Investigations of alleged CO2 leakage in Weyburn, Canada in the context of longer term surface gas monitoring

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Abstract

The Weyburn oilfield in SE Saskatchewan, Canada has been in production for more than 50 years. A CO_2 flood was started in 2000 to enhance oil recovery. The gas is piped from a coal gasification plant across the US border in North Dakota. In addition to boosting oil production it is expected that about 30 million tonnes of CO_2 will be permanently stored in the reservoir, at a depth of about 1400 m, by the end of the 30 year lifetime of the project.

Near surface gas monitoring has been carried out from the early stages of CO_2 injection. It forms part of the IEAGHG Weyburn-Midale research project and has received additional support from EU-funded research projects and UK national funding. The first surface gas measurements were made in July 2001, with subsequent surveys in the autumn of that year and then each autumn from 2002 to 2005. Repeat surveys were carried out in 2011 when new methods were trialled and specific investigations were made at a site of alleged CO_2 leakage.

An initial grid of soil gas and flux observations was made in 2001 covering some 13 km^2 (360 points at 200 m spacing) around the initial injection area. This was measured on each subsequent visit as were a selection of more detailed profiles (25 m spaced observations) chosen on the basis of the grid results. In 2003 the scope of work was expanded to investigate possible pathways for CO_2 migration towards the surface. This included the study of 2 abandoned/suspended well sites and lineaments that might represent the surface expression of deeper faulting or thinning of the reservoir seal. A background site with similar characteristics to the main grid, but remote from the CO_2 injection area was also added. Measurements made in the field, field laboratory and laboratory included a range of gas species (e.g. CO_2, O_2, N_2, CH_4, C_2H_6, C_3H_8, C_2H_4, He and Rn) and CO_2 flux. Radon probes were also buried at selected sites to monitor the temporal variations of this gas as a proxy for CO_2 migration.

In 2011 these measurements were supplemented by some continuous monitoring of CO_2 concentrations and fluxes using buried monitoring probes and an eddy covariance system. In addition, mobile open path laser measurements of CO_2 in the near ground atmosphere were made at selected sites. These methods were designed to address the potential need to locate spatially small surface leaks in a large project area and to deal with temporal variability.

Allegations of leakage of CO_2 to surface at the Kerr property, just SW of the CO_2 injection area, were made in early 2011. Consequently the area around the property was investigated with many of

the above methods and detailed C isotope ($\delta^{13}C$ and ^{14}C) studies were undertaken to help constrain the source of the soil gas CO_2, both at the Kerr property and at the background site.

The results show no evidence for any leakage of the injected CO_2. They are consistent with seasonal variations in biogenic CO_2 produced in the shallow subsurface. The CO_2 fluxes, as well as the concentrations of CO_2 and other soil gases, at the Kerr property were within the range of values recorded elsewhere, including the background site, during the 2011 campaign. In addition, these values were also within the range of those observed at the other sites during the various autumn campaigns from 2001 to 2005, and much below those observed during the summer campaign of 2001, indicating a strong seasonal control on soil gas chemistry. The relationship of CO_2 to O_2 and N_2, and the isotopic data, demonstrated clearly the near surface origins of the CO_2. The same conclusion was reached in a separate study of the Kerr property by other researchers.

The results of the 2011 and earlier studies will be used to help provide guidance on best practice for near-surface monitoring at CO_2 storage sites.