Geochemistry of Natural Gas Resources in the Piceance Basin Western Colorado, USA

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Abstract

Conventional and unconventional gas accumulations in the Piceance Basin represent one of the largest undeveloped energy resources in the U.S. today. A recent assessment by the U.S. Geological Survey estimated that there are 66.3 Tcf of technically recoverable gas in the Mancos Shale alone (USGS FS 2016-3030, 2016). Natural gas has been produced from practically every formation deposited during the Late Jurassic to the Eocene somewhere in the basin. Early production was predominately from conventional reservoirs in the Mesozoic (Dakota Sandstone, Morrison Formation, and Mancos “B” unit) and Tertiary (Green River Formation) strata and unconventional coal-bed methane (Cameo-Fairfield group). However, more recent exploration has focused on unconventional tight-gas sand (Williams Fork Formation) and shale gas (Mancos Shale) plays. Recent geochemical studies have indicated that the most important potential sources of Piceance gases include the Cretaceous shales (Mancos Shale and Mesaverde Group) and coals (Cameo-Fairfield coal group), as well as shales in the upper Paleocene (Fort Union Formation). The conventional accumulations were primarily charged by migrated gases dominantly sourced from the Mancos Shale. Gas migration distances likely ranged from 10’s (e.g., Mancos “B” unit) to 1000’s of feet (e.g., Wasatch and Fort Union Formations). In contrast, the tight gas sands of the Williams Fork Formation likely contain a mixture of gases sourced from indigenous shales and coals and gases that migrated from the deeper Mancos Shale source. Recent shale gas production out of the Mancos Shale has been found to be relatively 13C-enriched and dry (low C2+ content). This appears to provide an effective signature for mapping the contribution of gases from the Mancos Shale in shallower reservoirs (e.g., Williams Fork Formation). In general, non-

hydrocarbon gases are present at low concentrations throughout the Piceance Basin. CO2 and N2 are the most abundant (reaching concentrations as high as 25 and 34 mol %, respectively) and H2S is usually undetected. Helium occurs throughout the basin at concentrations below 1% but in many parts exceeds 0.3%, which suggests that there may be economic resource potential.