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Understanding the interaction of injected CO_2 and reservoir fluids in the Cranfield enhanced oil recovery (EOR) field (MS, USA) by non-radiogenic noble gas isotopes

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Identifying the mechanism by which the injected CO_2 is stored in underground reservoirs is a key challenge for carbon sequestration. Developing tracing tools that are universally deployable will increase confidence that CO_2 remains safely stored. CO_2 has been injected into the Cranfield enhanced oil recovery (EOR) field (MS, USA) since 2008 and significant amount of CO_2 has remained (stored) in the reservoir. Noble gases (He, Ne, Ar, Kr, Xe) are present as minor natural components in the injected CO_2. He, Ne and Ar previously have been shown to be powerful tracers of the CO_2 injected in the field (Györe et al., 2015). It also has been implied that interaction with the formation water might have been responsible for the observed CO_2 loss.
Here we will present work, which examines the role of reservoir fluids as a CO_2 sink by examining non-radiogenic noble gas isotopes (20Ne, 36Ar, 84Kr, 132Xe). Gas samples from injection and production wells were taken 18 and 45 months after the start of injection. We will show that the fractionation of noble gases relative to Ar is consistent with the different degrees of CO_2 – fluid interaction in the individual samples. The early injection samples indicate that the CO_2 injected is in contact with the formation water. The spatial distribution of the data reveal significant heterogeneity in the reservoir with some wells exhibiting a relatively free flow path, where little formation water is contacted. Significantly, in the samples, where CO_2 loss has been previously identified show active and ongoing contact. Data from the later stage of the injection shows that the CO_2 - oil interaction has became more important than the CO_2 – formation water interaction in controlling the noble gas fingerprint. This potentially provides a means to estimate the oil displacement efficiency. This dataset is a demonstration that noble gases can resolve CO_2 storage mechanisms and its interaction with the reservoir fluids with high resolution.

References:

Györe, D., Stuart, F.M., Gilfillan, S.M.V., Waldron, S., 2015. Tracing injected CO_2 in the Cranfield enhanced oil recovery field (MS, USA) using He, Ne and Ar isotopes. Int. J. Greenh. Gas Con. 42, 554-561.