Evidence of Hydrothermal Alteration in the Woodford Shale – Anadarko and Ardmore Basins, Oklahoma

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ABSTRACT

Three Woodford Shale cores, two from the Anadarko Basin and one from the Ardmore Basin, were obtained in order to conduct a diagenetic study and determine the timing of events. The shale is extensively altered and contains a complex paragenesis. Multiple fractures, both early and late, as well as brecciated intervals, are common. Fractures and parts of the matrix contain mineralogies which are interpreted as originating from hydrothermal alteration, including biotite, magnesite, gorceixite, and potassium feldspar. Additionally, there are numerous quartz-filled fractures associated with these altered areas. One core from the Ardmore Basin near the Ouachita thrust zone contains pyrobitumen displaying vitrinite reflectance equivalent (VRE) values of up to 1.57%, equating to alteration temperatures of approximately 210°C. Paleomagnetic analysis reveals the presence of a magnetic component having a south-southeasterly declination and a shallow inclination unblocked at 450°C interpreted to reside in magnetite. This characteristic remnant magnetization (ChRM) is interpreted as a chemical remnant magnetization (CRM) or a thermo-chemical remnant magnetization (TCRM) acquired during the Late Permian. High thermal maturities and the presence of hydrothermal minerals paired with this date suggests that this magnetization originated from post-collisional hydrothermal orogenic fluids from the Ouachita Orogeny (Pennsylvanian to Early Permian), suggesting the Woodford Shale has been an open diagenetic system in its history. This timing agrees with the dating of hydrothermal alteration found within the Ouachita and Arbuckle Mountains. In addition to causing heightened thermal maturities, these hydrothermal fluids both increase porosity through dissolution and decrease it through occluding mineral habits.