Study finds massive flux of gas, in addition to liquid oil, at BP well blowout in Gulf

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A new University of Georgia study that is the first to examine comprehensively the magnitude of hydrocarbon gases released during the Deepwater Horizon Gulf of Mexico oil discharge has found that up to 500,000 tons of gaseous hydrocarbons were emitted into the deep ocean. The authors conclude that such a large gas discharge—which generated concentrations 75,000 times the norm—could result in small-scale zones of "extensive and persistent depletion of oxygen" as microbial processes degrade the gaseous hydrocarbons.

The study, led by UGA Professor of Marine Sciences Samantha Joye, appears in the early online edition of the journal *Nature Geoscience*. Her co-authors are Ian MacDonald of Florida State University, Ira Leifer of the University of California-Santa Barbara and Vernon Asper of the University of Southern Mississippi.

The Macondo Well blowout discharged not only liquid oil, but also hydrocarbon gases, such as methane and pentane, which were deposited in the water column. Gases are normally not quantified for oil spills, but the researchers note that in this instance, documenting the amount of hydrocarbon gases released by the blowout is critical to understanding the discharge's true extent, the fate of the released hydrocarbons, and potential impacts on the deep oceanic systems. The researchers explained that the 1,480-meter depth of the blowout (nearly one mile) is highly significant because deep sea processes (high pressure, low temperature) entrapped the released gaseous hydrocarbons in a deep (1,000-1,300m) layer of the water column. In the supplementary online materials, the researchers provide high-definition photographic evidence of the oil and ice-like gas hydrate flakes in the plume waters.

Joye said the methane and other gases likely will remain deep in the water column and be consumed by microbes in a process known as oxidation, which en masse can lead to low-oxygen waters.

"We're not talking about extensive hypoxic areas offshore in the Gulf of Mexico," Joye explained. "But the microbial oxidation of the methane and other alkanes will remove oxygen from the system for quite a while because the time-scale for the replenishment of oxygen at that depth is many decades."

Leifer added that some of the larger gaseous hydrocarbons documented, such as pentane, have significant health implications for humans and potentially for marine life.

The study concludes that separating the gas-induced oxygen depletion from that due to liquid hydrocarbons is difficult, absent further research, because all hydrocarbons contribute to oxygen depletion. Therefore, documenting the total mass of hydrocarbons discharged is critical for understanding the long-term implications for the Gulf's microbial communities, food chain and overall system.

Joye's team examined samples from 70 sites around the leaking wellhead during a research cruise aboard the R/V Walton Smith during late May and early June of 2010. They combined their data with estimates of the volume of oil released to arrive at a figure that allows scientists to quantify, for the first time, the gas discharge in terms of equivalent barrels of oil. They calculated a gas discharge that's the equivalent of either 1.6 to 1.9 or 2.2 to 3.1 million barrels of oil, depending on the method used. Although the estimate reflects the uncertainty still surrounding the discharge, even the lowest magnitude represents a significant increase in the total hydrocarbon discharge.

"These calculations increase the accepted government estimates by about one third," MacDonald said.

The ever-shifting small-scale currents in the Gulf likely have dissipated the plumes and the low oxygen zones associated with them, Joye said, making them difficult if not impossible to find at this point in time. Although gliders are a new platform being used, scientists typically search for subsurface features by dropping instruments from research vessels, a process that's analogous to looking for a feature on the Earth's surface by randomly dropping instruments from a height of 1,500 meters (about 5,000 feet) in the atmosphere.

"It's like searching for a needle in the haystack," Joye said. "We may never know what happened to all of that gas."

Joye cautioned against assuming that microbes will rapidly consume the gases released from the well. Undoubtedly, the methane is a feast for them, Joye said, but she also noted that the microbes need nutrients, such as nitrogen, copper and iron. These nutrients are in scarce supply in the Gulf's deep waters, Joye said, and once they are depleted the microbes will cease to grow—regardless of how much methane is available.

"This study highlights the value of knowledge gained from deep sea hydrate seepage research but also how poorly deep sea processes are understood, such as the role methane hydrates played in forming the deep methane plumes documented by this study," Leifer said. "Deepwater Horizon underscored how ill-prepared the nation is to respond to future accidents. As a nation, we need to hear this deep sea Sputnik wake-up call."