Raptor Ridge, Wyoming - variation in $^{87}Sr/^{86}Sr$ distinguishes silicate and carbonate mineral dissolution during geological carbon storage

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The nature and significance of reactions between CO_2-bearing brines and minerals during geological storage of CO_2 are disputed. Key questions include whether dissolution of minerals will increase or decrease permeabilities and injectivity and whether re-precipitation of carbonate will contribute to long-term reservoir security.

Modelling of changes in brine composition during six months of CO_2 injection for EOR at the Salt Creek field, Wyoming, [1] implied significant dissolution of silicate minerals with later precipitation of carbonate. There were uncertainties related to the inherent errors in calculation of mineral reaction modes and interpretation of the fluid $^{87}Sr/^{86}Sr$ ratios. To resolve these, we sampled surface exposures of the Wall Creek Member of the Upper Cretaceous Frontier Formation, which comprise the reservoir studied at Salt Creek. At Raptor Ridge, Wyoming, study of surface outcrops, ground-penetrating radar and drill core by Bhatthacharya and his research group [2] allows reconstruction of the 3D structure of the tide-influenced deltaic deposits and the major calcite concretions. The whole-rock $^{87}Sr/^{86}Sr$ ratios of Wall Creek sediments at Raptor Ridge reflect diverse sources of silicate minerals and variable contributions from diagenetic calcite cements.

The present-day $^{87}Sr/^{86}Sr$ ratios of the low Ca sandstones range from 0.709 to 0.719 (average 0.714) reflecting mixtures of silicate minerals from primitive Cretaceous arc material and older basement from the Sevier orogenic belt. $^{87}Sr/^{86}Sr$ ratios of carbonate-rich samples and their acid leaches range from 0.7075 to 0.7088. The Sr-isotopic compositions of the brines from the Salt Creek EOR experiment evolve with relatively elevated $^{87}Sr/^{86}Sr$ ratios while cations increase by up to a factor of two. The new analyses confirm that input of Sr from dissolution of low $^{87}Sr/^{86}Sr$ calcite was balanced by Sr inputs from silicate minerals. Silicate mineral dissolution was significant even over the short timescale of the Salt Creek experiment.

[1] Bickle et al., (2013). Abstract, *AGU Fall meeting*, V34A. [2] Lee et al. (2007) *AAPG Bull* **91**, 191-214.