Monitoring Saharan groundwater resources overlying a terrestrial CCS site

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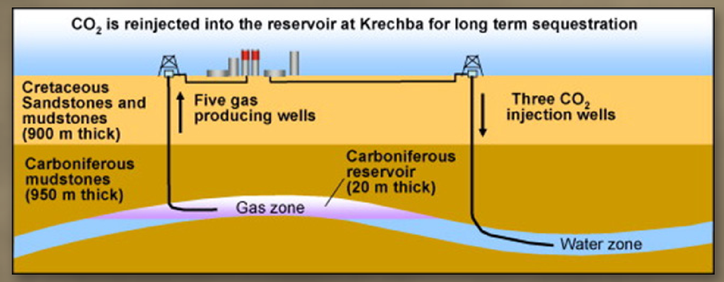
In Salah Joint Venture CCS

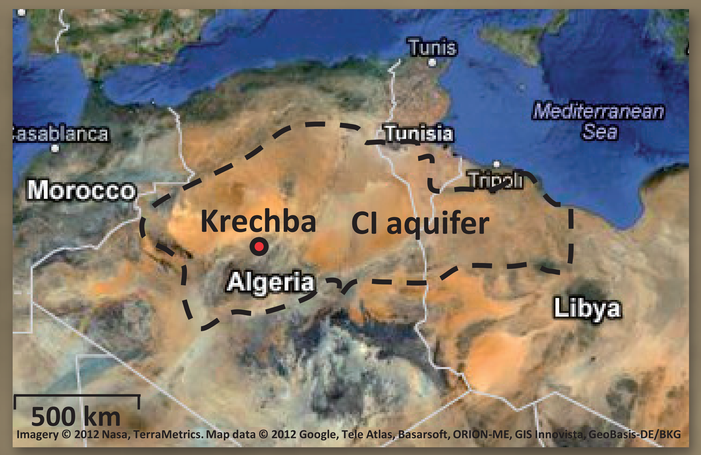
The In Salah Joint Venture is an industrial scale CCS research project at the Krechba gas field in Algeria, with the aim of storing 17 million tonnes of CO_2 over the next 20 years. Currently approximately 3 million tonnes of CO_2 have been successfully stored. CO_2 is removed from the abstracted gas and reinjected as a supercritical fluid into brines within the sandstone reservoir. The reservoir is capped by 900 m of Carboniferous mudstones which, in turn, are overlain by the confined Continental Intercalaire (CI) aquifer.



After Rutqvist et al. 2010

Continental Intercalaire (CI) aquifer

The CI aquifer is one of the world's largest groundwater systems (600 000 km^2) which extends across Algeria, Libya and Tunisia. Recharge is negligible and water resources are essentially mined over much of the area where often it is the only source of fresh water. In Krechba it is c. 500 m thick -predominantly medium-coarse sand with interbedded mudstones of up to 50 m thickness. It is confined by c. 150 m of Cenomanian muds at the site and the potentiometric surface is around 80–110 m bgl. There are five aquifer monitoring and three water supply boreholes at the site.



Hydrochemical baseline

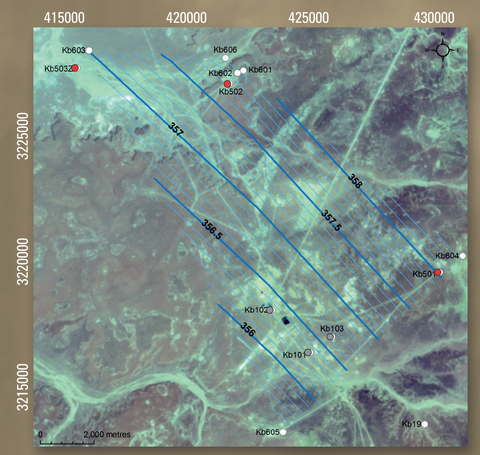
The CI waters at Krechba are of excellent quality:

- Relatively dilute with a SEC of <600 $\mu S\ cm^{-1}$
- Slightly alkaline with a pH of 7.7–8.0
- Dissolved oxygen is high and at/near saturation in cases
- Temperature of 30–34°C

Analysis of cuttings indicates the aquifer comprises of mainly quartz mineralogy, which supports the dilute chemistry. The high dissolved oxygen content is unusual considering ^{14}C dating indicates the waters are between 10 000 to 20 000 years old. Dissolved gas concentrations (CO_2/CH_4) are low suggesting there was no major alteration to the gas content following infiltration into the soil which is compatible with limited soil-zone productivity.

Hydrogeology

Single-well pumping tests have been undertaken and analysed analytically and numerically with hydraulic conductivity estimates of between 7–27 m/d. The south-westerly potentiometric gradient across the site is very shallow – in the order of 1:3000. Therefore groundwater velocity is slow: 4 to 20 m/yr. Groundwater levels are essentially static due to negligible recharge and abstraction.



Potentiometric surface in metres above sea level

Red - CO_2 injection well,
white - aquifer monitoring well,
grey - water supply well.

Hydrochemical monitoring

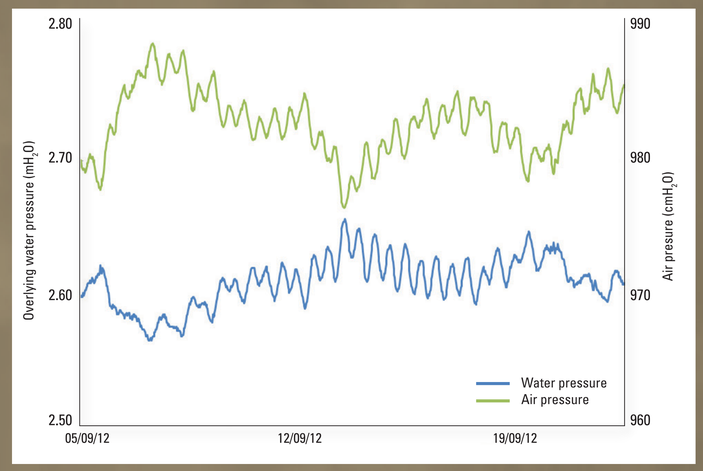
A potential leak from the injection reservoir could modify the water hydrochemistry:

- Higher concentrations of dissolved CO_2/CH_4
- Lower pH
- Higher TDS
- Elevated heavy metals
- Little/no detectable O_2
- Detected NH_4 rather than NO_3
- Very low or absent ^{14}C

Therefore samples are taken from all monitoring boreholes annually. Thus far there is no evidence for CO_2 ingress into the aquifer.

Water level monitoring

A potential leak of fluids from the reservoir may pressurise the confined aquifer system. This potential increase in pressure heads could propagate more widely than potential changes in hydrochemistry which may be localised around any point of leakage, particularly given the low groundwater velocities. Therefore, half-hourly logging pressure transducers have been installed within all aquifer monitoring boreholes. Three barometric pressure transducers have also been installed to remove barometric and earth tide effects.



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