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Carbon Sequestration

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ABSTRACT

In the face of uncertainty, soil carbon sequestration projects and carbon credit treding are beginning. Those firm that expects CO_2 emmission control to become mandatory or reductions to be valued by consumers of "green" products are looking for cost effective means to offset carbon emissions.

As the world striggle with how to address climate change, one of the most significant question is how to reduce increasing levels of carbon dioxide (CO_2) in the atmosphere one promosing technology in carbon capture and sequestration which consist of capturing CO_2 emission from power plant and industrial sources and sequestering them in deep geologic formation of long period of time.

- Hydrodynamics trapping
- Solubility
- Mineralization
- Phase trapping

The objective behind is to reduce rate of concentration of greenhouse gases in air reducing the pollution in air as well as improving natural carbon content in air, improvement of soil structure and restoring degraded soil leading to increase yield in crops.
Keywords : Greenhouse gases and carbon dioxide.

I. INTRODUCTION

Many studies have focused on technologies that are available for making deep emission cuts within a relatively short period of time. Carbon capture and sequestration (CCS) is a promising technology that could enable the continued use of inexpensive fossil fuels while dramatically reducing accompanying greenhouse gas emissions. This technology drastically reduces emissions from power plants and industrial sources by capturing CO2 emissions and injecting them into deep geologic formations, essentially sequestering them underground for long periods of time. Areas for potential CO2 sequestration include oil and gas fields, saline aquifers, and deep coal seams. Natural geologic analog , like geologic formations containing crude oil, natural gas, brine, and Co2, have proven storage capabilities that will last for millions of years. CCS technologies would attempt to take advantage of these storage capacities to reduce CO2 emissions into the atmosphere. Worldwide, there are four large-scale CCS projects, each injecting roughly 1 million tons of CO2 annually. The amount of carbon that can be stored in the soil will plateau in a 40- to

50-year range. The time period depends upon the geographic site and specific practices followed. In other words, as much carbon will be released to the atmosphere from soil as is saved per year at some point. Some opposition and concern exists about allowing carbon to be sequestered in soil, because it can be released easily in the future with tillage or erosion. However, sequestration and carbon credit trading in the soil allow major emitters of CO2 to buy time to reduce their emissions, while developing economical long-run solutions to greenhouse gas reduction by using more energy-efficient technology or renewable and carbon neutral energy sources. Just as some areas of the country are more efficient at producing wheat or corn, some areas may be more efficient at sequestering carbon. The same case applies in other geographic locations around the globe. Similar crops may produce less biomass in drier areas than in wetter areas. Warmer areas may sequester more carbon, but soil microbes also may be more active over longer periods. Higher moisture and moderately cooler areas may be at an advantages. Cover crops used over winter in wetter regions may be advantageous to some. Farmers in areas that can efficiently produce trees also may hold an advantage over other tree farmers or agricultural commodity producers.

II. WAYS THAT CARBON CAN SEQUESTERED

1. Geological sequestration: Underground
2. Ocean Sequestration: Deep in ocean
3. Terrestrial sequestration: In plant and soil

2.1 GEOLOGICAL SEQUESTRATION

Geological sequestration of carbon dioxide (CO_2) is defined as the capture of CO_2 directly from anthropogenic sources and disposal into geological formations for geologically significant periods of time. CO_2 can be stored in geologic formations by different processes and mechanisms. At the initial stages of injection, supercritical CO_2 is trapped under a low-permeability geological medium. The CO_2 can further react with the solid and aqueous phases and can become dissolved into the water phase, referred to as solubility trapping. It can also react, either directly or indirectly, with the minerals and organic matter in the geological phases; this is known as mineral trapping. The effectiveness of geological storage depends on a combination of physical and geochemical trapping mechanisms, which will be directly related to the host rock formations. The most effective storage sites are those where CO_2 is immobile because it is trapped permanently under a thick, low-permeability seal or is chemically converted to solid minerals or is adsorbed on the surfaces of coal or mineral micro pores or through a combination of physical and chemical trapping mechanisms .

The physical properties of CO_2 that is stored depend on pressure and temperature. CO_2 is a gas at normal temperature and pressure, and it can turn into liquid at a moderate pressure of 6.4 MPa at 298 K. It becomes supercritical when the temperature is higher than 304 K and the pressure is greater than 7.38 MPa. Carbon dioxide density increases rapidly at approximately 800 m depth, when the CO_2 reaches a supercritical state.

2.2. OCEAN SEQUESTRATION

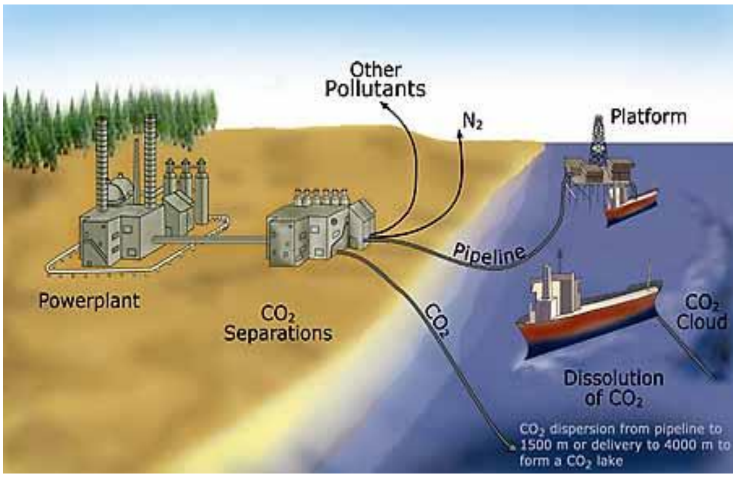

Figure1. Ocean Sequestration

One of the most promising places to sequester carbon is in the oceans, which currently take up a third of the carbon emitted by human activity, roughly two billion metric tons each year. The amount of carbon that would double the load in the atmosphere would increase the concentration in the deep ocean by only two percent.

Two sequestration strategies are under intense study at the Department of Energy's Center for Research on Ocean Carbon Sequestration (DOCS), where Jim Bishop of Berkeley Lab's Earth Sciences Division is codirector with Livermore Lab's Ken Caldeira. One is direct injection, which would pump liquefied carbon dioxide a thousand meters deep or deeper, either directly from shore stations or from tankers trailing long pipes at sea.

2.3 TERRESTRIAL SEQUESTRATION

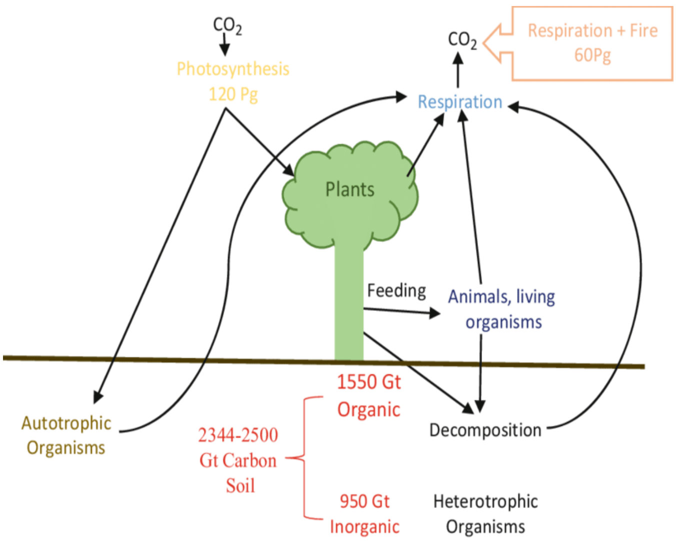

Figure 2 :- cycle in terrestrial ecosystems

Terrestrial (or biologic) sequestration means using plants to capture CO2 from the atmosphere and then storing it as carbon in the stems and roots of the plants as well as in the soil. In photosynthesis, plants take in CO2 and give off the oxygen (O2) to the atmosphere as a waste gas. The plants retain and use the carbon to live and grow. When the plant winters or dies, part of the carbon from the plant is preserved (stored) in the soil. Terrestrial sequestration is a set of land management practices that maximizes the amount of carbon that remains stored in the soil and plant material for the long term. No-till farming, wetland management, rangeland management, and reforestation are examples of terrestrial sequestration practices that are already in use.

III. SOIL CARBON SEQUESTRATION

Fossil fuel combustion, expansion of cultivated agriculture, and forest clearing have lead to an increase in atmospheric carbon dioxide (CO2) from 260 parts per million (ppm) to recent levels of greater than 370 ppm, Figure 1 (IPPC, 1995)

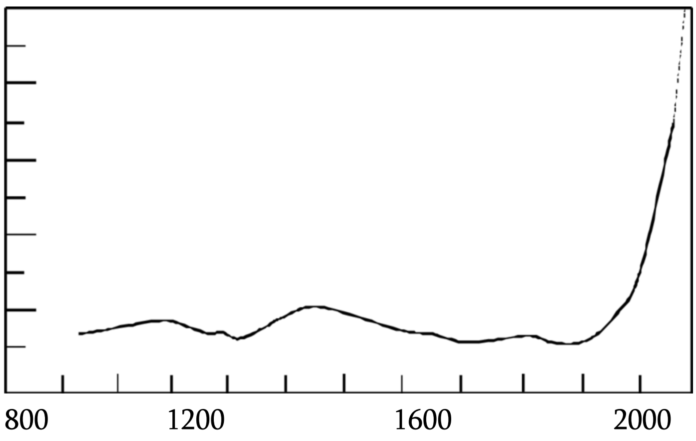

Figure 3. Temporal changes in atmospheric concentration of CO2 (Intergovernmental Panel on Climate Change, 1995). Global carbon cycle cycle in terrestrial ecosystems

Cardon dioxide is one of three greenhouse gases that are receiving increasing attention. CO2 , methane (CH4) and nitrous oxide (N2O) are believed to trap heat in the atmosphere the same way glass does in a greenhouse. The accumulation of these gases in the atmosphere is likely to cause changes in climate (USDA, 2000).

4. WHY THE CONCERN ABOUT CO2?

The accumulation of CO2 in the atmosphere is believed to lead to a warming of the earth's atmosphere that could have serious consequences. Carbon dioxide accounts for about 86% of total greenhouse gas emissions in the U.S. (Goodin et al., 1998). Although the extent and impact of increasing atmospheric CO2 on climate change are unknown and quite controversial, the Intergovernmental Panel on Climate Change (IPCC) reached an agreement in December, 1997, in Kyoto, Japan, to reduce greenhouse gas emission.

5. THE GLOBAL CARBON

Improving our understanding of the global carbon cycle, its fluxes, and its reservoirs, is intimately tied to successful implementation of carbon sequestration technologies.

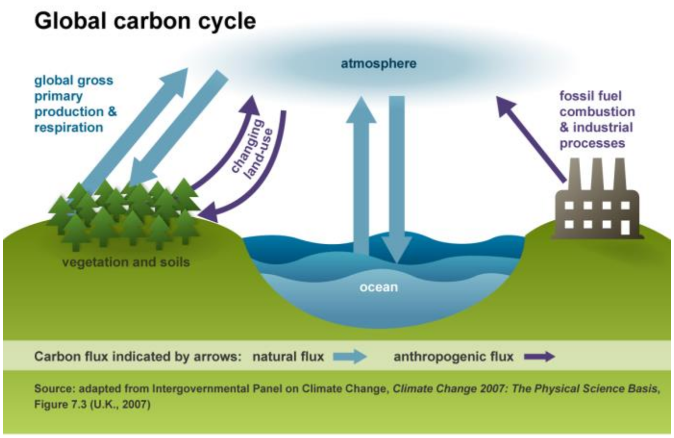

Figure 4. Global carbon cycle

6. CARBON SEQUESTRATION CYCLE

Six scientific/technical "focus areas" relevant to carbon sequestration were identified, and groups of experts in each area reported on the R&D issues. These focus areas are

1. Separation and Capture of CO2
2. Ocean Sequestration
3. Carbon Sequestration in Terrestrial Ecosystems (Soils and Vegetation)
4. Sequestration of CO2 in Geological Formations
5. Advance Biological Processes for Sequestration
6. Advanced Chemical Approaches to Sequestration

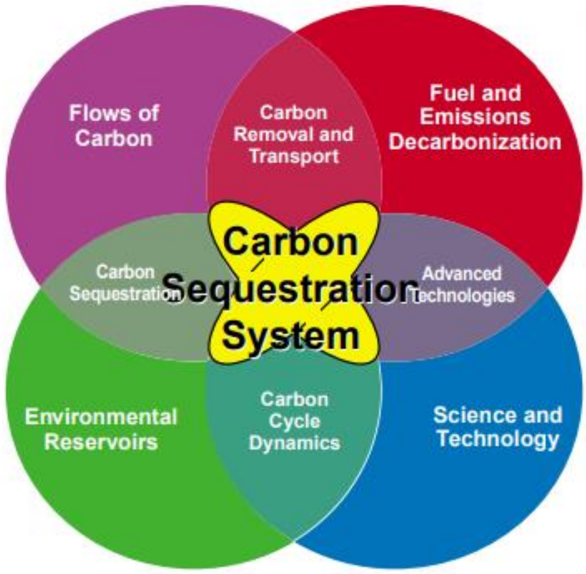

Figure 5. carbon sequestration system

These six focus areas represent one way to organize the scientific and engineering issues underlying carbon sequestration. Our vision for a carbon sequestration road map is to conduct the appropriate R&D so that options will be available for significantly reducing anthropogenic carbon emissions in the time frame of 2025 and beyond

7. SEQUESTRATION MECHANISMS

CO2 can be sequestered in geologic formations by three principal mechanisms (Hitchon 1996; DOE 1993). First, CO2 can be trapped as a gas or supercritical fluid under a low-permeability caprock, similar to the way that natural gas is trapped in gas reservoirs or stored in aquifers. This mechanism, commonly called hydrodynamic trapping, will likely be, in the short term, the most important for sequestration. Finding better methods to increase the fraction of pore space occupied by trapped gas will enable maximum use of the sequestration capacity of a geologic formation. Second, CO2 can dissolve into the fluid phase. This mechanism of dissolving the gas in a liquid such as petroleum is called solubility trapping

8. CAN SEQUESTRATION OF CARBON IN THE SOIL GO ON INDEFINITELY?

The amount of carbon that can be stored in the soil will plateau in a 40- to 50-year range. The time period depends upon the geographic site and specific practices followed. In other words, as much carbon will be released to the atmosphere from soil as is saved per year at some point. Some opposition and concern exists about allowing carbon to be sequestered in soil, because it can be released easily in the future with tillage or erosion. However, sequestration and carbon credit trading in the soil allow major emitters of CO_2 to buy time to reduce their emissions, while developing economical long-run solutions to greenhouse gas reduction by using more energy-efficient technology or renewable and carbon neutral energy sources.

IV. CONCLUSION

Although Greenhouse gas concentration in the atmosphere are increasing and the thread of global climate change requires our attention. Soil carbon sequestration is an effective tool to sequester atmosphere co_2 with better practical application than other approaches. It provide vast opportunity to sequester carbon in the soil. Because the ocean already is a large repository for carbon on the planet, it is not unreasonable to consider direct injection of CO_2 or enhancement of CO_2 fixation through fertilization as possible options for carbon sequestration. Technologies exist for direct injection of CO_2 at depth and for fertilization of the oceans with microalgal nutrients. However, we lack sufficient knowledge of the consequences of ocean sequestration on the biosphere and on natural biogeochemical cycling. Such knowledge is critical to responsible use of oceans as a carbon sequestration option.

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