PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

04/2004

APPLIED TERRESTRIAL CARBON SEQUESTRATION

Background

The key to any market-based carbon trading program that includes terrestrial sequestration is the ability to measure, across large and diverse areas, the quantity of carbon stored belowground in soils and aboveground in herbaceous plants and trees. Field data are needed to support carbon accounting, to monitor and verify carbon stocks, and to validate models of the carbon cycle for terrestrial systems. Therefore, the development and deployment of cost-effective measurement technologies is essential. The Applied Terrestrial Carbon Sequestration Project is addressing these needs with state-of-the-art technologies. The Project is producing cutting edge science and technology that will help reduce greenhouse gas (GHG) emissions, improve the productivity and sustainability of soils, and establish the scientific credibility required for a viable carbon measurement systems to support a carbon trading market.

Primary Project Goal

The primary project goal is to advance carbon measurement and monitoring technologies by developing a suite of robust and cost-effective technologies. The technologies under development include laser-induced breakdown spectroscopy (LIBS) to address the need to measure soil carbon and to be able to distinguish between organic and inorganic carbon. LIBS offers to provide a rapid, field-deployable, and cost-effective method for soil carbon determination. Another technology is microbial indicators to address the need to quickly and inexpensively assess the carbon status in soils when for example implementing new land management practices. A third technology is assessing the risks associated with terrestrial carbon inventories in lands under different management practices. Finally, another goal is to develop and implement methods to improve native plant growth/productivity and for the purpose carbon sequestration through improving vegetation on mine sites and other degraded lands.

The laser-induced breakdown spectroscopy (LIBS) units

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PARTNERS

Los Alamos National Laboratory (LANL)

COST

Total Project Value

$3,900,000

DOE/Non-DOE Share

$2,800,000/$1,100,000

Objectives

- To develop an integrated suite of technologies to measure, monitor, assess, and manage terrestrial carbon inventories.
- To increase analytical sensitivity, measurement accuracy, and precision of these technologies.
- To develop and test person-portable LIBS instruments.
- To develop LIBS calibration protocols independent of soil type.
- To address the need for a LIBS compatible bulk density measurement capability.
- To further develop microbes as early indicators of changes in soil carbon concentration to enable an early assessment of the effectiveness of land management practices for increasing soil organic carbon sequestration.
- To demonstrate field applications to mine sites, degraded lands, and rapid carbon cycling systems.
- To provide integrated technology for risk assessment of carbon management alternatives and uncertainties.

Accomplishments

- Designed and fabricated two field-portable LIBS units with multi-element analysis capability.
- Continued testing and benchmarking of field-portable LIBS units using core and discrete soil samples.
- Bench-tested and calibrated LIBS with over 1,000 soil samples.
- Obtained correlations between soil type and carbon calibration to develop robust calibration methods.
- Tested field-deployable LIBS at three sites.
- Designed and constructed two person-portable LIBS units for carbon soil analysis.
- Developed calibration curves for Raman detection of organic soil carbon
- Developed critical risk assessment metrics associated with plant available water, vegetation pattern and plant mortality.
- Demonstrated that soil microbes are sensitive, practical biological indicators of small annual increases in soil carbon concentrations.
- Developed industrial partner for soil microbial indicators; a phase one STTR proposal was submitted
- Refined method for improving revegetation/stabilization of semiarid mine land.
- Received R&D100 award for work on LIBS contribution to integrated measurement system called CARISS

Benefits

Concern over the potential for the buildup of GHGs in the atmosphere to contribute to global climate change has led the President to set a goal of reducing the amount of CO_2 emitted per dollar of GDP by 18% by 2012. A possible effective and low-cost method of contributing to the achievement of this goal is through the terrestrial sequestration of CO_2. However, this can only be achieved if we have effective measurement and analysis tools to verify carbon concentrations in a wide variety of environments. This project is working to provide these tools by meeting the need for (1) highly accurate portable measurement system(s), (2) effective and inexpensive bioindicators of changes in soil carbon and (3) advances in methods for assessing the risks associated with maintaining terrestrial carbon inventories. This integrated approach will provide a set of unique technologies and management tools required to address the GHG issue. An additional benefit of developing these technologies has been the advancement of mine-site revegetation/ stabilization methods.