

## Investigation of H<sub>2</sub>S Presence in Bakken Production

**Timothy O. Nesheim<sup>1</sup>, Alexander Chakhmakhchev<sup>2</sup>, Bethany Kurz<sup>2</sup>, David Miller<sup>2</sup>, Carol Grabanski<sup>2</sup>, Saptashati Biswas<sup>2</sup>, Marc Kurz<sup>2</sup>, Nicholas Azzolina<sup>2</sup>, and James Sorensen<sup>2</sup>**

<sup>1</sup>North Dakota Geological Survey

<sup>2</sup>EERC

### Abstract

Hydrogen sulfide (H<sub>2</sub>S) is an undesired by-product of oil and gas production in both conventional and unconventional plays. Seemingly randomness of occurrence, unclear geographical and temporal trends, and potential linkage to recent well stimulation practices add complexity to data interpretation and understanding of H<sub>2</sub>S generation mechanisms in the Bakken petroleum system (BPS). Multiple known mechanisms can potentially lead to the occurrence of H<sub>2</sub>S in the production stream of oil and gas reservoirs. These mechanisms can be grouped into several broad categories, including thermogenic, biogenic, kerogen-related, and linked to reservoir stimulation. The goal of this study was to provide insight into one of the potential mechanisms that causes H<sub>2</sub>S generation in the BPS, thereby enabling more effective H<sub>2</sub>S mitigation strategies. Specifically, this work focused on hypothetical H<sub>2</sub>S generation by Madison and Bakken source rocks during the thermal maturation of kerogen. The Madison petroleum system was initially considered a primary source of H<sub>2</sub>S, which is coproduced from Bakken reservoir out-of-zone well completion, which creates fluid communication between the Bakken and Madison reservoirs. Organic-rich samples representing geographical areas with various levels of H<sub>2</sub>S concentration in the Williston Basin (Divide, McKenzie, Dunn, and Bottineau Counties), stratigraphic units (Bakken and Madison), and a wide range of maturities were collected to investigate cracking of kerogen during source rock maturation as a possible mechanism of H<sub>2</sub>S generation in the BPS. The Rock-Eval 7S method did not indicate elevated levels of total sulfur and organic-linked sulfur in the organic-rich rocks selected for this study, refuting an initial hypothesis of Type II-S kerogen presence in the BPS or in the overlying Upper Lodgepole/Lower Mission Canyon rocks. In addition, the H<sub>2</sub>S-producing areas of Divide County did not show a higher content of total organic sulfur in source rocks of the Bakken Formation or Madison Group. However, there were visible differences in source rocks including 1) distributions of saturate biomarkers, sulfur-containing benzothiophenes, and 2) contents of carbonate material and pyrite-linked sulfur. Low- and high-temperature pyrolysis of organic matter proved that the source rocks included in this work have immense potential to generate significant concentrations of H<sub>2</sub>S via thermal breakdown. However, the sulfur-isotope ( $\delta^{34}\text{S}$ ) values of the pyrolysis gas did not match those measured in the H<sub>2</sub>S of a sizable group of producing wells included in this study, suggesting that the thermal cracking of the organic matter of the source rocks was not the only contributor to H<sub>2</sub>S generation in the production. It is likely that the current presence of H<sub>2</sub>S in the Bakken reservoir is primarily due to other mechanisms of H<sub>2</sub>S generation such as thermochemical sulfate reduction or/and chemical reactions triggered by injected stimulation fluid.