

Carbon Sequestration: Injection Versus Mineralization

Greg Croft

Carbon capture and sequestration increasingly appear necessary to limit anthropogenic carbon dioxide emissions. Two approaches to geologic sequestration of carbon are carbon dioxide injection in aquifers or depleted oil and gas reservoirs, and mineralizing dissolved carbon dioxide in basalt or peridotite. All current, commercial scale carbon sequestration projects use the injection approach.

The Sacramento Valley has produced more than 10 trillion standard cubic feet of natural gas. The volume of carbon dioxide that could be injected into these same reservoirs is several times more than that due to the phase behavior of carbon dioxide and the fact that some of it will dissolve in the water leg. The initial conditions of the largest Sacramento Valley gas reservoirs are all within the supercritical range for carbon dioxide, while methane is gaseous-phase. Using depleted gas fields has the advantage that there is voidage and a known trap, but legacy wells raise well integrity questions. Projects that inject into saline aquifers can be developed in areas with few or no legacy wells, but they must be monitored long after injection stops to watch for updip migration. The Sleipner carbon injection project uses a single well in a shallow (900 meters) aquifer. It has been injecting 0.9 million tonnes of carbon dioxide per year since 1996, making it the world's most established carbon injection project. An issue with injection projects in California is that aquifers tend to be compartmentalized by faulting, resulting in pressure buildup unless some of the water is produced from the aquifer.

Mineralization projects, such as the CarbFix project in Iceland, allow for very long term storage. These tend to use mafic igneous rocks such as basalt or peridotite. The carbon dioxide is injected under pressure (25 bar in the case of the CarbFix project) into a stream of injected water. The resulting carbonic acid reacts with calcic plagioclase feldspar and olivine to produce calcite, magnesite and ankerite. The carbon storage is long-term, but large amounts of water are required. Since most carbon mineralization projects involve moving water through mafic or ultramafic igneous rock, it is worth asking where that takes place naturally on a large scale. The answer is midocean ridge hydrothermal systems. These circulate the entire volume of the world's oceans through vesicular basalt over a period of tens of thousands of years.

Biography: Greg Croft is an adjunct professor of Environmental and Earth Science at Saint Mary's College in Moraga, California. He holds a PhD in Civil and Environmental Engineering from UC Berkeley, an MS in geophysics from Stanford and a BA in geology from UC Santa Barbara. Dr. Croft has more than 30 years' experience in oil and gas exploration and production and is a frequent public speaker on energy issues and geology. Much of his current work is about carbon sequestration.