STATEMENT OF
DR. ROBERT C. BURRUSS
RESEARCH GEOLOGIST, ENERGY RESOURCES TEAM
U.S. GEOLOGICAL SURVEY
U.S. DEPARTMENT OF THE INTERIOR
BEFORE THE
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND INNOVATION
SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
HEARING ON
CARBON SEQUESTRATION TECHNOLOGIES
NOVEMBER 7, 2007

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to present testimony on terrestrial sequestration and geologic capture and storage of carbon dioxide and their role in reducing atmospheric carbon. In addition to these topics, I also plan to discuss in my statement today the role of science in evaluating the potential geologic storage capacity for industrial carbon dioxide and in furthering our understanding of the carbon cycle.

Introduction

Let me begin by saying that the challenges of addressing carbon dioxide accumulation in the atmosphere are significant. Fossil fuel usage, a major source of carbon dioxide emissions to the atmosphere, will continue in both industrialized and developing nations. Therefore, a variety of strategies are being investigated to reduce emissions and remove carbon dioxide from the atmosphere. Such strategies include the facilitated sequestration of carbon from the air to terrestrial biomass, including soils and the capture and storage of carbon dioxide in geologic formations.

The current atmospheric carbon dioxide concentration is approximately 380 parts per million volume and rising at a rate of approximately 2 parts per million volume annually, according to the most recent information from the Intergovernmental Panel on Climate Change (IPCC). The fraction of carbon emissions from all sources that must be eliminated or sequestered to impact the magnitude of climate change is large. For example, to stabilize carbon dioxide concentrations at about 550 parts per million volume, the extent to which carbon dioxide emissions would need to be reduced may be as much as 70 percent. Reductions of this magnitude could involve implementation of several mechanisms, including geologic storage and biological sequestration, fuel shifts from fossil sources to renewable biological sources, increased electricity generation from solar and wind systems and nuclear power, and increased efficiency of power generation, transmission, and end use. Each of these mechanisms has distinct geological, hydrological, ecological, economic and social implications that should be assessed on a wide range of scales, from molecular to basin scales, to allow informed policy discussions and decisions on implementation and deployment of technologies.

Geologic Storage of Carbon

The 2005 IPCC Special Report on *Carbon Dioxide Capture and Storage* concluded that, in emissions reductions scenarios striving to stabilize global atmospheric carbon dioxide concentrations at targets ranging from 450 to 750 parts per million volume, the global storage capacity of geologic formations may be able to accommodate most of the captured carbon dioxide. However, geologic storage capacity may vary on a regional and national scale, and a more refined understanding of geologic storage capacity is needed to address this knowledge gap.

Geological storage of carbon dioxide in porous and permeable rocks involves injection of carbon dioxide into a subsurface rock unit and displacement of the fluid or formation water that initially occupied the pore space. This principle operates in all types of potential geological storage formations such as oil and gas fields, deep saline water-bearing formations, or coal beds. Because the density of injected carbon dioxide is less than the density of formation water, carbon dioxide will be buoyant in pore space filled with water and rise vertically until it is retained beneath a nonpermeable barrier (seal). A critical issue for evaluation of storage capacity is the integrity and effectiveness of these seals.

Terrestrial Carbon Sequestration

Terrestrial carbon sequestration practices seek to effect the transfer of carbon between the atmosphere and terrestrial biosphere (the earth and the living organisms that inhabit it) to reduce atmospheric carbon dioxide concentrations. Land management practices in the United States can affect the transfer of carbon from terrestrial systems into the atmosphere. Land conversion, especially deforestation, continues to be a significant source of global carbon dioxide emissions. Good land stewardship practices can reverse this and enhance biological uptake of carbon dioxide from the atmosphere, an approach termed terrestrial sequestration. Many of these practices, including tree planting and conservation tillage, are widely adopted and well understood. The Department of Agriculture is promoting the adoption of these practices through conservation programs implemented under the Farm Bill. The knowledge gained on the benefits of terrestrial sequestration will improve our understanding of the duration and extent to which the biological uptake of atmospheric carbon dioxide can be enhanced to reduce atmospheric concentration of carbon dioxide.

Role of the U.S. Geological Survey

While the USGS currently has no experience assessing the national geologic storage capacity, USGS-generated data and information were included in the Carbon Sequestration Atlas of the United States and Canada developed by the Department of Energy. In addition, our experience with national and international assessments of natural resources could allow USGS to develop geologically based methodologies to assess the National capacity for geologic storage of carbon dioxide. We envision the national geologic carbon dioxide storage assessment methodology would be largely analogous to the peer-reviewed methodologies used in USGS oil, gas, and coal resource assessments. In addition, the USGS' knowledge of regional groundwater aquifer systems and groundwater chemistry would allow USGS to develop methods to assess potential carbon storage in saline aquifers. Previous studies have postulated the existence of very large carbon dioxide storage capacities in saline aquifers, but the extent to which these capacities can be utilized remains unknown.

The USGS could create a scientifically based, multi-disciplinary methodology for geologic carbon dioxide storage assessment that can be consistently applied on a national scale. Some potential areas for further study include understanding the capabilities of seals to retain carbon dioxide and the role of abandoned wells that may act as migration pathways for carbon dioxide and formation water; defining the potential for mobilization of trace metals and organic materials by carbon dioxide reactions with minerals or dissolution of organic compounds; and understanding the role of bacteria and other microorganisms in water-rock-carbon dioxide interactions relevant to storage.

There are also a number of potential issues for further study pertaining to terrestrial sequestration, including the natural processes that affect carbon cycling. It is now widely recognized that the global carbon cycle and climate varied together, before human influence, as interactive components in a highly complex system of global feedbacks. These feedbacks have profound implications for the response of climate to anthropogenic carbon dioxide emissions, and for the potential response of the carbon cycle to changes in climate.

Along with our partners in the Department of Agriculture, the Department of Energy, and other agencies, ongoing USGS research addresses these issues. In particular, USGS research on soil carbon dynamics focuses on soil development and the buildup and stabilization of soil organic matter, a large carbon reservoir in the terrestrial biosphere, which play key roles in water distribution, and in turn control both sediment transport and carbon production and respiration. This research is critically important in explaining the processes affecting the flow of carbon dioxide from soils. The response of soils to human land use is a significant component in the global carbon dioxide budget, and their response to climate change may cause significant feedback on a global scale. Land use – particularly agriculture – significantly alters patterns of terrestrial carbon storage and transport, nutrient cycles, and erosion and sedimentation. Current models of the terrestrial carbon cycle do not adequately account for the interactions among changes in erosion, sedimentation, and soil dynamics. Additional research on variable scales (local to global) of carbon flow would provide a more thorough understanding of the carbon cycle.

Conclusion

It is clear that addressing the challenge of reducing atmospheric carbon dioxide and understanding the effect of global climate change is a complex issue with many interrelated components. A better understanding of geologic storage potential for carbon dioxide combined with research to understand the implications of terrestrial carbon sequestration on the carbon cycle would provide a scientific foundation for future decisions regarding carbon management. We believe additional study of geologic and terrestrial opportunities will better prepare decision makers as they deal with these issues. Thank you for the opportunity to present this testimony. I am pleased to answer questions you and other Members of the Committee might have.