CCUS Risk Evaluation in the San Juan Basin Using Rock Volatiles Stratigraphy - Identification of Fractures and Lateral Migration Pathways and Implications for CO_2 Injection and Storage

Christopher M. Smith[1], William Ampomah[2], Luke Martin[2], Timothy Smith[1], Patrick Gordon[1], and Michael Smith[1]

[1]Advanced Hydrocarbon Stratigraphy
[2]New Mexico Tech

Abstract

As part of a DOE funded grant to examine the role of faults and other possible communication pathways which may allow injected CO_2 to escape its target storage zones New Mexico Tech (NMT) and Advanced Hydrocarbon Stratigraphy (AHS) have been working together in the San Jan Basin (SJB). The goal of the grant is to demonstrate the utility of new technologies for carbon capture and storage applications with the field work being done used to support NMT's CarbonSAFE program at the Farmington site. The field work will culminate in a well to be drilled later in 2022; while being drilled as a monitoring well, it will be completed such that it could serve as a US EPA Class VI well and inject CO_2 into the Jurassic aged Entrada and Bluff formations. Prior to drilling, Rock Volatiles Stratigraphy (RVS), developed by AHS was used on legacy cuttings from wells in the SJB and the Ute and Barker Dome fields to create an ~8 mile four well transect. RVS gently extracts, identifies, and quantifies over 40 volatile compounds from rock samples that can be fresh or several decades old; compounds include the $C_{1\text{-}10}$ hydrocarbons (HCs), water, CO_2, and several sulfur species among others. The RVS analysis of the cuttings from the Jurassic section of Kirtland 1, drilled in 1961, revealed previously unknown fractures containing HC liquids, most likely condensate. The fractures in the Jurassic were charged by three different pulses of increasingly mature HCs with the most mature charge possibly matching the API gravity of Paleozoic production from the relatively close Hogback Field. The SJB and the Ute Dome Field (UDF) are separated by the Hogback Monocline (HM) fault (which may possibly be a fault/fold system) with 3-7000' of displacement. The Paleozoic section of Stephenson 1, in the UDF less than a mile away on to the HM, aligns such that Paleozoic HC liquids on the HM could laterally charge the fractures in the Jurassic on the SJB side of the fault. The chemical composition of the HC liquids in the Paleozoic section Stephenson and Kirtland share similarities re-enforcing this mechanism. The Jurassic section of the Stephenson also shows HC liquid filled fractures that are vertically too removed to be charged by the Mancos shale in Stephenson but would reasonably be charged via lateral fractures from the Mancos in the "downthrown" SJB. These RVS data demonstrate lateral communication across the HC. Other RVS signatures from Stephenson document vertical gas migration. Other features of the transect will be discussed, but this study has uncovered a previously unknown potential migration conduit for CO_2 to escape the target injection zone along - lateral fractures in the Jurassic section of the SJB that lead back to the HM fault where CO_2 may come to reside in the shallower Dakota formation gas fields. It is yet unclear if the CarbonSAFE well will encounter these fracture networks – if the well has been drilled and RVS data are available these will be discussed too.

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