

Testing of Subsurface Samples for Reactivity with Carbon Dioxide, Kemper County, Mississippi

Anh Nguyen¹, Lauren Beckingham², Christopher Kyler³, Brenda Kirkland¹

¹Mississippi State University; ²Auburn University; ³Sunburst Consulting, Inc.

9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

The objective of this study was to test for reactivity with carbon dioxide in cuttings of previously untested shale units and the Pennsylvanian unconformity from the well MPC 10-4 in Kemper County, Mississippi. Samples were taken at depths of 4,480 ft (Big Fred Sand, near base), 4,520 ft (Washita-Fredericksburg Shale), 4,580 ft (Washita-Fredericksburg Shale), 5,140 ft (Lower Paluxy), and 5,380 ft (Pennsylvanian unconformity). One sample of glauconite from central of Texas was also tested as a control. The batch experiments for the shale-CO₂ reaction were in 100 ml hydrothermal autoclaves with Teflon liners. The synthetic fluid was made with concentrations of 0.5 M NaCl and 0.25 M CaCl₂. In each autoclave, 2 g of the disaggregated rock were placed in the liner, then 40 ml of the fluid was added. In the last step, 5 g of dry ice were added, and the autoclaves were closed immediately. After 34 days of reaction at 124 degrees Celsius, the sample was cooled down to room temperature. The solid products and fluid were separated for SEM-EDS, XRD and ICP-OES analysis. XRD analysis of the sample from MPC 10-4, 5,380 ft before and after reaction with CO₂ suggested the formation of new minerals as a result of reaction of the sample with carbon dioxide. Original minerals seen with XRD were: quartz, illite, and muscovite while thin sections of cuttings included carbonates and metamorphic rock fragments. After reaction, XRD data revealed the presence of the unusual minerals bustamite, foshagite, and vermiculite based on the software database. Petrographic study of cuttings from this depth revealed that they were lithologically extremely diverse and it is possible that gypsum, bustamite, foshagite, and vermiculite may all be products of reaction with CO₂. SEM images showed no evidence of reaction of the rock samples from MPC 10-4, at the depths of 4,480 ft,

4,520 ft, 4,580 ft, 5,140 ft, or in the glauconite control. Although there was no change in morphology of the grain surface, the alternation of brine chemistry was seen with ICP-OES analysis with the presence of Na⁺, Ca²⁺, K⁺, Mg²⁺, Si⁴⁺. SEM images of the sample from 5,380 ft (Pennsylvanian unconformity) include what appear to be gypsum rosettes coating much of the surface of the sample. Southern Company - Mississippi Power hosted the drilling site for this study. This material is based upon work supported by the Department of Energy National Energy Technology Laboratory under the Southern States Energy Board's Cooperative Agreement Award Number DE-FE0029465.