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Using Modern Cave Systems as Analogs for Modeling Paleokarst Reservoirs

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Surveys of modern cave systems provide useful analogs for understanding paleokarst reservoirs. The geometry and scale of modern caves can be keys to interpreting subsurface paleocave systems known only from their log signatures, drilling histories, or seismic character. Predicting the location, spatial distribution, or internal geometry of paleokarst reservoirs requires reconstructing paleohydrology within realistic stratigraphic and structural bounds. Simulation of paleocave reservoirs can be used to help make significant investment decisions in well design, well spacing, and injection strategies.

Modern karst systems are complex, but not random. Most originate by flow of meteoric water from a recharge area to a discharge area. Others develop by tidal pumping, or from deep acidic sources. The porosity pattern that evolves is a function of structure (material properties, hydrologic boundaries, and fractures), process (physical & chemical), and time. Following burial, collapse, compaction, and mineralization modify the original cave geometry.

Cave collapse creates interconnected fracture networks and cave-fill breccias that may expand to several times the diameter of the original cave passages. Productive wells need not penetrate the initial cave, so long as they intersect the connected volume of the coalesced, collapsed cave system.

Embedding single caves and high-connectivity cave systems in flow simulation models adds little porosity: surveyed caves occupy only 0.04 to 3.51% of the gross rock volume surrounding them. Permeability, however, may be greatly enhanced. Additive permeability factors to account for caves and fissures can assist in quantifying drilling risk, forecasting well performance, and predicting injection breakthrough pathways.