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Compartmentation of Oil and Gas Fields: A Geochemical View

Gas and oil fingerprinting techniques allow the prediction of reservoir compartments in a detailed manner not possible with 3D seismic analyses.

Natural gases and oils vary in their chemical and isotopic compositions as a function of their formation and migration history. Compositional and isotopic variations are often caused by mixing of two or more compositionally and isotopically different gases. Isotopic properties in gases can be used to determine the mixing ratio of the two end members and/or calculate the composition of the end members from different mixing ratios. The variation of isotopic properties of gases within a continuous reservoir is generally small, but can be significant between fault blocks of one reservoir or between unconnected but closely stacked reservoirs. Inter-reservoir variations can help solve many of the problems occurring during gas field development and operation.

- **Fingerprinting of Oils and Gases:** Isotope analyses of C_1 to C_4 compounds in natural gases allow a precise correlation of gases through a comparison of their compound isotope patterns (isotopic fingerprints).
- **Reservoir Identification:** Oils and gases in reservoirs of most oil and gas fields exhibit differences between individual reservoirs owing to different filling and mixing histories. In many oil and gas fields, each reservoir can be differentiated from another, but gases within a single reservoir are very similar. Isotope analyses of gases could be helpful in such cases to identify the production zone in new completions.

Reservoir Compartmentalization and Fault Block Mapping: Numerous case histories show subtle compositional changes across sealing faults. Oil and gas analyses can be used to indicate compartmentation into fault blocks. Such variations can be used by field geologists to better define faults and reservoir configurations. Results of a new GRI study show that gas isotope analyses can readily identify production compartments.

Production Allocation: Isotope analyses in commingled production may be used to allocate contributions from individual sands if isotopic differences exist between the gases from the contributing reservoirs. Theoretical mixing curves for two end member scenarios and three end member scenarios will be discussed.

Production Monitoring of Conventional And Horizontal Wells: Production monitoring is a new application of gas isotope analyses that may be particularly valuable for horizontal wells. Isotope variations in the produced gases would reflect variations in the input of different reservoirs. Chevron has developed computer programs that determine the individual contribution of up to five different reservoirs from the analysis of the commingled production.

Biographical Sketch

Martin Schoell received his Ph.D. from the University of Clausthal (Germany) in 1970 and obtained a lecturer degree (habilitation) in 1983 from the University of Bochum (Germany). Martin worked for 13 years at the German Geological Survey on isotope geochemistry of hydrothermal systems and natural gases. He joined Chevron Petroleum Technology Company in 1984 and conducts research and regional studies in petroleum and natural gas geochemistry. He lectures extensively in Chevron on natural gas geochemistry and works with affiliate offices on large regional studies concerning petroleum formation and occurrence in SE Asia and NW Australia. He is editor of many special publications on natural gas and isotope geochemistry and has published more than 70 papers on natural gas, petroleum and bio-geochemistry. Martin won the AAPG best paper award in 1995 and was an AAPG distinguished lecturer for 1996–97. ☐

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