CO_2 mineralization in a saline aquifer-like environment, Pannonian Basin, Hungary

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Mineralization of injected CO_2 results in its permanent removal, desirable for climate mitigating carbon storage. Although the process has been shown to occur in small-scale gas injection studies[1], it has not been shown in large scales in saline reservoirs, which are essential for industrial scale CO_2 storage. The Mihályi-Répcelak field in the Pannonian Basin (Hungary) has reserves of ~22 Mt of CO_2 derived from 4-7 Ma magmatism. The turbiditic sandstone facies where CO_2 accumulated is similar to the large saline aquifer in the Szolnok Formation that is widespread in the Pannonian Basin (Central Europe). Thermodynamic conditions for carbonate precipitation are present, as demonstrated by the large quantities of carbonates recovered in drill core[2]. The field provides an easily accessible inverse analogue of CCS for studying carbonate mineralization in an industrialized saline aquifer-like environment (~0.1 Mt/a CO_2 production).

The CO_2-$^3He/^4He$ composition of commercially-extracted gases in 2010[3] and 2017 shows a significant increase in the loss of CO_2 from the gas phase in 7 years. The majority of the gases extracted in 2010 have $CO_2/^3He$ ratios and $\delta^{13}C_{CO2}$ that require both CO_2 dissolution in groundwater and carbonate precipitation as we independently model the reservoir pH to be 6±0.1, which data do not fit into. The $\delta^{13}C_{CO2}$ of the 2017 gases are typically lighter, and provide clear evidence that the proportion of CO_2 that has been removed by carbonate precipitation has increased. We observe a systematic 10% decrease in $CO_2/^3He$ caused by ~0.4 Mt CO_2 production in 7 years. This may reflect the role that CO_2 production is generating thermodynamic conditions that are more suitable for carbonate precipitation (e.g., reduced CO_2 partial pressure, intermixing with other formation fluids related to gas production). Quantification of these field data based conditions is a milestone in large-scale permanent CO_2 storage. **Ref**: **[1]** Snæbjörnsdóttir et al. Int. J. Greenh. Gas Con. **2017**, 87-102. **[2]** Király et al. Geol. Soc. Spec. Pub. **2016**, 435. **[3]** Palcsu et al. Mar. Petrol. Geol. **2014**, 216-227. **[4]** Gilfillan et al. Nature **2009**, 458, 614-618.