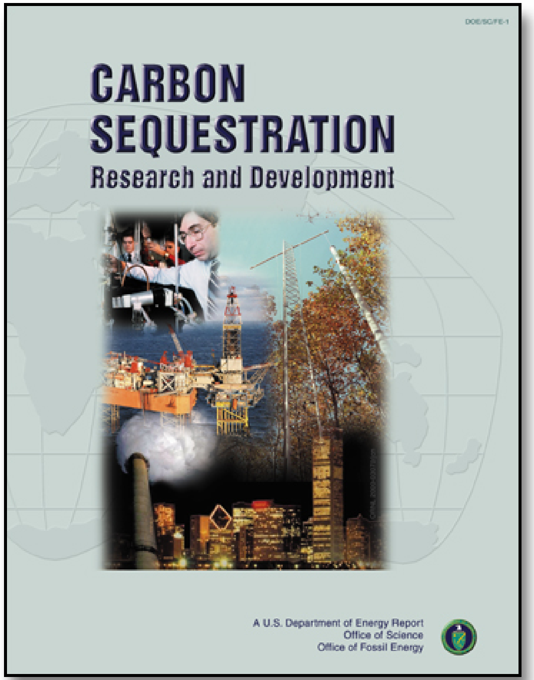
Utilizing the DOE National Laboratory Complex to Develop and Evaluate Technologies and Systems to Reduce Carbon Intensity

Dr. Raymond L. Orbach
Director

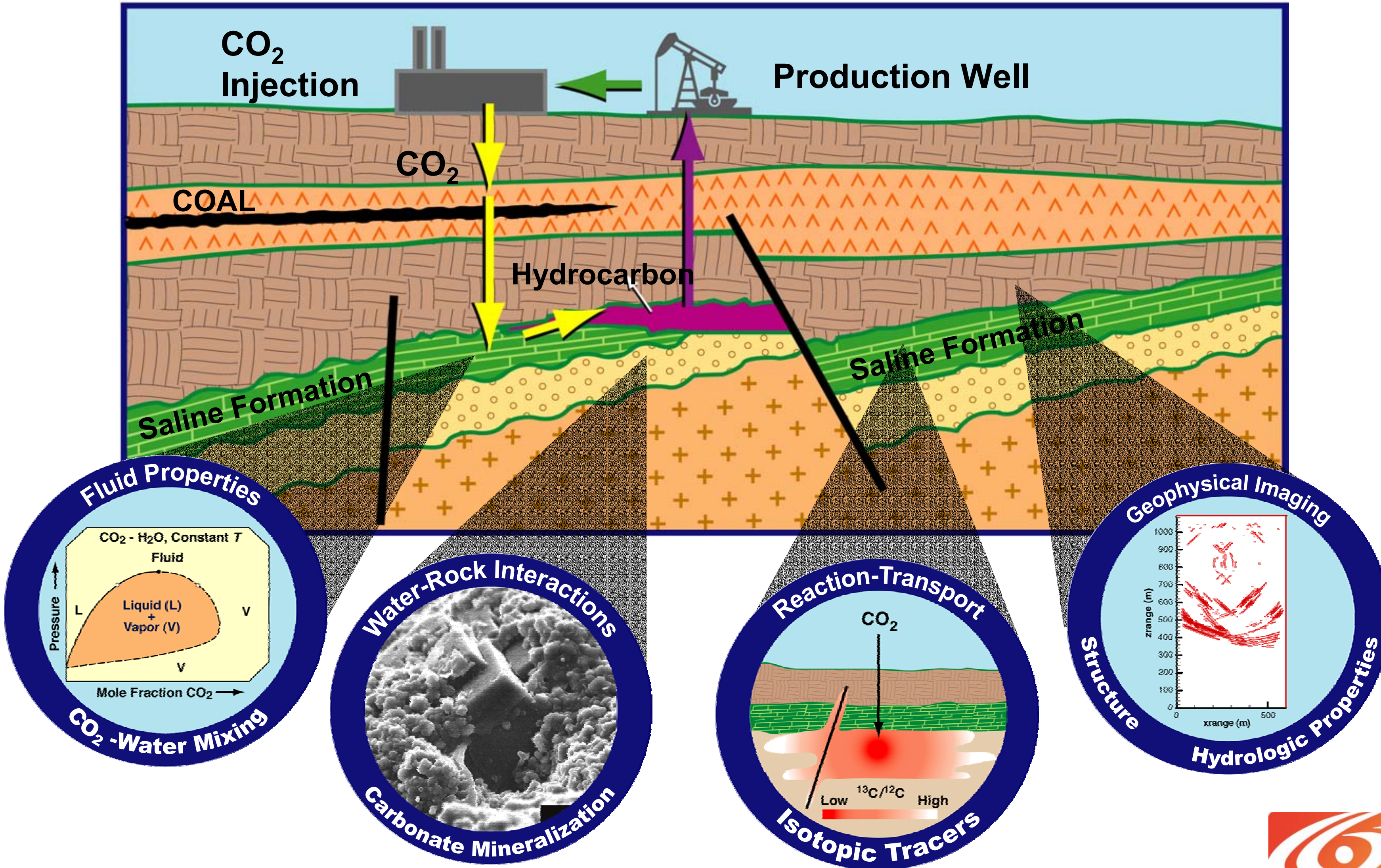
Second Annual Conference on Carbon Sequestration
Hilton Alexandria • May 8, 2003

Carbon Sequestration Roadmap

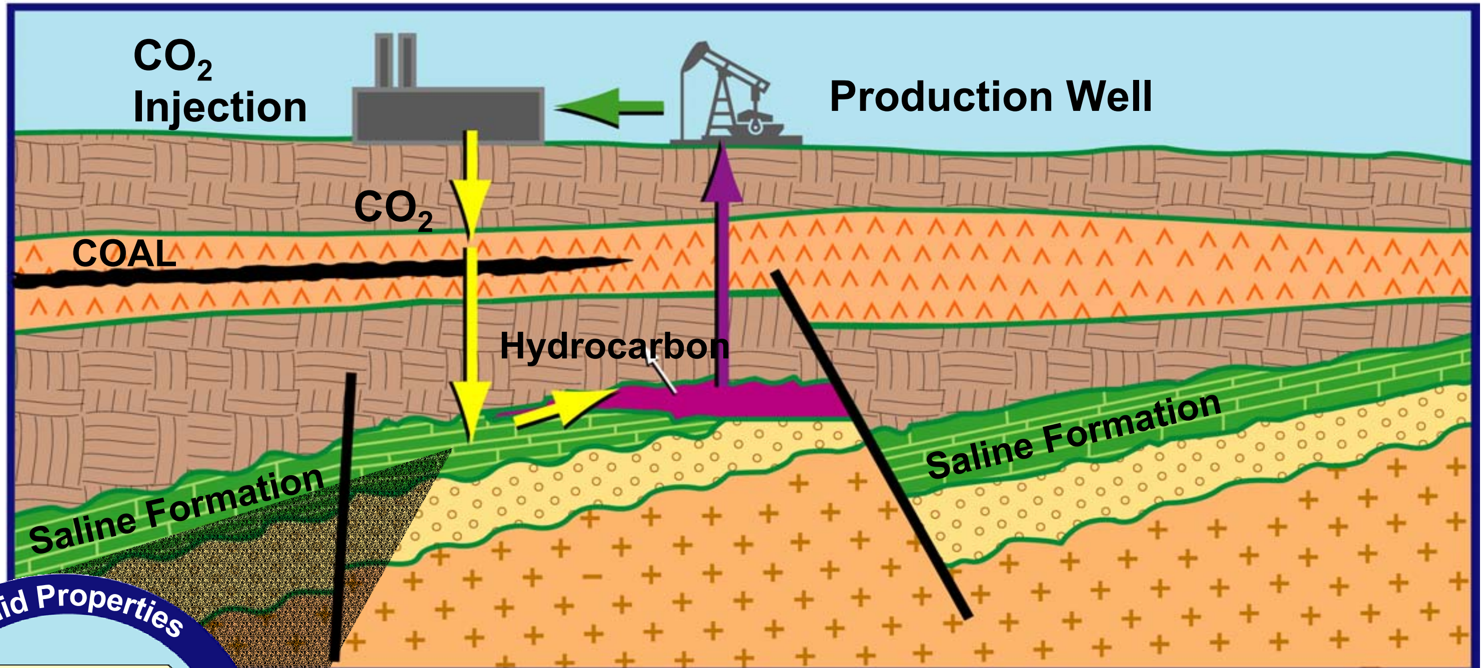
- Written by over 70 scientists with comments from a stakeholder workshop of more than 200
- The Vision: Develop the understanding to sequester a significant fraction of 1 GtC/year by 2025 and 4 GtC/year by 2050
- Provides consensus on salient research topics that would bring about the vision
- Provides a research agenda for Office of Science and Office of Fossil Energy sequestration research programs

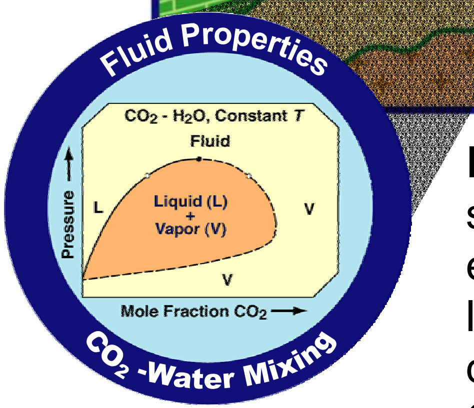


Geological Sequestration: Depicting the injection of Carbon Dioxide Captured from a Power Plant into a Saline Formation



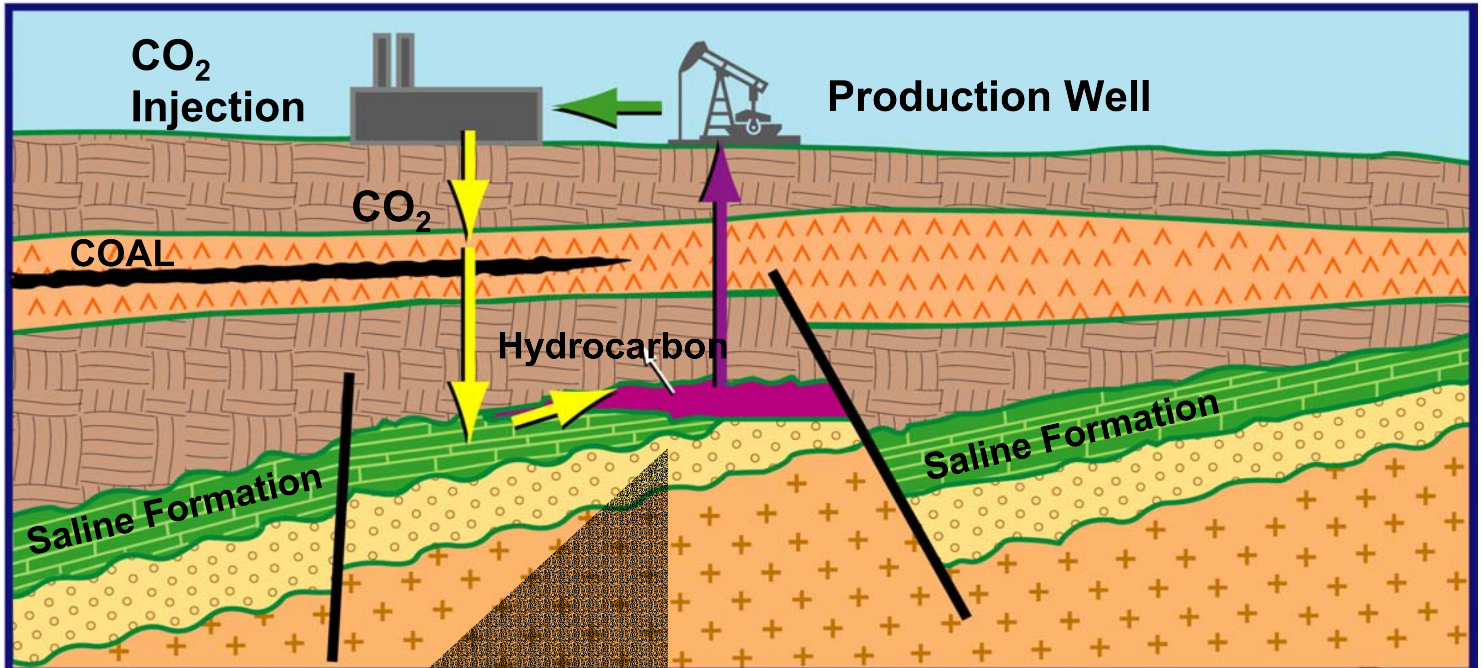
Geological Sequestration: Depicting the injection of Carbon Dioxide Captured from a Power Plant into a Saline Formation





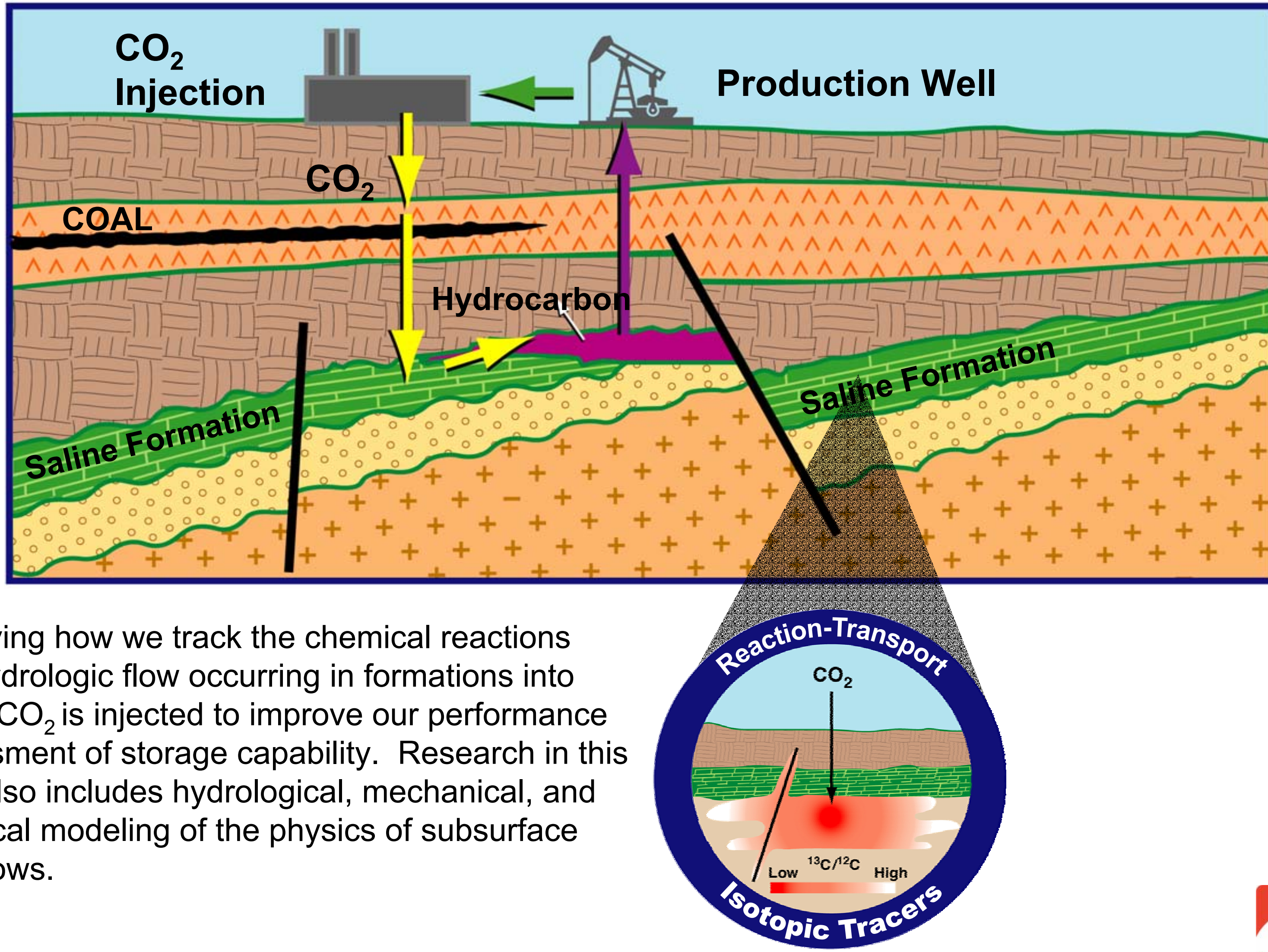
Investigating the complex flow and mixing of multiphase fluids such as carbon dioxide and water. The goal is to predict the effect of CO_2 injection on the pore fluids, telling us about the likely flow and the geological and hydrological stability of the depleted hydrocarbon reservoirs or saline formations into which CO_2 in injected.

Geological Sequestration: Depicting the injection of Carbon Dioxide Captured from a Power Plant into a Saline Formation



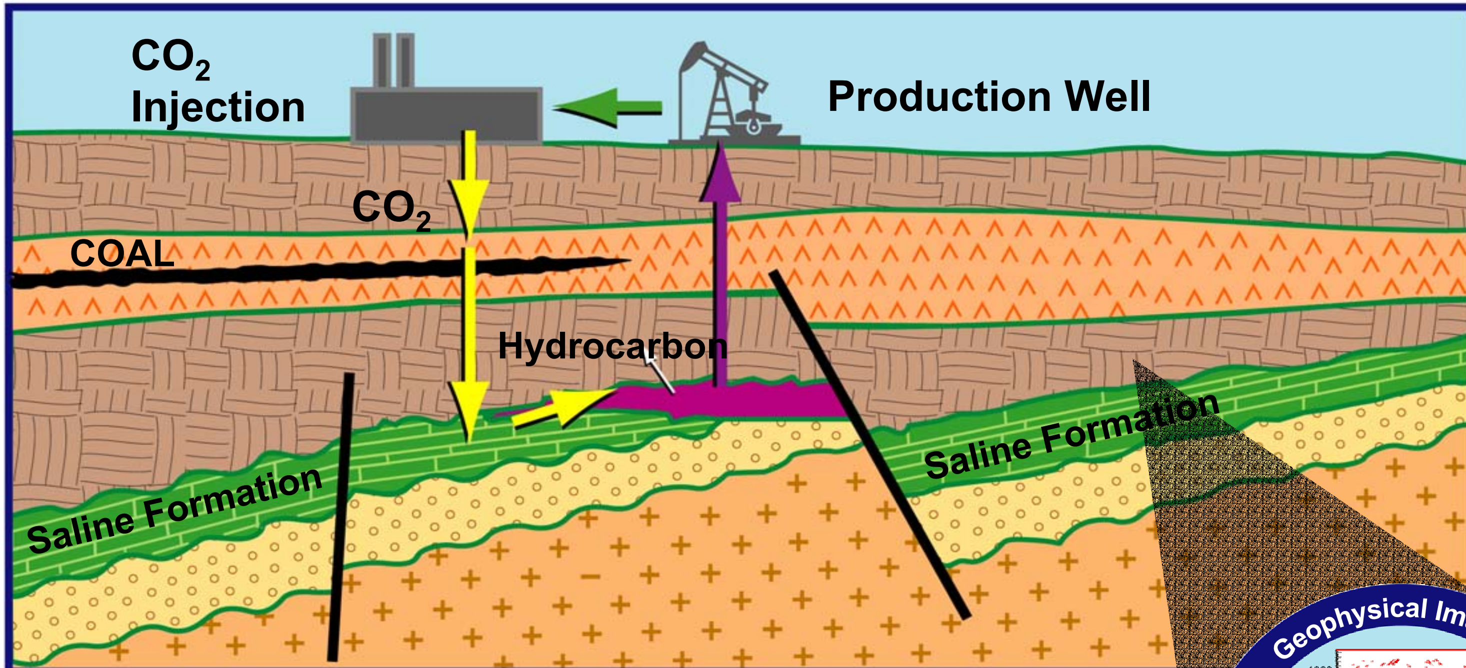
Understanding the geochemical reactions between carbon dioxide and the formation of materials. If the CO_2 is incorporated into minerals, it could provide permanent storage, but it could also make injection more difficult by clogging the flow pathways and thereby limiting the amount of CO_2 that could be injected into a formation.

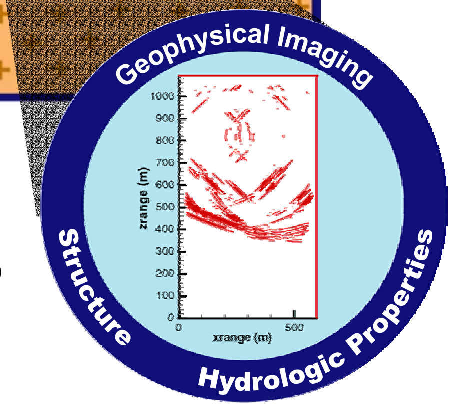
Geological Sequestration: Depicting the injection of Carbon Dioxide Captured from a Power Plant into a Saline Formation



Improving how we track the chemical reactions and hydrologic flow occurring in formations into which CO_2 is injected to improve our performance assessment of storage capability. Research in this area also includes hydrological, mechanical, and chemical modeling of the physics of subsurface fluid flows.

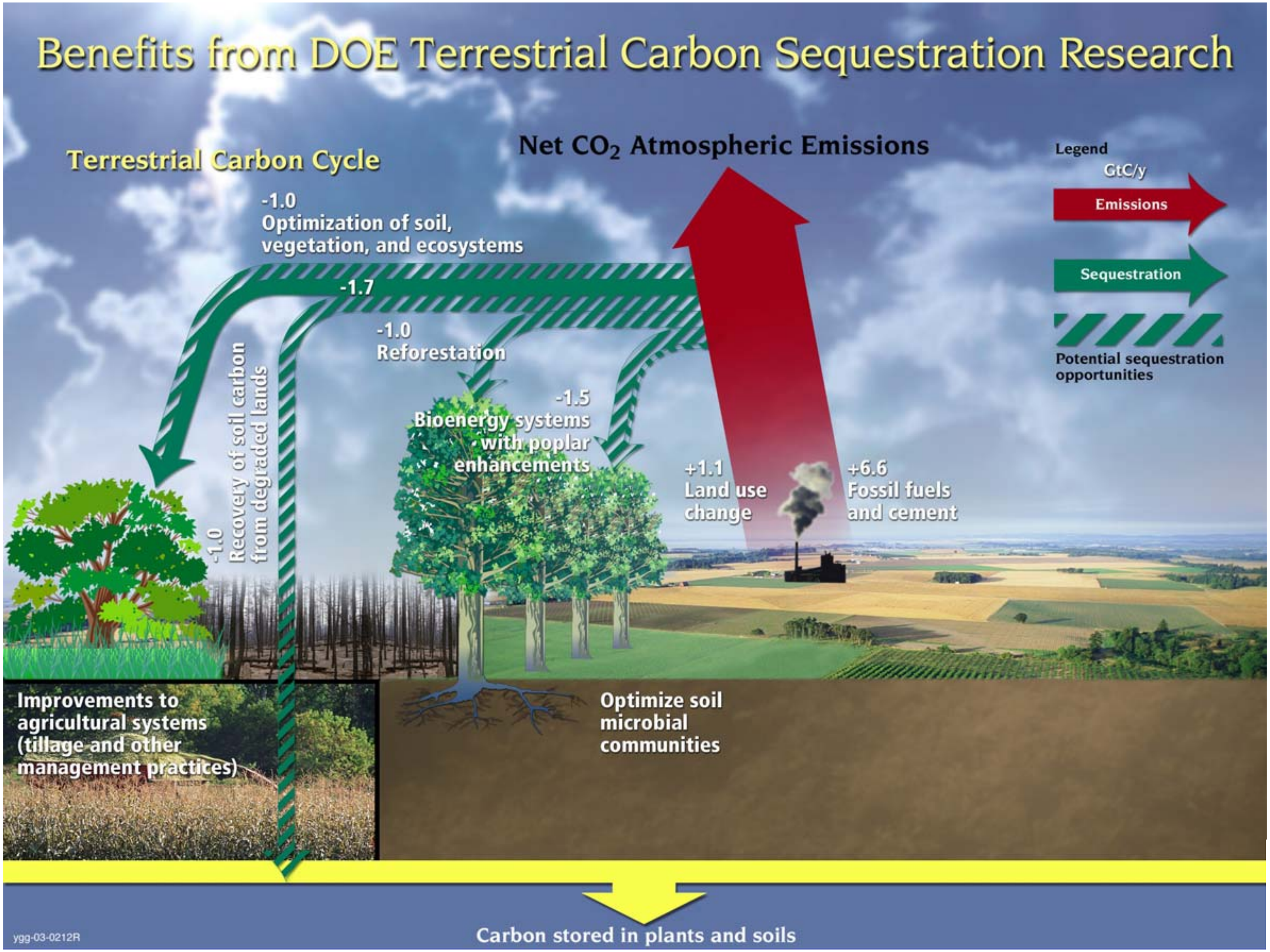
Geological Sequestration: Depicting the injection of Carbon Dioxide Captured from a Power Plant into a Saline Formation





Imaging will be critical to monitor the location of the injected carbon dioxide. More needs to be known about how to detect where the carbon dioxide goes once it is injected into geologic formations and to image changes caused by the carbon dioxide to the formations that contain it.

Terrestrial Carbon Sequestration



Terrestrial Carbon Sequestration

The scientific issues being addressed by the terrestrial carbon sequestration research include:

- **Understanding carbon capture and sequestration mechanisms in vegetation and soils, including how to increase the photosynthetic efficiency of plants to fix more carbon dioxide and how to promote the formation of long-lived pools of soil organic matter where the carbon will remain isolated from the atmosphere;**

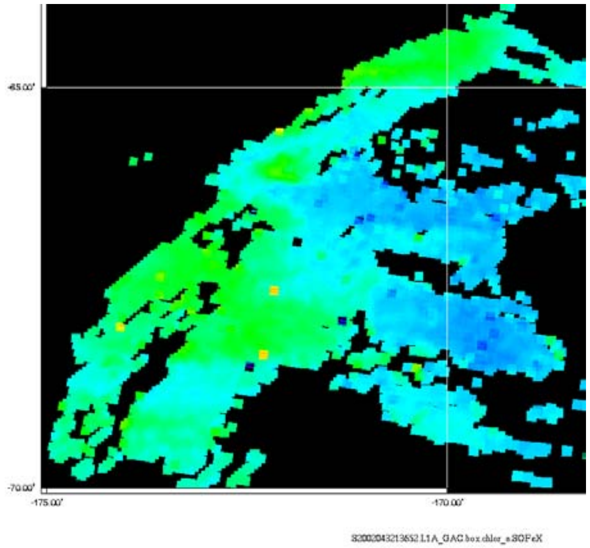
- **Developing simulation models to extrapolate the understanding of carbon sequestration processes across not only different spatial and temporal scales but also across different and potentially changing environmental conditions, such as climate change;**

- **Improving understanding of both possible ancillary environmental benefits and unintended impacts of enhancing carbon sequestration and the resulting economic implications; and**

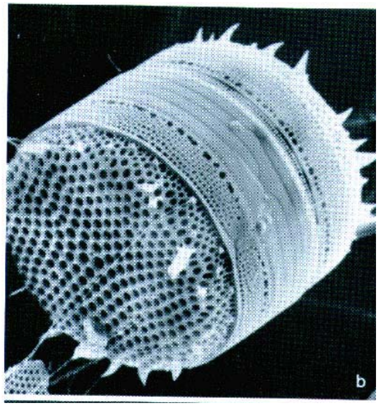
- **Developing accurate, reliable, non-invasive methods for rapid measurement of carbon sequestration in terrestrial vegetation and soils.**

Carbon Sequestration in the Oceans

Southern Ocean Iron Fertilization



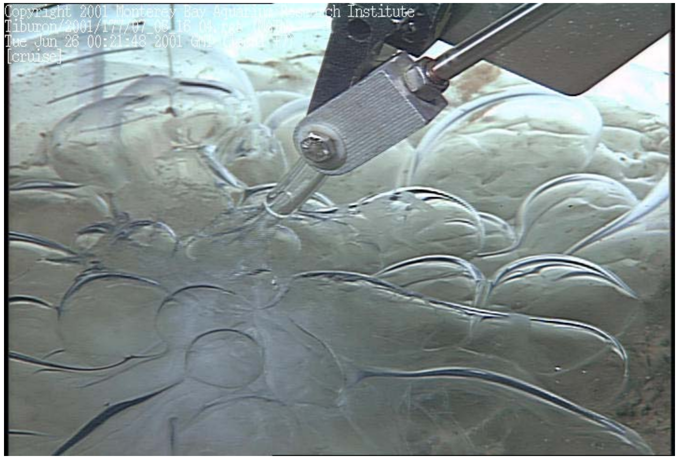
Satellite image of iron fertilization patch in Southern Ocean



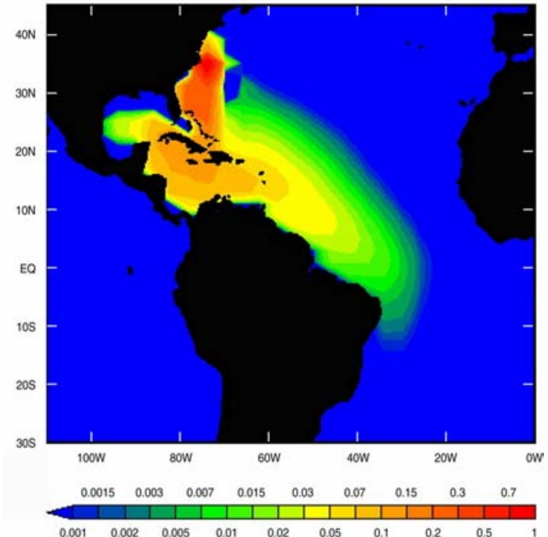
Marine diatom

Monterey Bay Aquarium Research Institute

Small scale direct injection of $C0_2$ into the ocean



Lawrence Livermore National Laboratory



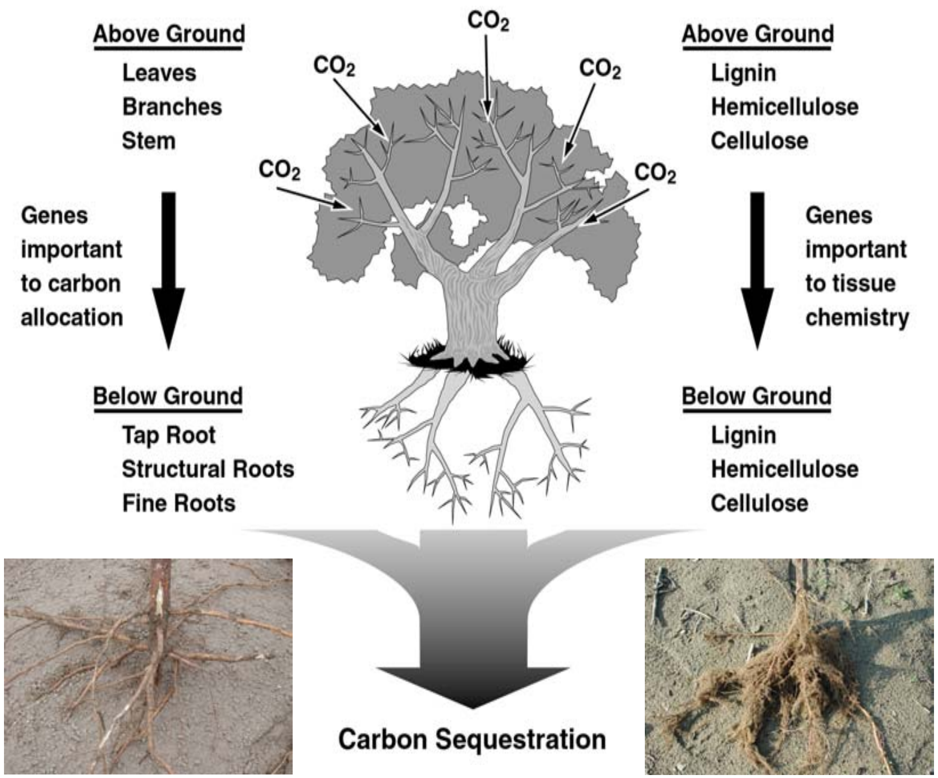
Numerical model of fate of injected CO_2

Genome-Enabled Discovery of Carbon Sequestration Potential in *Populus*

Sequencing the Genome of the Populus genus, the so-called Poplar tree
(i.e. Aspen, Black Cottonwood and Hybrid Poplars)

A *Populus* tree

Greenhouse testing

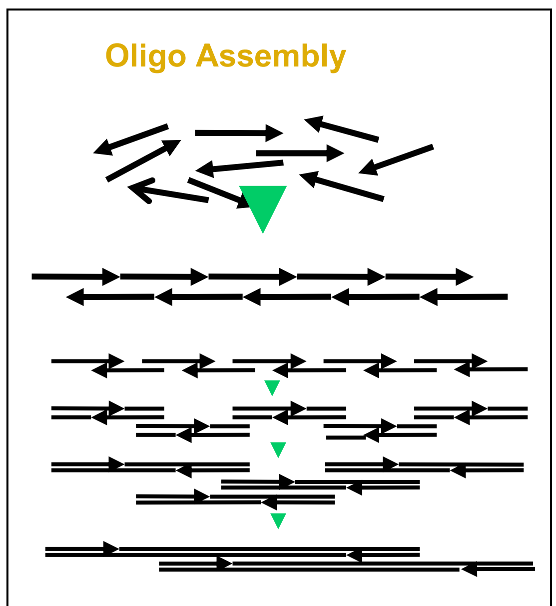


Advanced Biological Techniques

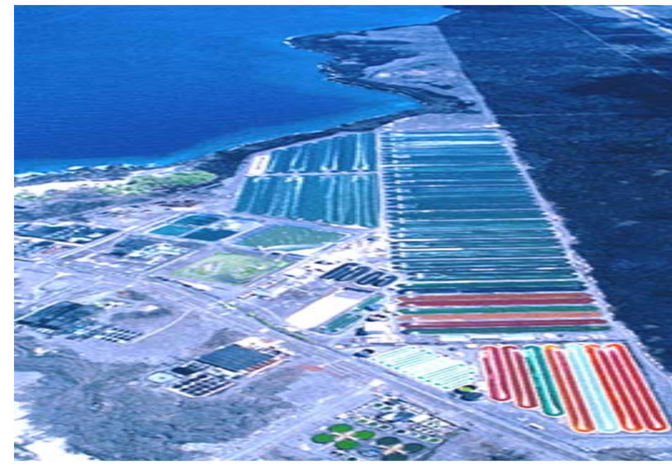
Environmental Sampling: Microbial Communities

Source: Frank Dazzo, Center for Microbial Ecology, Michigan State University

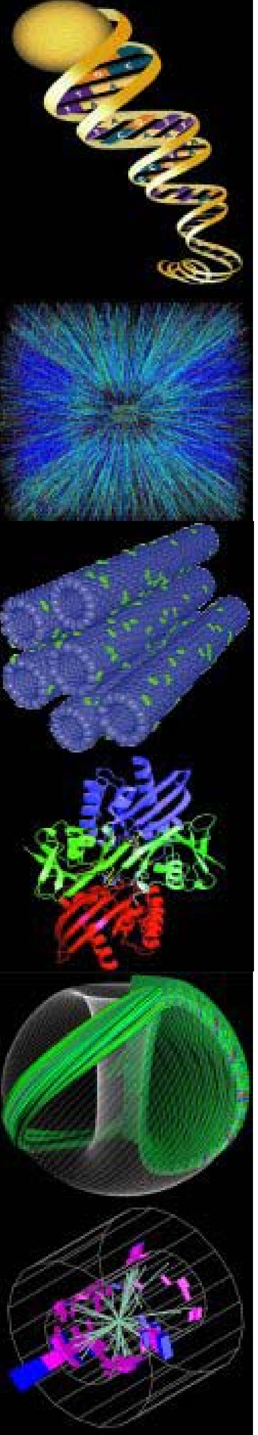
Artificial Chromosome: Minimum Genome



Applications: Algae Ponds



Microalgae production facility of Cyanotech, Inc. in Kona, Hawaii.



Office of Science

U.S. Department of Energy

Utilizing the DOE National Laboratory Complex to Develop and Evaluate Technologies and Systems to Reduce Carbon Intensity

For More Information Contact:

Dr. Ari Patrinos

ari.patrinos@science.doe.gov

301-903-3251