Geochemical and Biological Effects of Oil and Gas Wastewater Releases

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Liquid wastes produced during development of oil and gas (OG) resources pose potential risks to water quality and the health of organisms, including humans. Analysis of data from spills reports from 2008-2015 for North Dakota, USA, revealed >8,000 spills that constituted over 20-million gallons of waste fluids. Researchers from USGS and collaborators are conducting interdisciplinary environmental studies at laboratory to regional scales to understand the environmental effects of OG wastewater releases. We are 1) characterizing geochemical composition of OG wastes; 2) studying geochemical alterations of water, soil, and sediments from OG wastewater-impacted sites; 3) defining compounds of potential aquatic and human health concern and constituents that could serve as tracers of waste materials in the event of a release to the environment 4) employing geophysical techniques to trace movement of potential contaminants, and 5) conducting in-situ and lab investigations of biological responses to field spill conditions. Our approach includes characterization of reactive and potentially toxic components of OG wastewater and examination of field sites where releases have occurred. To track materials from releases, we developed analytical methods for trace hydrocarbons, used stable and radioactive isotopes, and characterized microbial communities as a proxy for ecological disturbance. Our field-based studies include watershed-scale investigations of impacts from drilling activities in Pennsylvania, a large wastewater spill in North Dakota, legacy wastewater disposal activity in Montana, and a wastewater disposal facility in West Virginia. We found that elevated concentrations of Na, Cl, Ba, Sr, Li, NH_4, and trace hydrocarbons, when combined with Sr and Ra isotopic ratios, were key markers to identify OG-wastewater signatures. Biological effects in situ included mortality of resident and caged-fish. Combining these geochemical markers with hydrologic and geophysical investigations, we can identify contaminant discharges and track them over time to assess impacts of OG wastes on water quality and health.