Carbon Sequestration in the Illinois Basin

The energy in our coal is really 300-million-year-old sunlight!

Carbon dioxide (CO_2) gas is a naturally occurring and essential part of our atmosphere. Plants use CO_2 and sunlight to grow. The energy in the plants is stored over thousands of years as plants die, accumulate, and are compressed into coal. Burning coal also creates CO_2 when carbon atoms in the coal combine with oxygen in the atmosphere. The release of CO_2 into the atmosphere is a natural, reoccurring process, but too much of a good thing can be harmful. Ancient carbon is being put back into the atmosphere at much greater rates than it takes for the plants to grow, die, get buried, and turn into coal and other fossil fuels. Returning ancient carbon, as CO_2, to the atmosphere at our present rate may be contributing to global warming.

Carbon dioxide, methane (natural gas), and water vapor are greenhouse gases that trap heat from the Sun's rays in the Earth's atmosphere. The Sun's rays enter the atmosphere and hit the Earth, where some of the energy is absorbed and some is reflected back into space. Greenhouse gases in the atmosphere trap some of this radiated energy before it reaches space. This makes our planet livable. However, as more greenhouse gases become present in the atmosphere, more radiated energy is trapped than is needed. This process heats the atmosphere and contributes to an overall warming of the planet.

Geological Sequestration

Reducing the amount of CO_2 released into the atmosphere may slow the global warming trends that have been observed in the last several years. Geological carbon sequestration is one method of isolating CO_2 from Earth's atmosphere. Sequestration can play a significant role in preventing continued CO_2 buildup in the atmosphere.

Geological sequestration of CO_2 by injection into the subsurface is a promising technology under study around the world. Carbon dioxide is captured from the emissions of combustion systems, processed to remove contaminants, transported to a storage site, and injected into geological formations for very long-term storage. Three types of subsurface formations can be used—all of which exist in the Illinois Basin: coal formations so deep as to be considered uneconomical for mining and development in the forseeable future, depleted or mature oil and natural gas reservoirs, and saline aquifers that contain non-potable water. The industrial processes necessary to make geological sequestration possible are known but have not been applied to sequestration at the scale needed to significantly reduce the buildup of CO_2. Carbon dioxide injection into coal is being tested for methane recovery by replacing the naturally occurring, adsorbed methane with CO_2. Injection of CO_2 into oil reservoirs has been practiced as an oil recovery method for over 30 years. Saline aquifers have been used for natural gas storage in the Illinois Basin for decades.

Enhanced Coal Bed Methane

Coal seams absorb methane that can be recovered during sequestration. Natural gas accounts for about 24% of U.S. energy consumption and is used for a variety of residential and commercial energy needs, such as cooking and heating. Using coal beds as storage for CO_2 provides another source of natural gas, an increasingly important fuel source. Methane is adsorbed onto the internal surface of the coal bed, but it is easily replaced by CO_2. Coal beds can adsorb approximately twice the amount of CO_2 compared with natural gas. Even if all the natural gas harvested from the coal beds were burned, the net effect would still be the removal of CO_2.

Storing CO_2 in coals deeper than 1,000 ft and thicker than 3.5 ft does not make the coal unmineable; it simply means that any CO_2 stored in the coal would be released upon mining. If coal becomes very valuable or very scarce in the future, then it might become economical to mine these coals, and the previously stored CO_2 could be produced and stored in another geologic sink.

Enhanced Oil Recovery

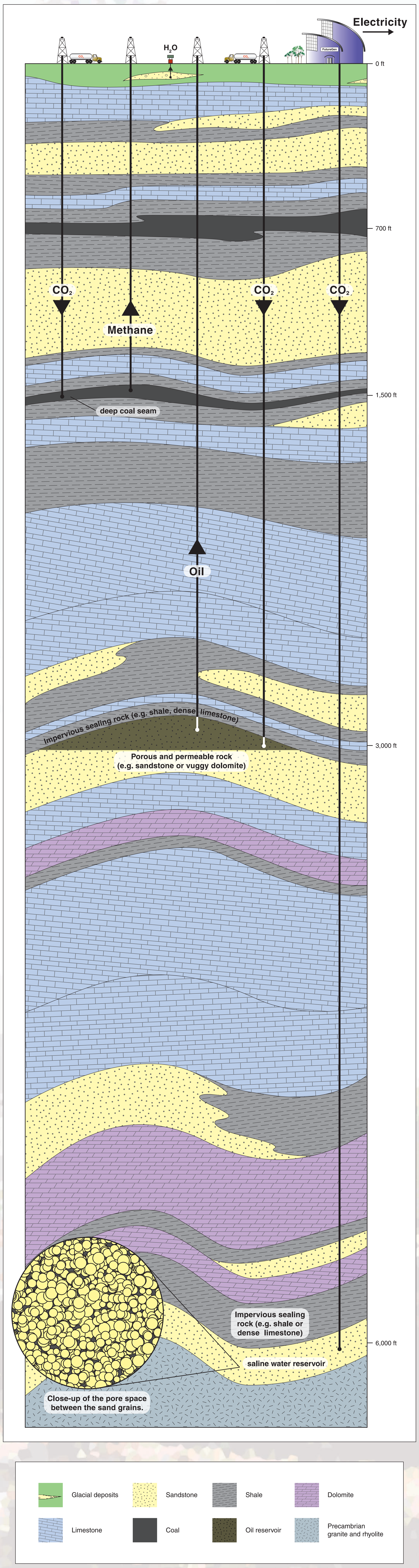
Enhanced oil recovery (EOR) uses CO_2 to recover the oil left behind after most of the oil has been pumped out of a reservoir. Oil does not always move easily through sandstone reservoirs, and much oil is left behind after an oil field produces under natural drive mechanisms. At a certain time it is no longer cost-effective to continue pumping oil from the ground in some fields unless recovery can be enhanced. Carbon dioxide is already being used as an EOR agent in oil fields in other basins. Using CO_2 for EOR becomes a more economical alternative when oil prices are high. A central well is used to inject CO_2, and surrounding wells are used to recover the oil. Liquid-like CO_2 under pressure is injected into the central well, and the oil moves toward the outer oil-producing wells. Using this method for storing CO_2 is simply the next step in the process. The CO_2 would be held in small pore spaces present in rocks and dissolved in the oil and water remaining in the oil reservoir. These pore spaces have held saline waters, oil, and natural gas for millions of years.

Saline Reservoirs

Saline reservoirs are bodies of rock with pore spaces containing water with high amounts of total dissolved solids (TDS), especially sodium chloride (table salt), that make the water too salty for human consumption or for agricultural and industrial uses. Saline reservoirs occur deep underground in rock formations that are expected to store large quantities of the injected CO_2 for long periods of time. The CO_2 would be held in the small pore spaces present in rocks. The ideal saline reservoir for carbon sequestration shares characteristics with the best oil-producing rocks. It should be sedimentary rock with good porosity (percentage of open pore spaces) and permeability (connectivity of open pore space). Directly above the reservoir, at depths of at least 3,000 ft, should be a relatively thick caprock unit of very low porosity and permeability, such as shale. The caprock layer acts as a lid or a cover for the saline reservoir. The depth of the reservoir is also important. A saline reservoir will be well below drinking water levels yet economically viable for drilling. Also, the volume of the potential storage space must be great enough to justify the expense of drilling a well, and having more than one shale caprock would also help ensure containment of the CO_2.

CO_2 Storage in the Illinois Basin

The Illinois Basin, which includes Illinois, western Indiana, and western Kentucky, is home to industrial activity that releases more than 283 million metric tonnes of CO_2 from stationary sources like electric power plants, refineries, cement plants, and other industrial facilities. The Basin is unique because three potential geological storage opportunities exist in close proximity to substantial CO_2 sources and, in some cases, may be accessed from one site. This geology represents a unique research opportunity to study all three storage options economically and may represent one of the best opportunities for initial commercialization of geological sequestration in the United States.



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