CREATING A 4D MODEL OF FRACTURE AND FAULT DEVELOPMENT WITHIN THE ARBUCKLE MOUNTAINS, OKLAHOMA

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ABSTRACT

Fractures, faults, and fault zones are ubiquitous features in regions of folded and uplifted rocks. Their occurrence is relevant to hydrocarbon reservoir and water aquifer studies, as well as seismic hazard analysis. The Arbuckle Mountains, in south-central Oklahoma, provides an excellent natural laboratory to study the spatial and temporal evolution of fractures and faults over a varying range of scales from kilometers to micrometers. The proposed research has three objectives: 1) construct a digital fault and fracture map based on aerial imagery (Google Earth) and field geology that will enable detailed field studies to evaluate the distribution, density, and style of these features along the southern flank of the Arbuckle anticline, a major geologic feature in the southern mid-continent; 2) integrate these data sets into a geo-referenced ARCGIS database that may then be visualized using 3D ARCSCENE software; and 3) use this data set to test the following hypotheses: i) Fracture sets within the Arbuckle mountains predate the folding and faulting associated with the main phase of orogenesis in the region (e.g., the Ouachita Orogeny); ii) fracture characteristics are a function of rock type and may be correlated by rock type across the anticline; and, iii) tectonics associated with the Ouachita orogeny reactivated the preexisting fractures as a function of proximity to regional faults. Faults and naturally occurring fractures play a fundamental role in increasing permeability whether it be in a hydrocarbon reservoir or in an aquifer. The morphology and density of these structures controls how effectively fluids can move through the subsurface and the rate at which they can be extracted or injected. Hydraulic fracturing, or “fracking” in the modern vernacular, is a technique used to extract hydrocarbons by injecting over-pressured fluids into the subsurface thus enabling existing or new fractures to form, allowing the release and migration of hydrocarbons into a well bore. Such a process is also used to re-inject waste water into the subsurface. Critical data that can help in evaluating the nature of permeability pathways in the subsurface include detailed analysis of the spatial distribution and characteristics of fractures as observed in natural outcrops. The Arbuckle Mountains, south-central OK provide an excellent natural lab to evaluate the 4D evolution of fault and fracture networks.

AAPG Search and Discovery Article #90298 2016 Grants-in-Aid Projects