

Multiple Isotope Application in Identifying H₂S Sources

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Abstract

The objective of this study is to use isotope technology to help identify hydrogen sulfide (H₂S) sources in petroleum reservoirs. H₂S is not an uncommon component in petroleum systems. It is important to understand its source and pathway of migration to help deal with it during the operations of petroleum exploration, production, and natural gas processing. There are three main sources, including bacterial sulfate reduction (BSR), thermochemical sulfate reduction (TSR) in reservoirs, and thermal cracking of sulfur-rich kerogen in source rocks. The BSR process occurs where the reservoirs are relatively shallow and cool (e.g., temperature < 80° C), and importantly sulfate-reducing bacteria and sulfate ion (e.g., in formation water, injection water, anhydrite/gypsum, or pyrite oxidation) are available. Commonly, a small amount of H₂S can be generated from the BSR process (e.g., < 3%). H₂S can be released in source rocks during sulfur-enriched kerogen cracking, and can migrate along with hydrocarbon gases to reservoirs. Studies have indicated that the amount of H₂S deriving from source rock is also relatively small (e.g., < 5%). TSR, however, can generate much more H₂ S than the other two processes. The TSR could occur in deeply buried hot reservoirs, where sulfate ion (e.g., anhydrite) is available and the temperature is high (e.g., > 120° C). The method in this study is to use the isotope technology, including multiple isotope analyses of rock, gas, and water samples along with petrographic studies of rock samples. The three H₂S sources are isotopically differentiable, because they have significantly different geochemical reactions at different geological conditions, resulting in different fractionations of isotopes. This study has demonstrated that the isotope technology is one of the most effective approaches to help determine the sources of H₂S in petroleum reservoirs.