

The Concept of Geologic Carbon Sequestration

Geologic carbon sequestration is a method of securing carbon dioxide (CO₂) in deep geologic formations to prevent its release to the atmosphere and contribution to global warming as a greenhouse gas. The figure illustrates some of the major concepts associated with geologic carbon sequestration. The figure is not to scale.

Earth's carbon cycle is the movement of carbon through the planet's atmospheric, biologic, geologic, and hydrologic systems (Sundquist and others, 2008). As illustrated in the figure, many activities of modern human life have altered the carbon cycle by increasing the amount of CO₂ produced. For example, power generating facilities, petrochemical plants, cement production plants, cars and trucks, industrial processes, and agricultural practices all produce CO₂ and release it into the environment. Some of this CO₂ is sequestered naturally in oceans, plants, and soils, but an increasing amount is making its way into the atmosphere. Additional forms of carbon sequestration are desirable to offset these increasing emissions.

Carbon dioxide can be captured from stationary sources, such as powerplants and other large industrial facilities, compressed to a fluid state, and injected deep underground into permeable and porous geologic strata in which it will remain isolated for long periods of time. This process reduces or eliminates the emission of CO₂ into the atmosphere. The geologic formation in which the gas is stored must be overlain by another layer of impermeable rock to seal in the injected CO₂. In the figure, injection wells are depicted as columns of brown "bubbles" with arrows pointed downward into the earth. Brown bubbles in the storage formation represent geologic storage of CO₂.

The technology for sequestering CO₂ is still being developed, although a few industrial-sized carbon sequestration projects are operating worldwide. Several are associated with offshore natural gas production, as depicted by the offshore platform at the far right of the figure. In addition, for many decades CO₂ has been injected into geologic formations to boost production from oilfields by displacing trapped oil and gas. This process, known as enhanced oil recovery, has not been optimized for storage of CO₂, although significant experience has been gained in handling carbon dioxide, including how to ship it through pipelines, how to prevent leakage by plugging abandoned wells, and how to construct injection wells and inject CO₂ into them.

Determining the amount of CO₂ that can be sequestered nationally is important so that long-term plans can be made to capture and store CO₂. Toward this end, the U.S. Geological Survey (USGS) has developed a method for assessing the

amount of CO₂ that might be sequestered in geologic formations (Brennan and others, 2010). As illustrated in the figure, the method developed by the USGS considers two main types of trapping to determine the technically accessible storage resource—that is, the amount of CO₂ that can be stored using current technology. One type, known as buoyant trapping, fills the pore space in the rock with CO₂; the CO₂ is held in place by seal formations on the top and sides of the porous rock. This type of trapping is somewhat analogous to how oil and gas are trapped and is illustrated in the figure by the accumulation of CO₂ in arc-shaped structures (anticlines) that are overlain by low-permeability seal formations that prevent upward leakage. The other type of trapping, known as residual trapping, occurs as injected CO₂ passes through the storage formation and leaves some CO₂ behind; the CO₂ is held in place by surface tension in pore spaces. This type of trapping retains less CO₂ per given rock volume, but there is much more rock for which this type of trapping applies.

References Cited

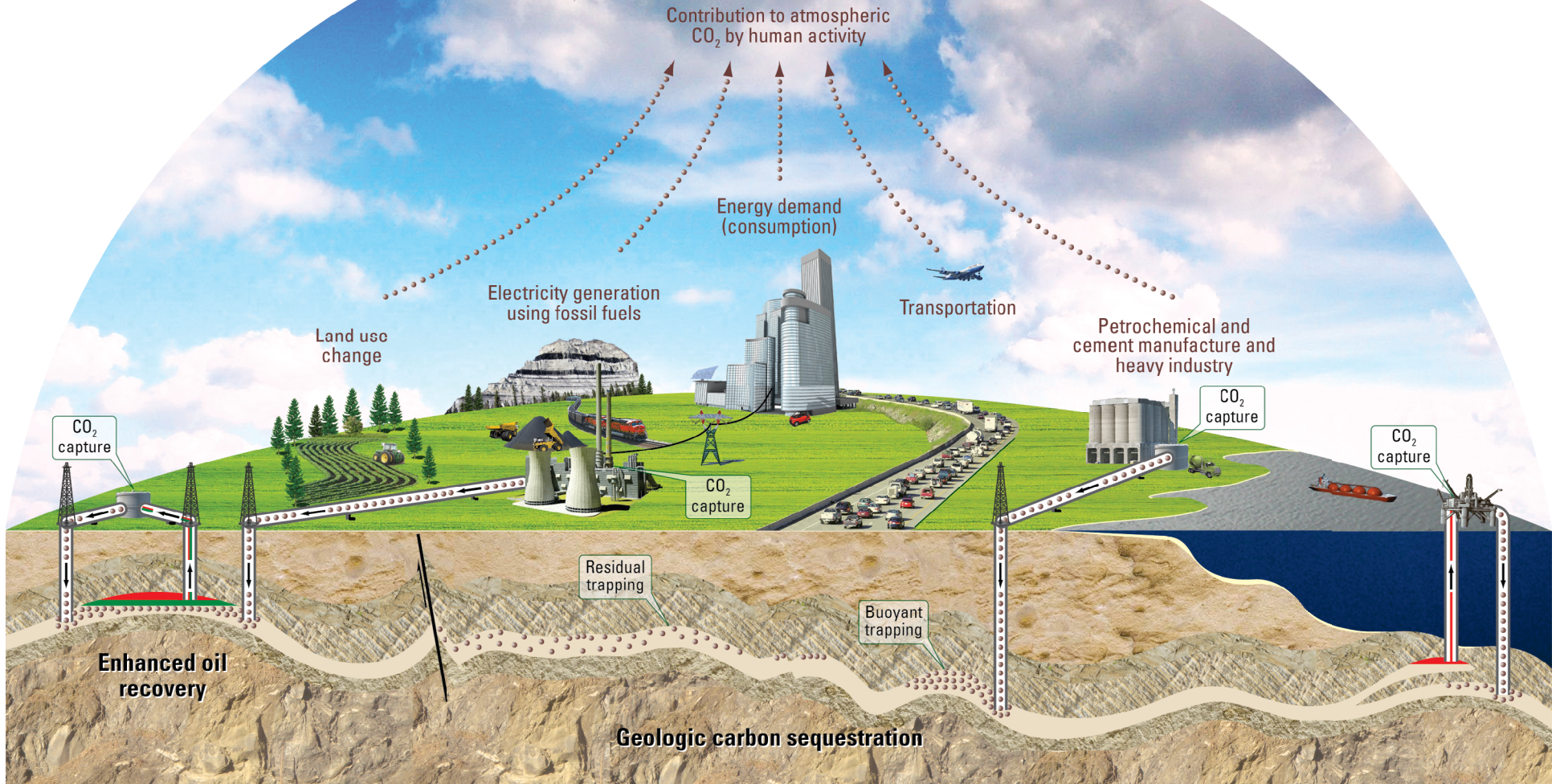
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For More Information

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NOT TO SCALE

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EXPLANATION

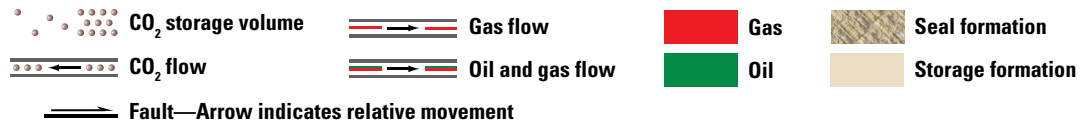


Figure 1. Figure illustrating the concept of geologic carbon sequestration. Figure composed by Douglas W. Duncan and illustrated by Eric A. Morrissey.