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TITLE: Petrophysical and Mechanical Properties of Fractured Aquifers in the Northern Newark Basin: Implications for Carbon Sequestration

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ABSTRACT BODY: One of the key factors in predicting the performance of low-permeability fractured reservoirs is a detailed understanding of the in-situ state of stress and the distribution and orientation of natural fractures and faults. In this study we analyze borehole geophysical data from a deep characterization well in the northern Newark Basin, a candidate CO_2-storage site, and provide petrophysical and geomechanical characterization of fractured sedimentary and igneous formations. Previous studies in the northern Newark basin demonstrated no unique relationship between hydraulic conductivity and degree of fracturing, fracture apertures or orientation. Therefore, in the absence of hydraulic testing data predicting fracture behavior under CO_2 injection condition presents a significant challenge for baseline formation characterization. Moreover, fluid injection in deep wells can cause reactivation of existing faults or new fracture initiation due to significant increase in the pore pressure. We analyze electrical resistivity images and full-wave sonic data to constrain the state of the current in-situ stress in the northern Newark basin, and to evaluate how the interaction between in-situ stress and the distribution and orientation of natural fractures influences their hydraulic properties. We then combine it with the full suite of wireline logs to describe petrophysical, hydraulic, and geomechanical properties of the fractured aquifers at the locality.

The Sandia Technologies, LLC Tandem Lot #1 geologic characterization well (Rockland County, NY) is about 6,800 ft deep and transects Triassic terrestrial sediments and the Palisades diabase sill that are both characterized by abundant natural fractures. A suite of standard wireline logs, high-resolution electrical resistivity images and full-wave sonic data were collected in the borehole but no hydraulic data or in-situ stress estimates are available. Borehole breakouts are clearly observed in the resistivity images in distinct sedimentary layers and strike predominantly SSE-NNW. In the Palisades sill breakouts are absent but the wellbore is consistently enlarged by up to 4 inches in the SE-NW direction (nominal hole diameter is 8.5 in). Drilling-induced tensile fractures and drilling-enhanced natural fractures appear in the tensile quadrants striking NE-SW. Preliminary analysis of sonic wavefields also suggest the NE orientation of the fast shear azimuth. For a vertical borehole these factors indicate maximum horizontal stress in the NE-SW direction, and are consistent with earthquake focal plane solutions and previous stress direction estimates in the Newark Basin. Borehole images also provide an excellent tool to describe natural fracture distribution and orientation. Combined with other petrophysical data such as core-calibrated density log, elastic moduli and stress-induced shear-wave anisotropy indicator, they allow to constrain geomechanical properties of the formation and to predict fracture behavior for potential CO_2 injection conditions.

KEYWORDS: [0915] EXPLORATION GEOPHYSICS / Downhole methods, [8168] TECTONOPHYSICS / Stresses: general, [1859] HYDROLOGY / Rocks: physical properties, [1699] GLOBAL CHANGE / General or miscellaneous.

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