Carbon Sequestration Pathways in 2030: Geological, Ocean and Terrestrial Systems.

G. K. JACOBS (Oak Ridge National Laboratory, BOX 2008, Oak Ridge, TN 37831; 865-576-0567; jacobsgk@ornl.gov), S. M. Benson (Lawrence Berkeley National Laboratory, One Cyclotron Road, Berkeley, CA 94720; 510-486-5875; smbenson@lbl.gov), K. G. Caldeira (Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA 94550; 925-422-6388; kenc@llnl.gov)

Increasing atmospheric CO_2 levels may result in climatic changes with significant impacts to human and environmental health. Carbon sequestration is one strategy to slow the CO_2 rise. It is defined as either capturing anthropogenic CO_2 at the source, or removing CO_2 directly from the atmosphere, and diverting that CO_2 to secure, long-term storage. Subsurface geologic formations have held vast quantities of natural gas and oil for thousands to millions of years. These formations, after having been exploited for their natural resources, offer large targets of opportunity to store CO_2 captured from anthropogenic sources for long periods of time. The uncertainty related to the sequestration performance of these reservoirs is great, however, because these systems must be manipulated in different ways to storage CO_2. Oceans are estimated to currently sequester approximately 2 Gt C/year through natural processes. Large-scale fertilization of the oceans might increase this rate through enhanced biological activity. Alternatively, CO_2 could be injected at great depths in the ocean where it would be stored for hundreds of years, or longer. There is, at present, little understanding of environmental consequences of these ocean sequestration strategies. Vegetation and soils capture and store CO_2 through natural photosynthetic and physiological processes. With wise ecosystem management, the current estimated global net ecosystem uptake of ~2 Gt C/year could be increased, while obtaining other benefits related to soil quality, erosion control, and water retention. Research into methods to enhance carbon storage in ecosystems could substantially increase that rate. Although all three of these natural systems offer opportunities to sequester CO_2, there are significant research challenges in understanding processes and their limits, developing methods to measure sequestration, creating cost-effective implementation schemes, and most importantly, assessing potential detrimental environmental consequences of these actions.