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Technical Conference Paper

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United Brine Services Company, LLC[(1)] ; Baker Hughes[(2)]

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Abstract

Interest in salt cavern evaluation has grown in recent years with the emergence and rapid growth of new green energies. Due to increasing demand for cleaner energy sources additional subsurface storage capacity will be required to accommodate such production. Despite progress in terms of operational expertise, there remains significant opportunity to improve the geological, geochemical, and geomechanical analysis and techniques given the internal structural complexity and lithologic heterogeneity often associated with salt formations.

The limited ability of surface seismic data to resolve the internal details of a deformed salt deposit coupled with the scarcity of whole cores and subsequent core analysis, often limit the sophistication of subsurface geologic characterization, especially where existing well data is limited. The use of cross-dipole shear acoustic measurements such as deep reflectivity shear image (DRSI) in combination with borehole imaging logs has been shown to detect detailed subsurface structures and reduce the uncertainty related to the scale of measurement. Moreover, 3D representation using geomodelling software provides a detailed view of the subsurface in the vicinity of the wellbore and significantly increases the understanding of key structural elements by building a conceptual model representing the near-wellbore region.

The current case study in a highly deformed bedded salt formation of Mississippian Age located in Saltville, Virginia aims to integrate all the available information from two wells separated by approximately 140 ft. (42.8 m) and to build a robust description of the subsurface area around these two wellbores. There are approximately 34 wells in the current high-pressure field, drilled between 1930 to 2023. The field is currently used to mine brine for United Salt Saltville, LLC and for gas storage by Enbridge in salt cavern galleries.

The Maccrady Formation which is comprised of highly deformed, intermixed mudstone, anhydrite and salt is bounded at the top by the ENE-WSW trending regional Saltville thrust fault, that overthrusts Cambrian carbonates over the Mississippian salt-bearing strata.

In this case study, two closely spaced wells penetrated the salt formation with the intention of solution mining a gallery connecting the two wellbores. Mineralogic, resistivity borehole imaging and cross-dipole acoustic logs were acquired and provide a detailed characterization of the near-wellbore formation up to 100 ft. (30.5 m) from the borehole in one of the wells, while mineralogy and resistivity borehole imaging was acquired in the other well drilled a few years earlier, which describe the evaporitic deposition, affected by tectonic processes. A 3D schematic representation of the area was proposed highlighting a main zone with planes of preferred dissolution intersecting the wells and striking E-W. Further 3D data integration and correlation between the wells confirm the extension of this planes of preferred dissolution that will influence gallery development between the two wells and help anticipate cavern geometry during brine mining.

The results from this study will help to build a more reliable subsurface geologic model not only in the vicinity of the two wells but will also help improve the overall understanding of the poorly known internal details of this highly deformed and complex salt deposit to better understand salt distribution, assist with cavern development, site new caverns, and manage geologic risk.

Key words: bedded salt deposit, salt caverns, Appalachian Basin, Virginia, geology, well logging