

Geologic Characterization for CO₂-EOR Simulation: a Case Study of the Farnsworth Unit, Anadarko Basin, Texas

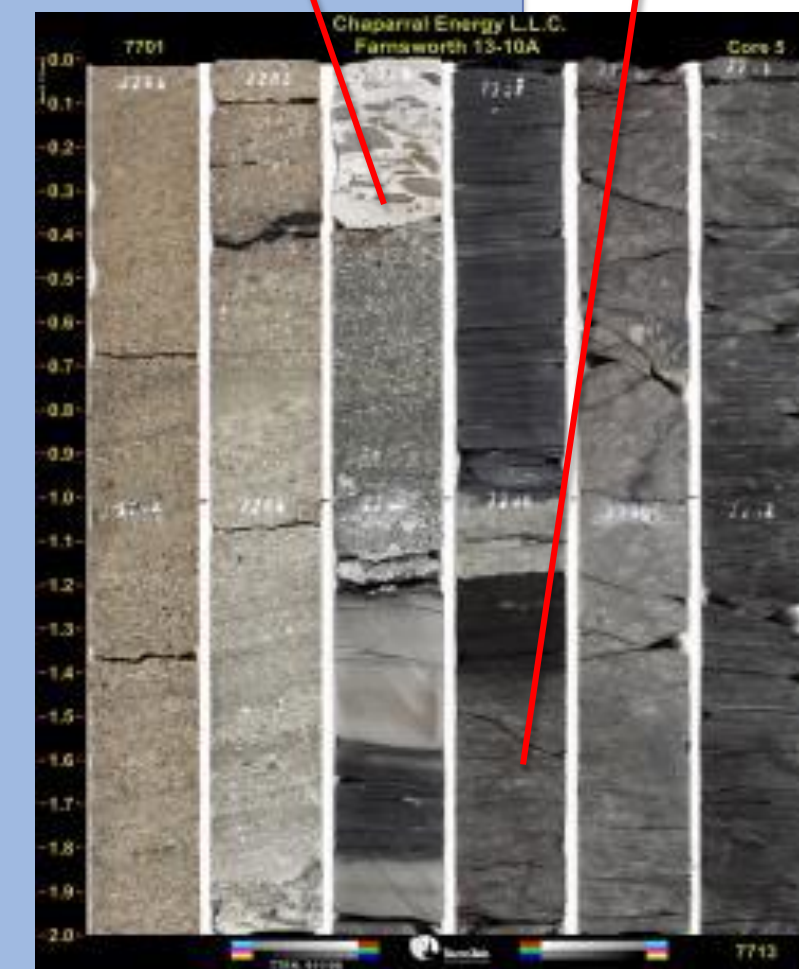
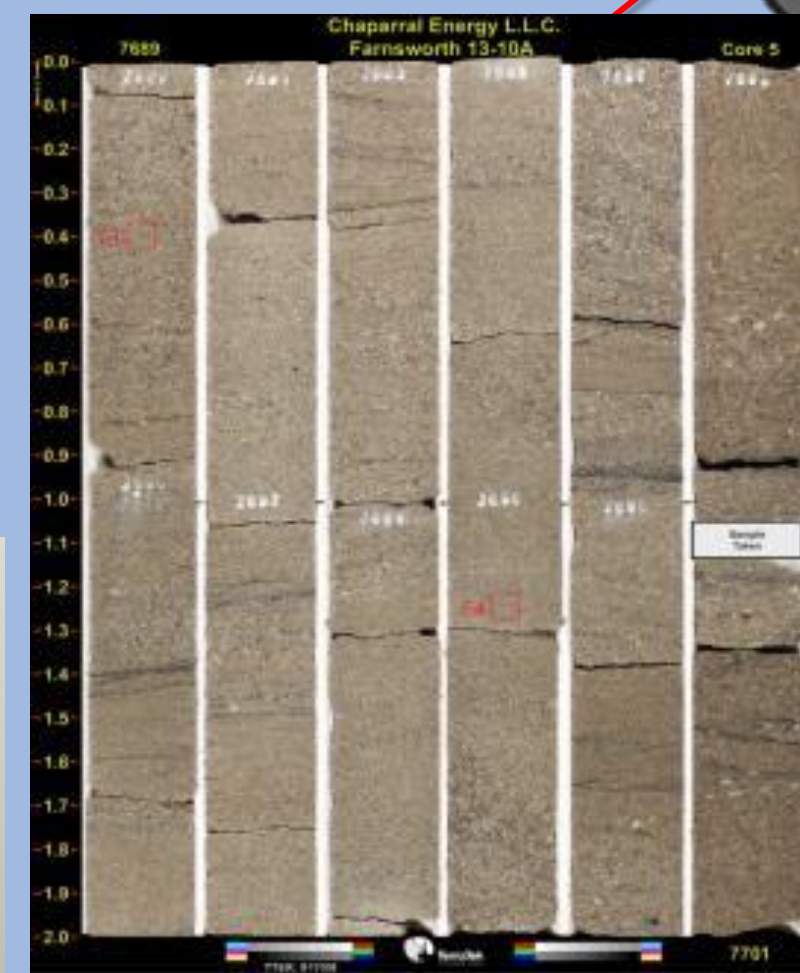
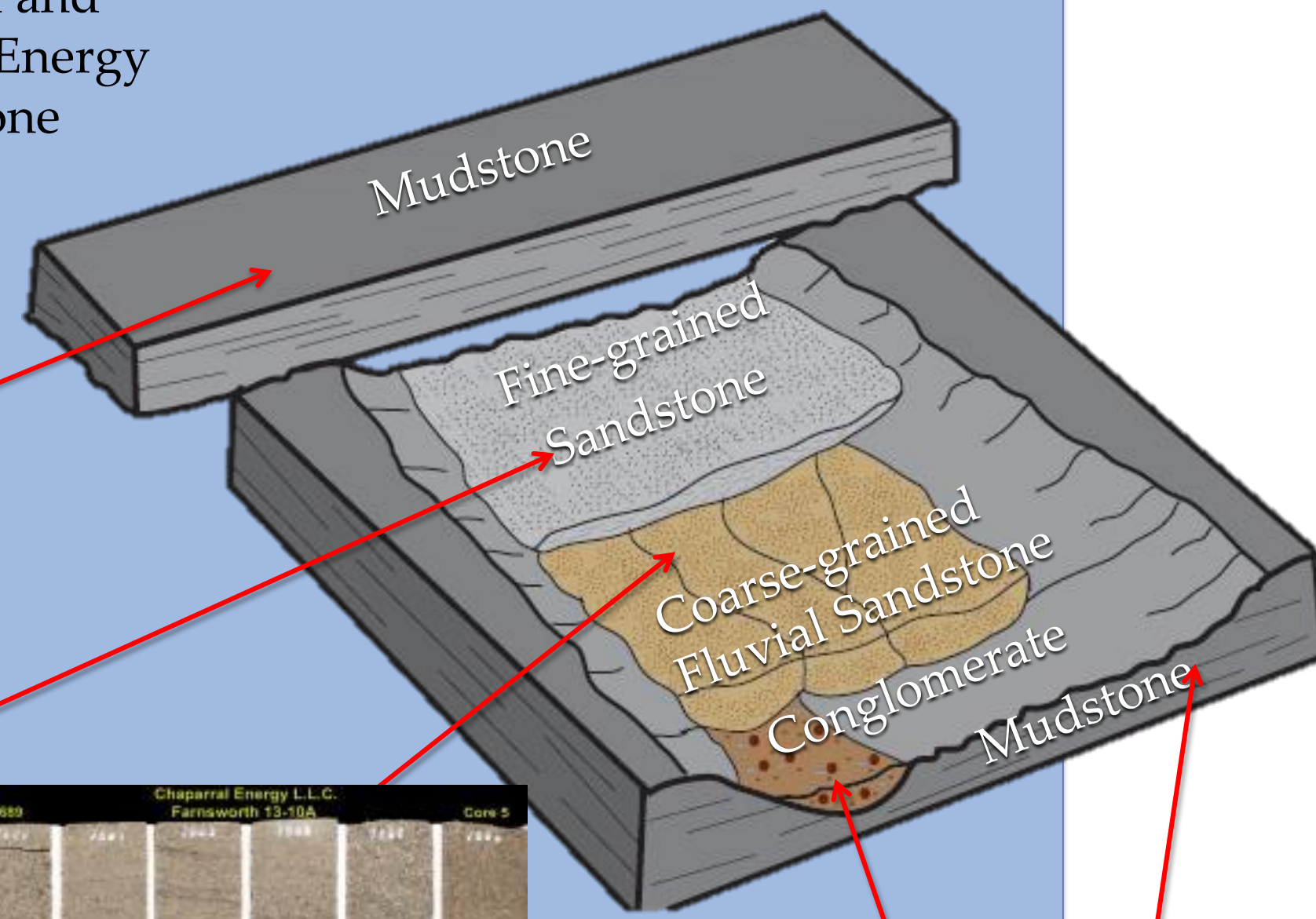
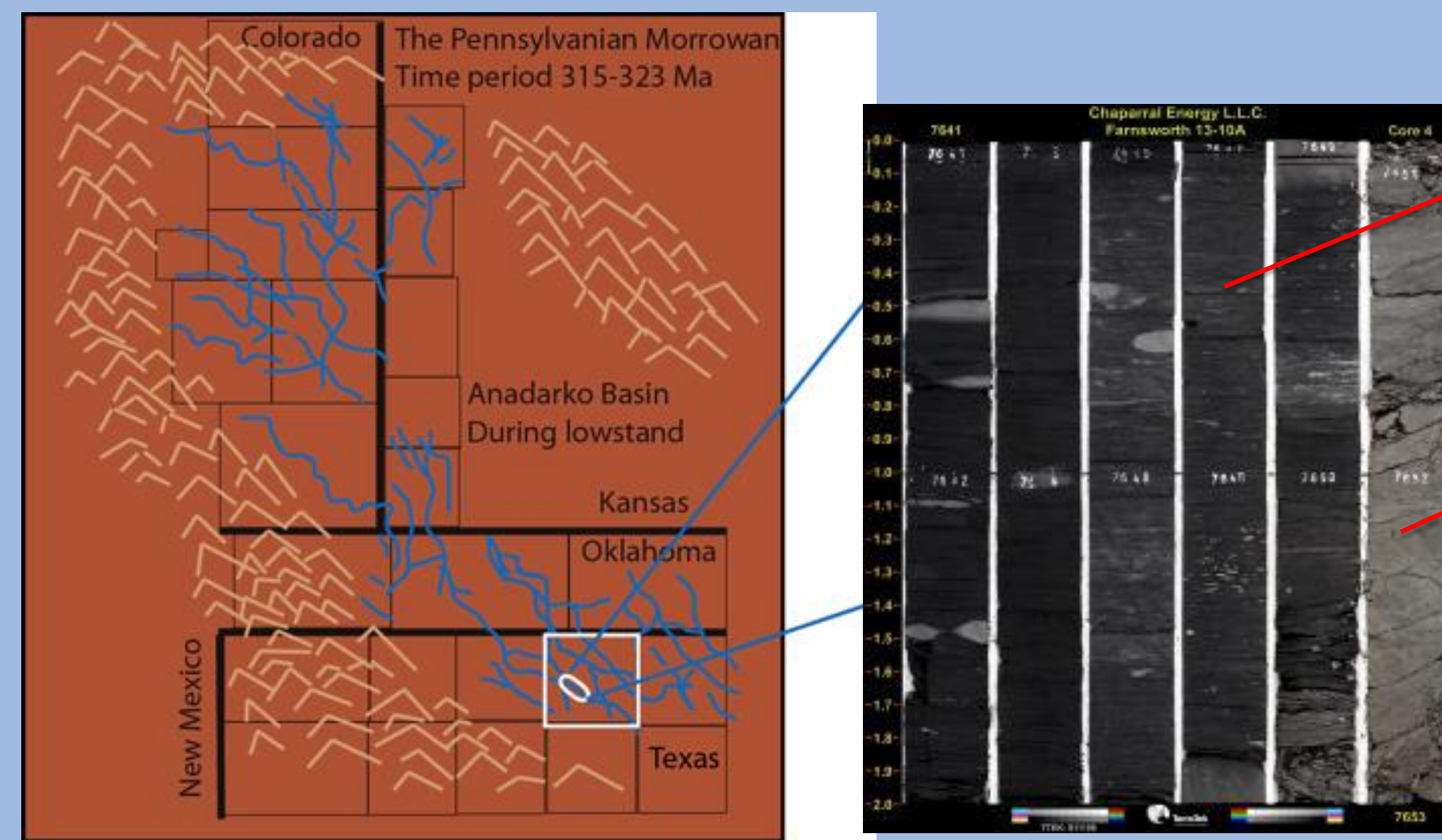
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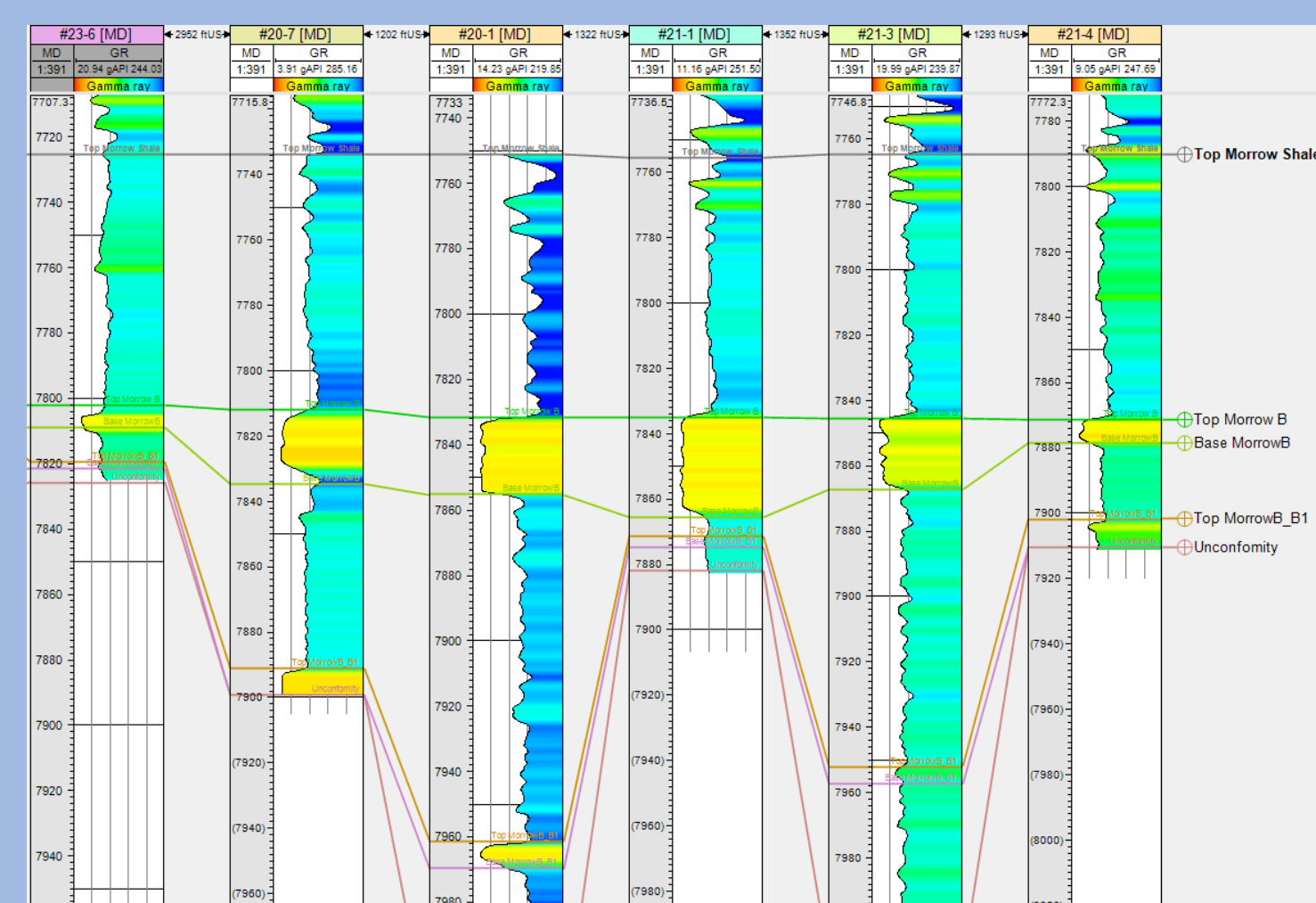
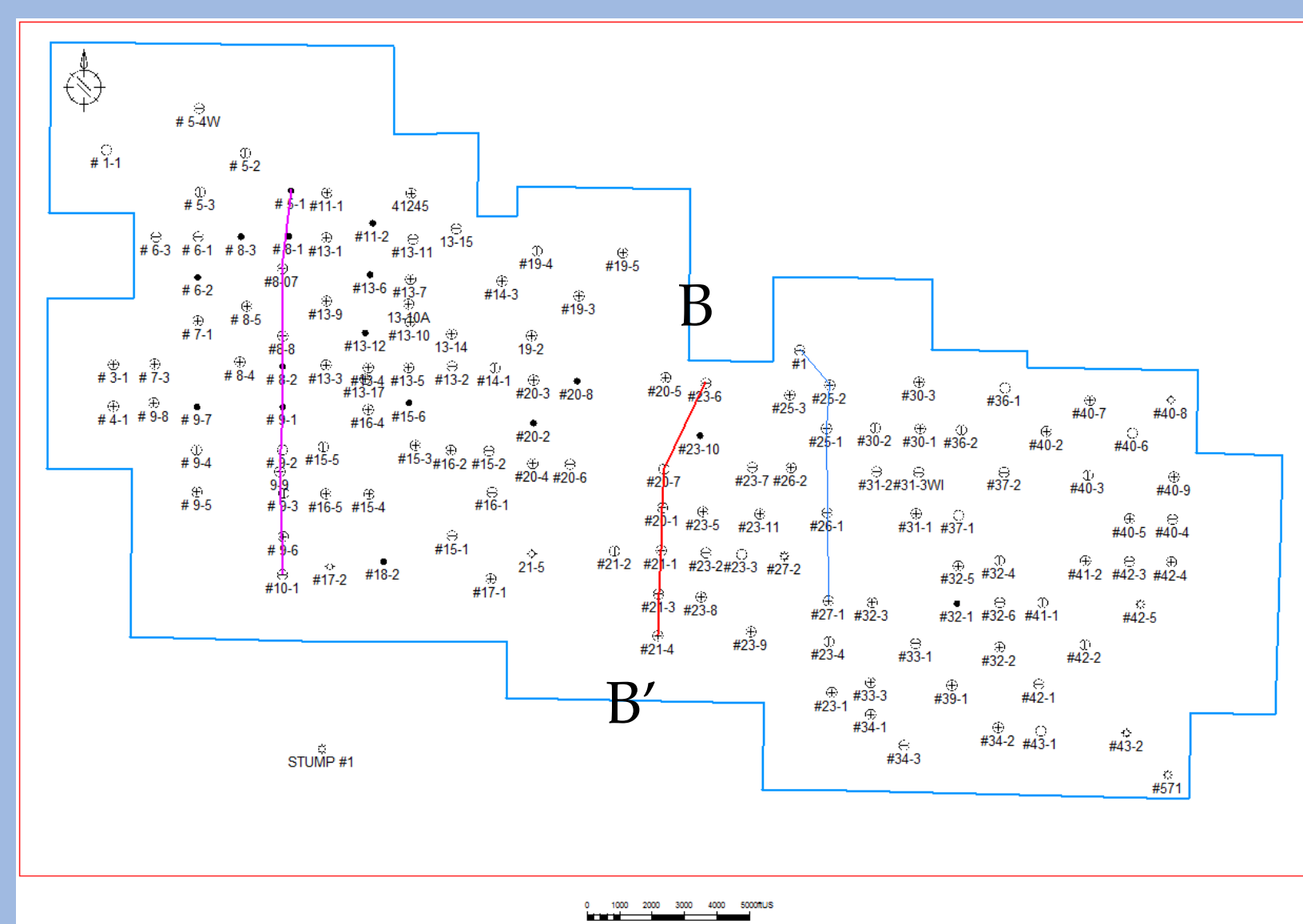
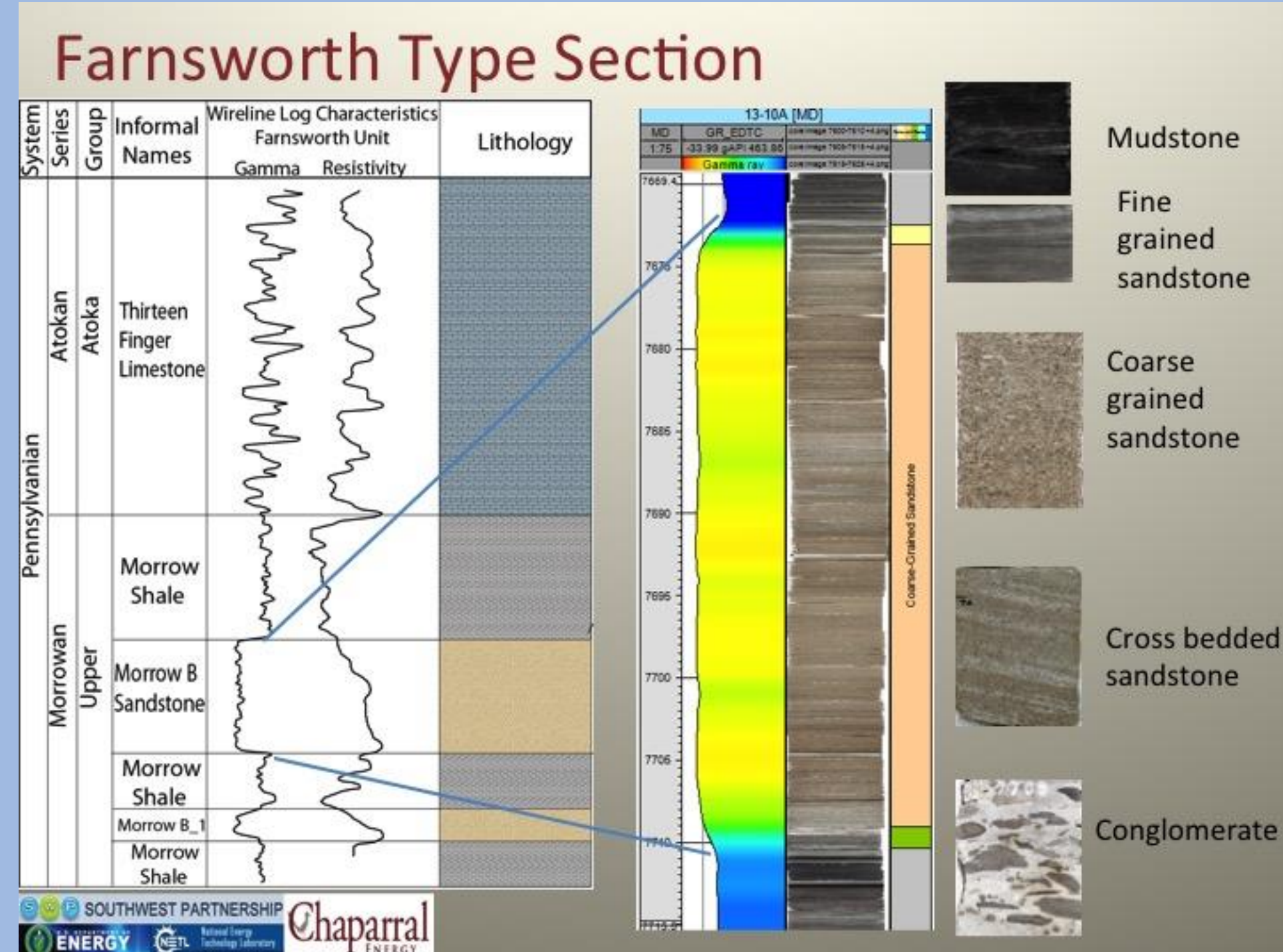
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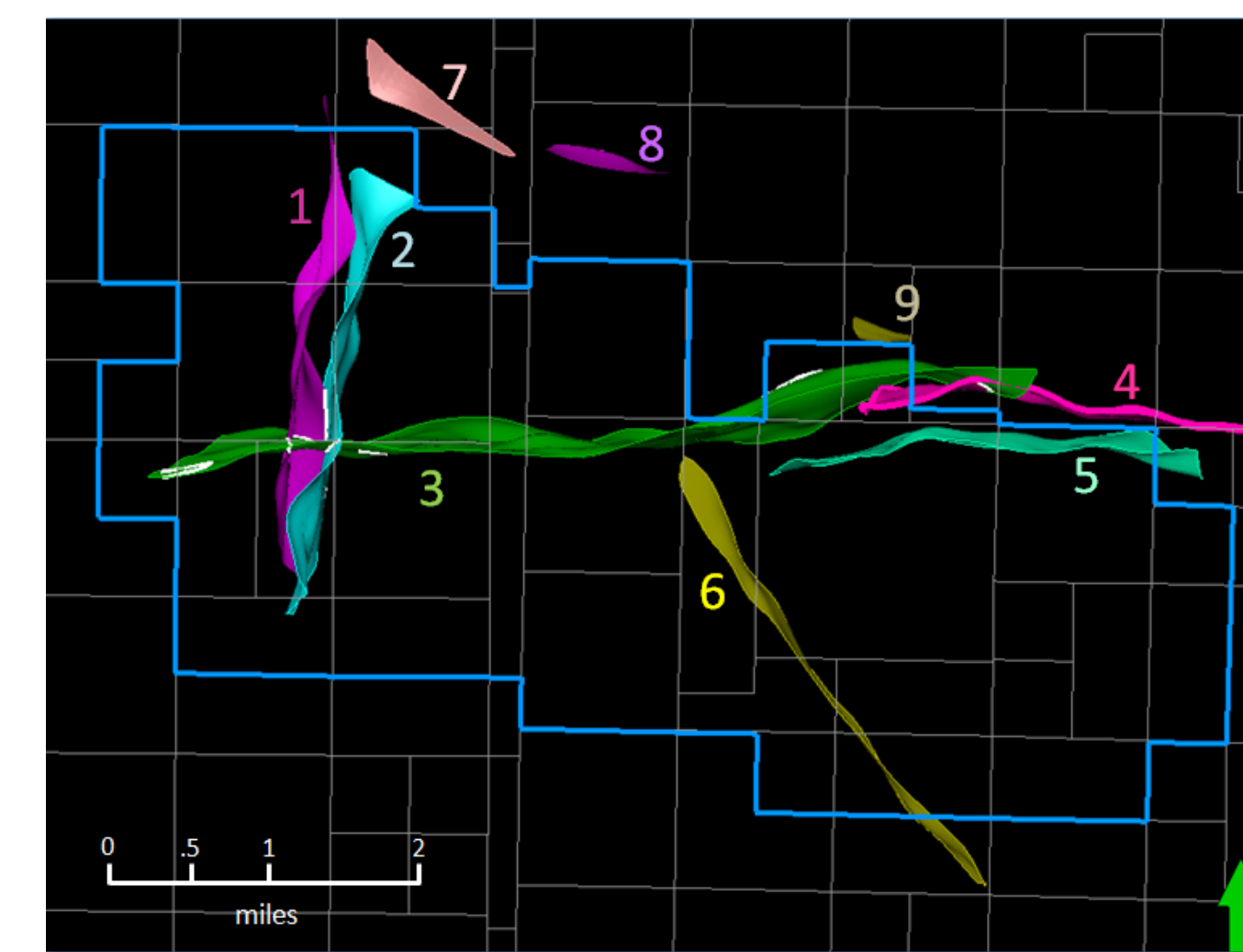
The numerous hydrocarbon reservoirs of the Pennsylvanian Morrowan sequence of northwest Texas through southeast Colorado present an opportunity for carbon dioxide (CO₂) enhanced oil recovery (EOR) and carbon sequestration. The Farnsworth Unit (FWU) of Ochiltree County, Texas, operated by Chaparral Energy L.L.C., is the site of a CO₂-EOR project using anthropogenic CO₂ and a Southwest Regional Partnership on Carbon Sequestration carbon capture, utilization and sequestration project sponsored by the Department of Energy's National Energy Technology Laboratory. The target reservoir is the upper Morrow sandstone (Morrow-B).



Core data and descriptions, electric logs from legacy and new science wells, and thin section petrography were all used to refine the interpretation of depositional setting and reservoir architecture of the Farnsworth. Cores and associated thin sections provided information on mineralogy, provenance, diagenetic history, depositional environment and porosity types. Originally interpreted as a fluvial-deltaic reservoir, the improved model is that of an incised valley fill sequence.

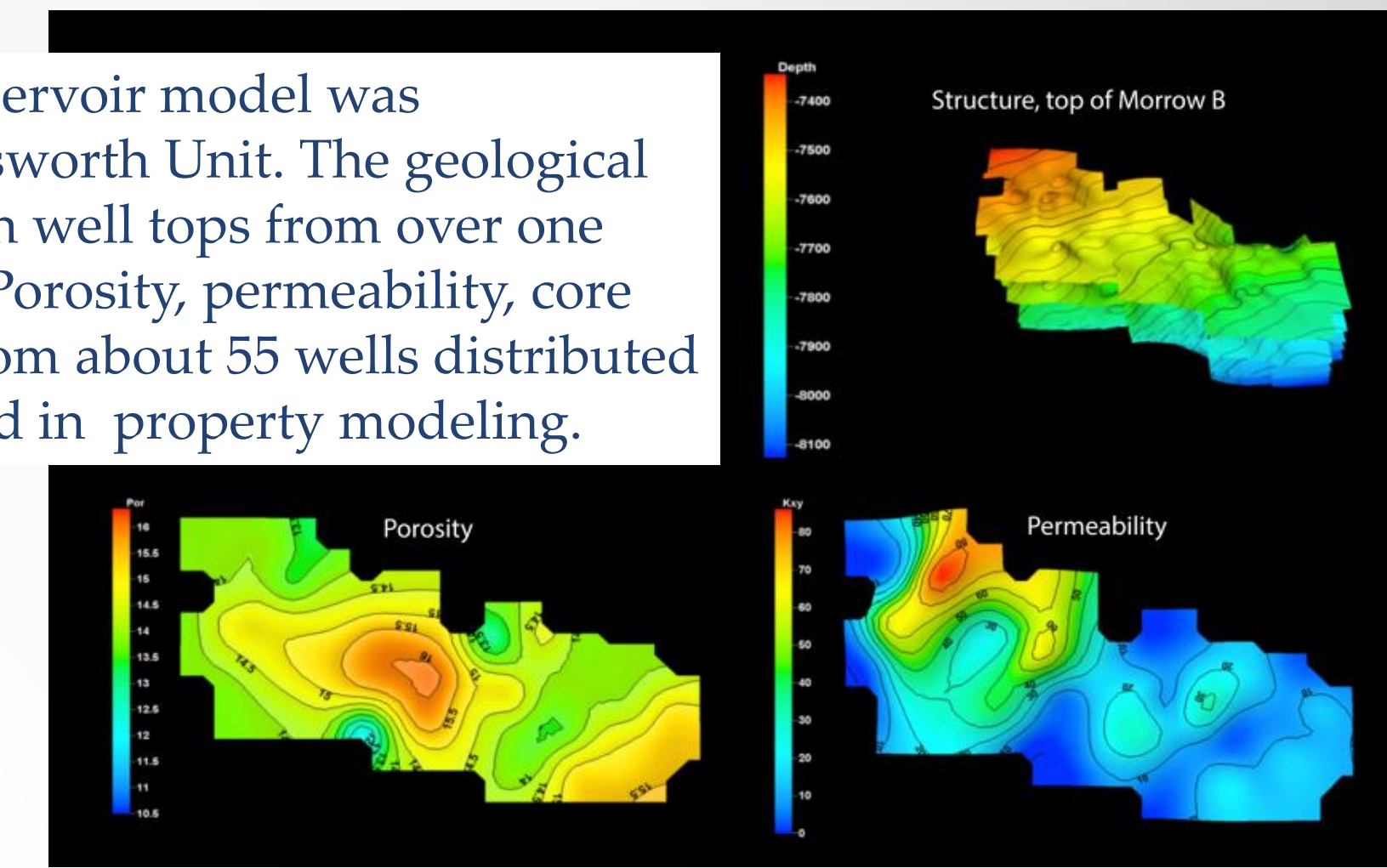


Cross-section B-B' hung on the Morrow Shale, showing the channel shape extending across the field.

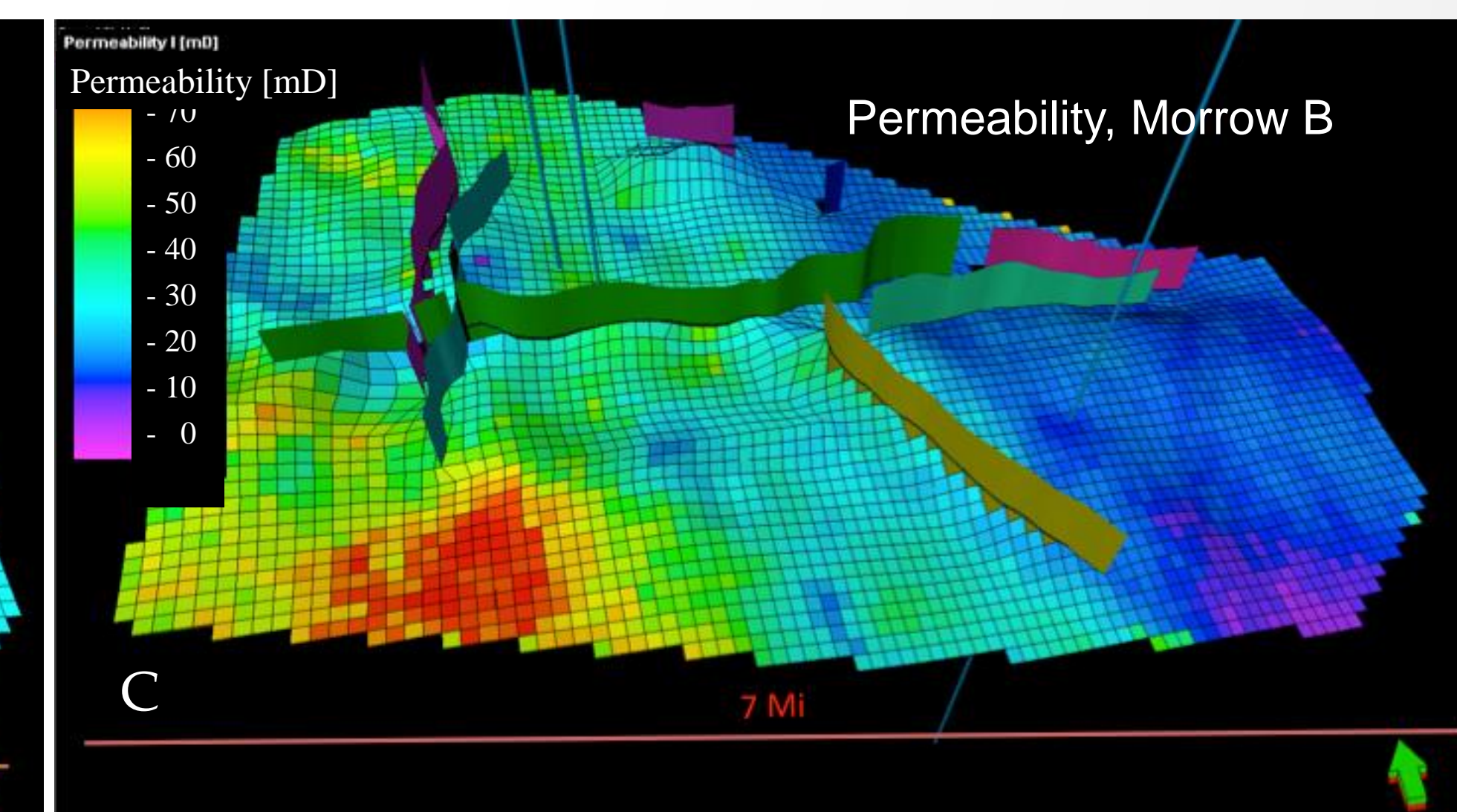
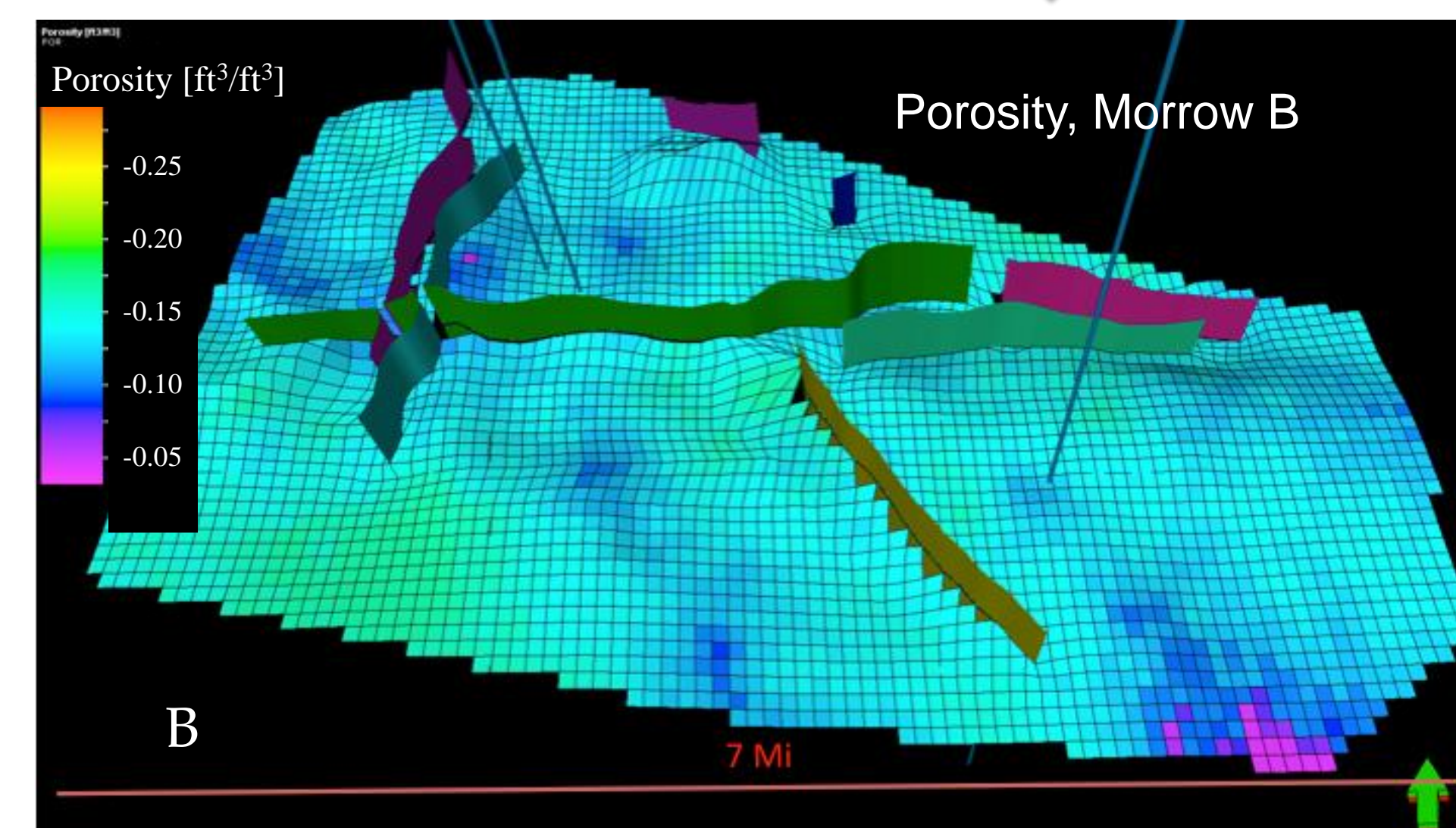
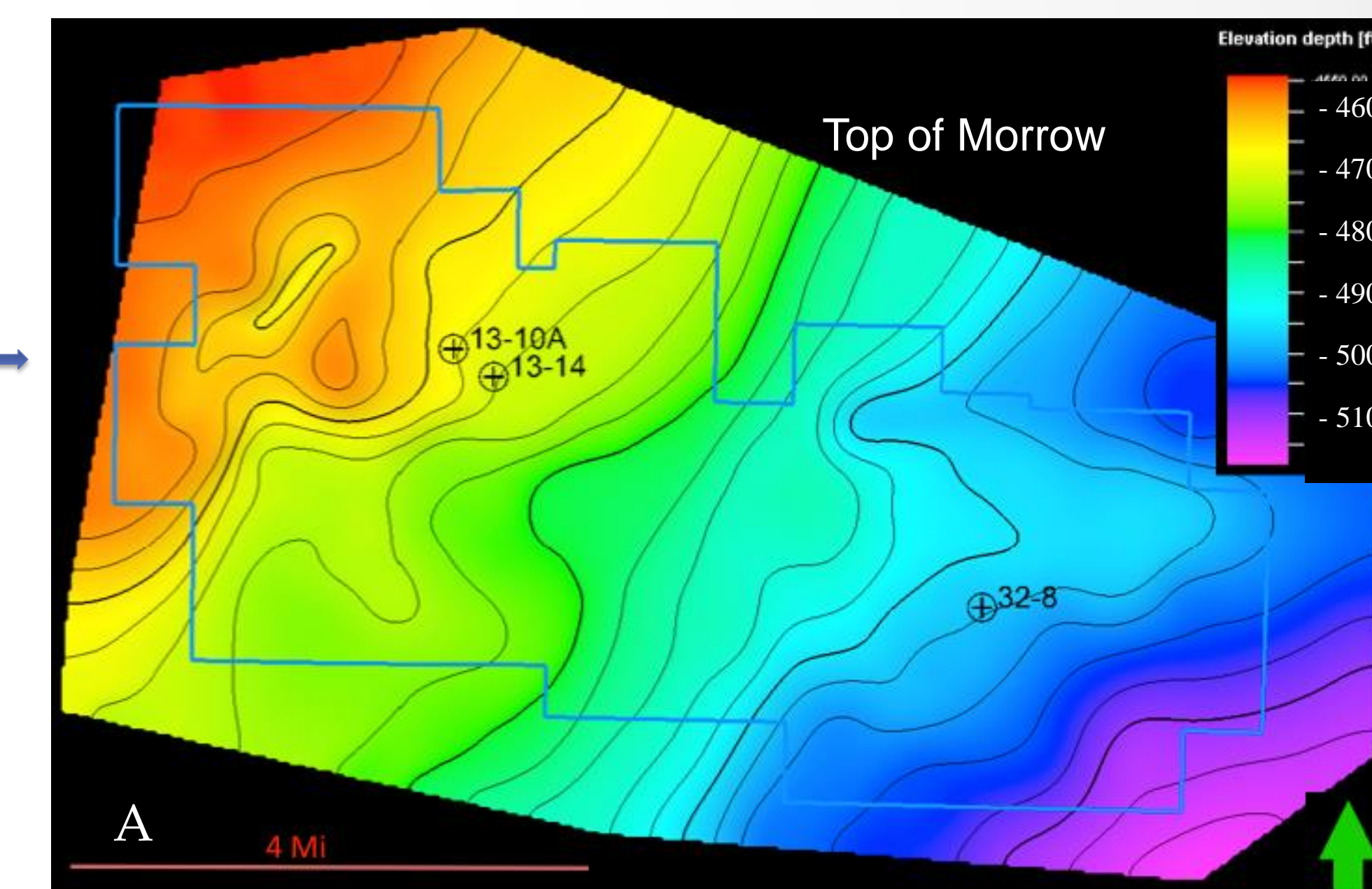


Forty-eight wells with permeability and porosity core data were then used for property modeling. In addition, 7 wireline logs were interpreted for porosity and incorporated into the modeling. A variety of geostatistical techniques were used to populate reservoir rock properties and quality checks helped ascertain which geostatistical technique resulted in the best property distribution. The lithofacies-based geologic model was successfully used to constrain the porosity and permeability distributions. The quality check procedure ensured the well log and core data were honored in the property modeling.

In 2014 a preliminary reservoir model was constructed for the Farnsworth Unit. The geological model was built based on well tops from over one hundred wells in FWU. Porosity, permeability, core and wire line log data from about 55 wells distributed across the field were used in property modeling.



A new 3D seismic survey was used to improve the preliminary reservoir model. Several faults that were previously unknown were interpreted from the seismic data – fault traces are shown on the figure at left. Time to depth conversions also allowed refinement of the geologic model. Compare figures above (preliminary), with those below (most recent) that show the results of the most recent fine-scale property modeling.



Structure (A), porosity (B), and permeability (C) of FWU based on refined geological and property modeling that incorporates log and seismic data. The straight blue subvertical lines in B and C are representations of the well bores for three new wells drilled and cored by SWP as shown in A.

The geological model was upscaled for numerical flow simulation. A history match of the waterflood was constructed as the basis for the CO₂-EOR study. The performance of the current CO₂-flood patterns was analyzed and optimized for CO₂ storage and EOR. The results from the simulation show a great potential for CO₂ storage and prolific oil production from the FWU.

