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Hydrocarbon-Induced Diagentic Aureoles (HIDA): Indicators of Deeper Leaky Reservoirs

The Permian redbeds overlying some giant oil fields in southern Oklahoma have undergone extensive mineralogical and chemical diagenesis. The diagenetic minerals occur within a distinctly zoned aureole that delineates the oil field. The geometries of aureoles strongly reflect major structural elements that controlled emplacement of hydrocarbons in the underlying rocks. Calcite, ferroan calcite, manganese-rich calcite, dolomite, ankerite, pyrite, and native sulfur are the major diagenetic minerals. The innermost zone of the aureole (Zone 1) is characterized by abundant carbonate cementation and generally coincides with a major fault system. Zone 2 is composed of altered (bleached) redbeds with minimal calcite cement. Pyrite cement (Zone 3) is commonly associated with the carbonate-cemented zones and is disseminated in some bleached sandstones. Zone 4 represents the unaltered redbeds.

δC^{13} values of carbonate cements indicate three major sources of carbon: (1) organic, (2) freshwater, and (3) hybrid (freshwater and organic mix). A mixing model was developed to calculate the proportion of organic carbon in carbonate cement. δS^{34} values in sulfides are similar to those of oils in underlying reservoirs. Formation of diagenetic pyrite is explained by reduction of iron oxides in redbeds by hydrogen sulfide or other organic material associated with hydrocarbons.

Gas chromatography and isotopic analysis suggest oil in shallow Permian sandstones in Cement field leaked from deeper Pennsylvanian reservoirs. Leaky deeper reservoirs supplied oil and gas that formed shallow petroleum accumulations and contributed to the alteration of redbeds. Faults served as conduits that carried leaked hydrocarbons to these shallow rocks.