

14. SOIL GAS MONITORING

14.1 Introduction

Soil gas monitoring has been widely accepted as one option to detect CO₂ that has migrated from a storage site to the near surface, before leaking into the atmosphere. It has been applied to a number of CO₂ storage projects, such as Cranfield, USA (Romanak et al. 2012), Gorgon, Australia (Flett et al. 2009), In Salah, Algeria (Mathieson et al. 2011) and Weyburn, Canada (White et al. 2004).

The concentration of CO₂ and other gases in the soil is highly variable as a result of the geological and seasonal variability in the vadose zone as well as the variable level of biological activity (Amundson and Davidson 1990). A strength of soil gas monitoring is that it is relatively easy to measure the composition of the soil gas. It can also be used to collect samples for later analysis of tracers that are characteristic of the stored CO₂. These may have been artificially added (Jenkins et al. 2012; Martens et al. 2012), or may be distinctive natural isotopes such as

¹³CO₂ (see below). A disadvantage of measuring only composition is that it is not possible to infer fluxes from concentrations, without having extra information about transport mechanisms through the vadose zone. Since a leak of CO₂ to the surface represents a flux of CO₂ soil gas measurements are difficult to interpret in terms of leakage, or limits on leakage, in a quantitative way.

It is standard practice to undertake soil gas surveys a number of times before injection of CO₂ commences (Schloemer et al. 2013); these baseline surveys are then a reference for post-injection data. If the post-injection data are similar to the baseline, this is taken to be evidence that leakage has not occurred. However, the meaning of “similar” is hard to define. For example, datasets may be the same to within the error bars, but if the error bars are large, then the method may have little statistical power. Ideally there would be some definite idea of what size of difference would be produced by a leak. But as mentioned previously, distinguishing changes of concentrations from changes in fluxes does require detailed knowledge of transport properties such as soil permeabilities, and these can be difficult to acquire.