Detection and understanding of natural CO_2 releases in KwaZulu-Natal, South Africa.

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A natural CO_2 release is present near the village of Bongwana in KwaZulu-Natal, South Africa. The CO_2 release was first described in the early 20th century (Young, 1924, Gevers, 1941) and a commercial CO_2 bottling plant was established. Subsequently, additional sites of CO_2 release were identified along a N-S trend away from Bongwana that coincides with a mapped fault, including significant travertine deposition at Umtamvuna (Gevers, 1941) and reported springs in the river at Manzimhlanga. The Bongwana natural CO_2 release thus appears to be controlled by an ~80km long N-S fault where CO_2 release is in distinct regions rather than along the whole trace of the fault (Fig. 1). In addition a groundwater well drilled on a farm (Baker) near the trace of the fault encountered CO_2 at depth and following a vigorous release was subsequently plugged and abandoned. Two leakage scenarios are defined for CO_2 storage. These are '(1) abrupt leakage, through injection well failure or leakage up an abandoned well, and (2) gradual leakage, through undetected faults, fractures or wells' (IPCC, 2005). As such the Bongwana CO_2 releases provide an excellent opportunity for detecting CO_2 in an analogue for a failed CO_2 storage site under both leakage scenarios.

Here, we present results from a field campaign conducted in late September 2015 to begin to ascertain the nature and magnitude of the CO_2 releases. Fieldwork was conducted at three sites: 1) Baker Farm, 2) Umtamvuna, 3) Manzimhlanga (Fig. 1). At Baker Farm a soil gas survey over a grid of 500 x 100m was conducted recording both gas content and flux. In addition the two groundwater wells were sampled for fluid and gases present and flux measured. One of these wells was the well that had encountered CO_2 on drilling. At Umtamvuna the travertine deposits were mapped and sampled. Fluid and gases were sampled for geochemical analysis from both the river and the travertine springs, and a soil gas survey was undertaken following a transect line across the fault. In addition, structural mapping and analyses were performed. Lastly at the Manzimhlanga site all of the analyses described above were undertaken. Results from all three sites indicate that relatively pure CO_2 gas (>95% CO_2) is emanating from the releases and gas compositions and stable isotope results indicate a largely abiogenic source of the CO_2. Fluxes are highest at the borehole and nearest to the trace of the fault with flux dropping away to minor amounts within 10s of meters of the fault. Significant differences in water chemistry (pH, EC, DO) are apparent between the CO_2-rich and CO_2-poor sites and perturbation of $\delta^{18}O$ values of water are noted at the CO_2-rich sites. Structural analysis and the delineation of the CO_2 release by the soil gas survey indicates that the main control on natural migration (i.e. other than borehole drilling) is fracture permeability along zones parallel to the trend of the N-S main Ntlatkwe-Bongwana fault.

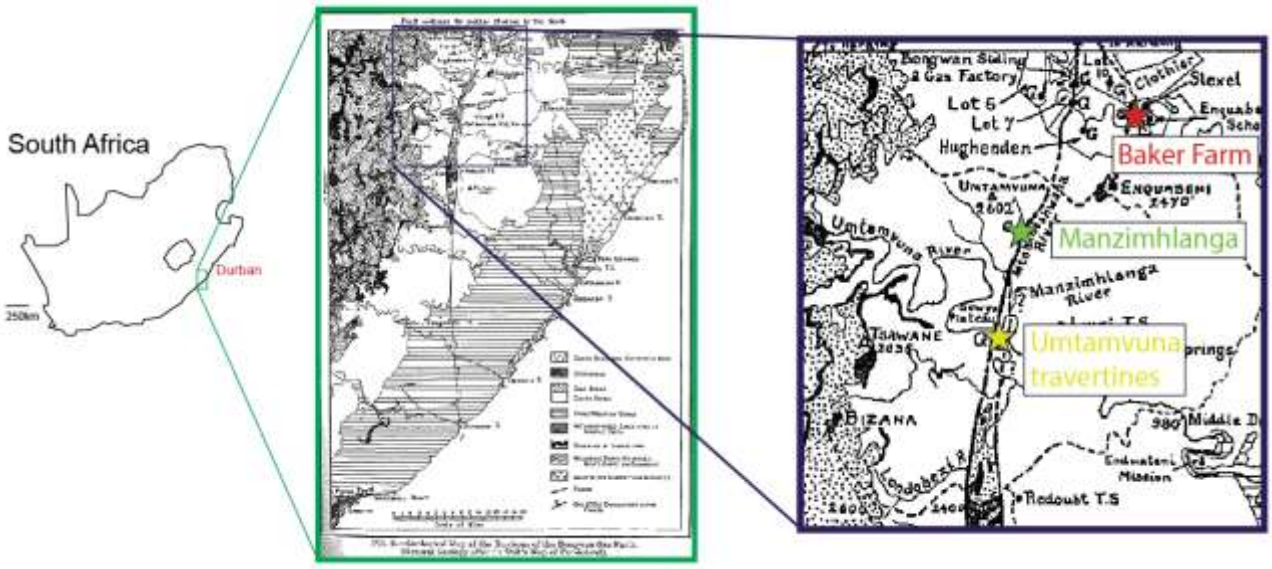

Figure 1. Location map of the three fieldwork sites. Map from Gevers (1941).

Successful deployment of CCS as a climate change mitigation tool relies heavily on engaging a range of stakeholders with different perspectives. Not least of these is public perception of CCS that for local communities largely centres on the safety of CO_2 storage. Indeed public perception has been described as critical to the deployment of CCS (Benson and Cole, 2008) and examples exist of local communities successfully halting the deployment of storage sites e.g. Barendrecht, NL (Wallquist et al., 2012). Benson and Cole (2008) outline four key questions that are asked by all stakeholders:

1. Will geological reservoirs leak?
2. If leakage occurs what are the health, safety and environmental risks?
3. Can leakage be predicted, detected and quantified?
4. What can be done to stop or slow a leak, should it occur, and how much would it cost?

The sites along the Bongwana fault provide the opportunity to address the latter three questions with detailed assessment of the mechanisms of natural CO_2 releases. In doing so we hope to address public confidence in CO_2 storage in South Africa and beyond.

References

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