Geomechanical Assessment of Fractured Cambrian-Ordovician Reservoirs in Northern Appalachian basin for Carbon Storage

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Abstract

The Cambrian-Ordovician age Conasauga and Knox Groups constitute a regional succession of carbonates punctuated by brief periods of clastic deposition. Diagenesis and a history of multiple orogenic events contributed to the development and distribution of a complex fracture system. Understanding the distribution of the developed fracture network in the region is of significance in screening location for CO2 storage. In this study, we seek to understand natural fracture distribution on the western flank of Northern Appalachian basin and the implications for injecting CO2 into the fractured reservoir. Geomechanical assessment of fracture system in the study area was determined from integrating density log. Natural fracture observations were interpreted on the newly acquired image logs collected at multiple well locations ranging in depth from 375m to 1430m. Results of observations were used to study fracture intensity variation from west to east of the studied area. Using the structural parameters of the observed natural fractures and well bore failures observed from image logs, we assessed the likelihood of observed fractures to slip under current stress conditions using 3D Mohr circle analysis. Multiple scenarios were modelled for injecting CO2 at varying pressure to understand slip likelihood. Study on fracture intensity variation shows formations on the western part of the studied area are more fractured and may be more suitable for CO2 storage. Critically-stressed fracture analysis shows the natural fractures are not critically stressed in the current state but some of these fractures have the potential to slip at elevated pressures.

Objectives

In this study, the aim was to use resistivity and acoustic image log data to co-localize observed bore induced and natural fractures within the Cambrian-Ordovician carbonate reservoirs and evaluate the spatial distribution of natural fractures within individual geologic units. Open natural fractures are sometimes present in carbonate reservoirs and could act as storage space for CO2 as well as good fluid conduits that could enhance the injectivity of CO2 into storage aquifers. While the presence of natural fractures in carbonate reservoirs has been determined from integrating density log. Natural fracture observations were interpreted on the newly acquired image logs collected at multiple well locations ranging in depth from 375m to 1430m. Results of observations were used to study fracture intensity variation from west to east of the studied area. Using the structural parameters of the observed natural fractures and well bore failures observed from image logs, we assessed the likelihood of observed fractures to slip under current stress conditions using 3D Mohr circle analysis. Multiple scenarios were modelled for injecting CO2 at varying pressure to understand slip likelihood. Study on fracture intensity variation shows formations on the western part of the studied area are more fractured and may be more suitable for CO2 storage. Critically-stressed fracture analysis shows the natural fractures are not critically stressed in the current state but some of these fractures have the potential to slip at elevated pressures.

Study area

The study area is located on the western flank of northern Appalachian basin within central to eastern Ohio.

Natural fracture interpretation & analysis

Ten resistivity and acoustic log images were collected within the Cambrian-Ordovician interval. The logs were interpreted to identify natural fractures and well-bore features. Examples of interpreted natural fractures are shown in figures 3 and 4.