

An Investigation of Petroleum Systems of the Permian Basin, U.S.A

Hill, Ronald¹, John Zumberge², Dan Jarvie³, Jack Williams⁴ (1) USGS, Denver, CO (2) GeoMark Research, Houston, TX (3) Humble Geochemical Services, Humble, TX (4) Consultant, Tulsa, OK

The Permian Basin, located in western Texas and southeastern New Mexico, USA, is one of the most prolific petroleum provinces in North America, having produced 35 billion barrels of oil, 91 trillion cubic feet of gas and 5.5 billion barrels of natural gas liquids through 1990. Hydrocarbons are produced from reservoirs of Cambrian through Cretaceous age, although most production is from Paleozoic reservoirs. Potential source rocks for Permian Basin oils include the Ordovician Simpson Group, Silurian Fusselman Formation, Devonian Woodford Shale, Mississippian Barnett Shale, a source of Wolfcampian (Permian) age, two facies of the Permian Bone Spring Formation, two facies of Guadalupian (Permian) age, and a Pennsylvanian (?) source. Despite the prolific hydrocarbon production, little published information is available regarding petroleum systems of the Permian Basin. In this study, geochemical data from approximately 400 oils, including biomarker parameters, sulfur content, and saturate and aromatic carbon isotope ratios, were used to differentiate oil types as a first step in defining Permian Basin petroleum systems. Hierarchical cluster analysis and principle components analysis were used to differentiate oil families utilizing the detailed geochemical analyses, and revealed the complexity of Permian Basin petroleum systems. Mixing of oil types is widespread and biodegradation has occurred in some reservoirs. The recent exploration focus on unconventional shale gas resources in the Permian Basin highlights the need for understanding details of the petroleum systems.