Energy transitions – putting carbon in its place

MicroSeismic, Inc. is playing a key role in carbon capture utilization and sequestration

By Peter M. Duncan, President and CEO at MicroSeismic, Inc.

MicroSeismic, Inc. (MSI) was founded in 2003 with a mission to bring passive seismic technology to the oilfield. Our vision was to apply the technology to issues such as wellbore stability, monitoring of carbon capture (CO_2) sequestration, development of enhanced geothermal systems, induced seismicity by disposal wells, hydrocarbon production, and reservoir stimulation. The shale gale that blew in during the mid-2000s overwhelmed us with demand for our services and soon 99% of our business was hydraulic fracture (frac) monitoring. Through 2012 we grew to command about 40% of the worldwide frac monitoring market. We both acquire data in the field and analyze those data to provide critical information on wellbore interaction and reservoir stimulation effectiveness. We have monitored more than 50,000 frac stages for more than 200 clients in 18 countries including China, Australia, Argentina, and the UK in addition to North America.

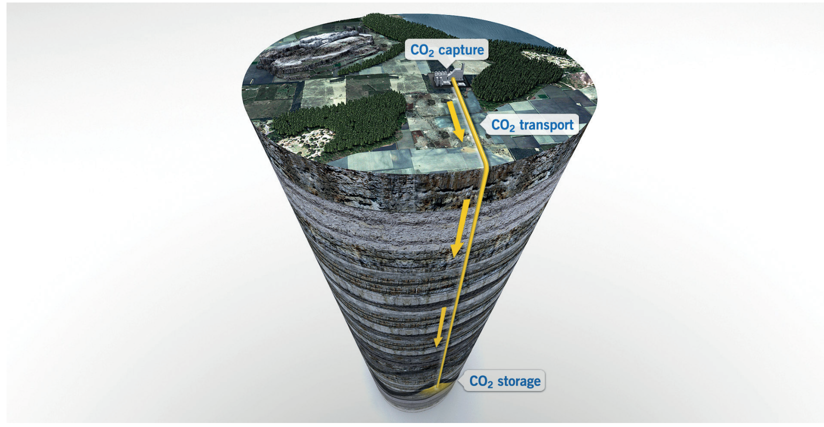
Recently the global priorities have shifted and while frac monitoring is still a business driver, the opportunities are opening for us to revisit our original vision. In 2021 nearly 25% of our revenue was derived from other than frac monitoring. We expect that number to be 40% in 2022 and for that trend to continue. Importantly, the experience of the past nearly 20 years will allow us to perform projects in these other areas of interest efficiently and effectively. Specifically, in the quest for carbon neutrality the technologies for carbon capture utilization and sequestration (CCUS) have pushed to the fore. Monitoring sequestration sites to ensure that the carbon is staying in place falls right in the wheelhouse of MSI's expertise.

What is CCUS?

CCUS is the series of processes by which CO_2 (or monoxide, CO) is removed from the waste stream of power generation or other industrial processes and stored in some fashion such that it does not escape into the atmosphere where it can be a powerful agent of global climate change. It is estimated that global emissions of CO_2 in 2020 amounted to 35 billion metric tons (sometimes referred to as gigatons or gt) (https://www.statista.com/statistics/276629/global-co2-emissions/). Among the larger sources of emission are power plants (coal, natural gas or oil fired), ethanol plants, and cement factories. Simply put, CCUS is a 3-step process: capture the CO_2, transport it to a disposal facility and then put it away for good. Capture of the CO_2 at power plants is mostly achieved by scrubbing it from the combustion exhaust. Chemical plants can sometimes remove or reduce the CO_2 prior to the particular chemical production process or sometimes with post process combustion systems. Transport of the CO_2 is done with the gas compressed into a super critical fluid in pressurized tankers (trucks, trains or ships) or pipelines. Several pipeline projects have been announced recently involving newbuild projects such as the Midwest Carbon Express or the repurposing of older pipelines (www.summitcarbonsolutions.com).

While there are a growing number of industrial uses for the captured CO_2, the majority is injected underground. A major use of CO_2 for several decades has been for enhanced oil recovery (EOR). The CO_2 is injected into a hydrocarbon reservoir where it increases the pressure and in a very real sense sweeps the reservoir pushing the remaining hydrocarbons up the production wells. Some of the CO_2 is produced with the hydrocarbons, but it can be captured and reinjected.

As we strive for carbon neutrality, the bulk of CO_2 to be sequestered most likely will be injected underground in depleted oilfields, deep saline formations or coal bearing formations. In these cases, the process is often termed just CCS. At present there are about 46 sequestration projects underway globally that in sum sequester between 20 and 40 million metric tons of CO_2 annually. The stated goal of the global community is to raise that number to 1 gt/year by 2030 and 6 gt/year by 2050. Clearly this is an ambitious goal that is driving predictions for the CCUS market to be at least $5 billion and perhaps as much as $13 billion by 2025.



© Global CCS Institute | **The carbon capture and storage process**

Issues around geologic sequestration

Subsurface formations into which the CO_2 can be injected are plentiful. For example, the US Department of Energy estimates that storage capacity in the US alone is enough to hold at least 3000 gt of CO_2. However, there are several issues of concern around geologic sequestration: will the CO_2 remain in the reservoir indefinitely or will it leak out? How can we monitor the environment of the reservoir to detect if the CO_2 is leaking? Will the injection of the fluid induce seismic activity that may damage the reservoir storage efficacy or even result in damaging seismic waves at the surface? The approval process for establishing and operating a CCS facility will vary from jurisdiction to jurisdiction but will generally require that the questions above be adequately addressed. Interestingly many of the same issues are relevant to the geologic storage of hydrogen, helium, and other fluids.

A 3D seismic imaging of the proposed reservoir is a requirement to establish the size of the container, the nature of the seal or caprock, and the presence of any faulting that might be a hazard for natural or induced seismicity. Rock properties such as the porosity and permeability of the reservoir rock will be obtained from core and wellbore log measurements. Similar properties will be assessed for the caprock. If the reservoir has been previously produced the issue of proper plugging and abandonment of old wells such that they do not allow for CO_2 to escape will need to be addressed.

If the reservoir passes this initial evaluation, the operator next will have to propose a measurement, monitoring and verification program (MMV) to be implemented over the life of the facility and beyond to assure that the CO_2 remains in place. Elements of the MMV plan will include: monitoring of the air, groundwater and soil gas at the sequestration site to detect any increase in CO_2 levels, monitoring of formation pressure above the caprock to detect increases as a result of leaking gas, continuous microseismic monitoring in the vicinity to detect any unusual induced seismic events that might lead to reservoir, seal or surface damage, repeated geophysical surveys (seismic, electromagnetic, microgravity) to map the dispersion of the injected fluid and verify reservoir integrity.

Capturing the opportunity

Over the past four years MSI has developed and deployed a permanent passive seismic system to monitor the geologic integrity of phosphate mining facilities in Florida. We have recently received a Department of Energy grant to fund the redesign of this technology for application to long term monitoring of CCS facilities. We intend to marry our world leading passive seismic experience to what has been learned in previous research projects such as the Illinois Industrial Carbon Capture and Storage Project (http://energy.gov/fe/archer-daniels-midland-company), Whitecap Resources' Weyburn EOR project (https://www.wcap.ca/sustainability/co2-sequestration) and Shell's Quest project (https://www.shell.ca/en_ca/about-us/projects-and-sites/quest-carbon-capture-and-storage-project) to develop a turn-key monitoring system that meets the MMV needs of this emerging industry. gw

ABOUT MICROSEISMIC, INC

MicroSeismic, Inc, with headquarters in Houston, is a provider of microseismic data acquisition and event description utilizing surface, near-surface, and downhole arrays.