Natural Gas in the San Joaquin Basin—Geochemical Characterization of the Petroleum Systems

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The Great Valley of California is a petroleum-productive Cretaceous-Paleogene forearc basin located between the Sierra Nevada and Coast Ranges. The north-trending basin is moderately asymmetric with its structural axis shifted to the west. An east-trending (Stockton) arch separates the Great Valley into the Sacramento Basin to the north and the San Joaquin Basin to the south. Gas in the San Joaquin Basin is present in six petroleum systems: two dry-gas systems and four oil and associated gas systems. First, a mixed biogenic-thermogenic gas (169 BCF) of the Winters-Domengine(?) gas system extends southward from the Sacramento Basin. The fields included in this trend start with Chowchilla on the north and extend south to Raisin City. The reservoir rocks are Late Cretaceous to Neogene in age. The largest fields are Gill Ranch at 88 BCF and Chowchilla at 35 BCF. Gas analysis indicates a thermogenic gas system ($^{13}C_1$ of -40 to -34‰) is mixed with varying amounts of biogenic gas ($^{13}C_1$ of less than -60‰) and nitrogen gas of unknown origin.

Second, a dry (C_1/C_1-C_5 of 1.000 to 0.998) biogenic ($^{13}C_1$ of -70 to -58‰) gas system is present in shallow Plio-Pleistocene reservoirs at depths of less than 5000 ft and originally contained about 368 BCF of gas. Some of this shallow biogenic gas in structural traps overlies deeper oil and wet-gas accumulations, and may be secondary biogenic gas generated from oil biodegradation. Trico (201 BCF), Buttonwillow (38 BCF), Paloma (26 BCF), and Semitropic (24 BCF) are fields in this system and reside in the southern San Joaquin Basin.

Lastly, four oil systems with associated wet gas (18 TCF associated with 15 BBO) were generated from the Upper Cretaceous Moreno Formation, Eocene Kreyenhagen Formation, Eocene Tumey shale (industry usage), and Miocene Antelope Shale Member of the Monterey Formation source rocks in the Maricopa and Buttonwillow depocenters of the southern San Joaquin Basin. Stable carbon isotopic ($^{13}C_1$ of -50 to -31‰) and wetness composition (C_1/C_1-C_5 of 0.63 to 0.94) data indicate that the associated thermogenic gases are co-products of oil generation.