Potential well water contaminants highest near natural gas drilling, study says

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A new study of 100 private water wells in and near the Barnett Shale showed elevated levels of potential contaminants such as arsenic and selenium closest to natural gas extraction sites, according to a team of researchers that was led by UT Arlington associate professor of chemistry and biochemistry Kevin Schug.

The results of the North Texas well study were published online by the journal *Environmental Science & Technology* Thursday. The peer-reviewed paper focuses on the presence of metals such as arsenic, barium, selenium and strontium in water samples. Many of these heavy metals occur naturally at low levels in groundwater, but disturbances from natural gas extraction activities could cause them to occur at elevated levels.

"This study alone can't conclusively identify the exact causes of elevated levels of contaminants in areas near natural gas drilling, but it does provide a powerful argument for continued research," said Brian Fontenot, a UT Arlington graduate with a doctorate in quantitative biology and lead author on the new paper.

He added: "We expect this to be the first of multiple projects that will ultimately help the scientific community, the natural gas industry, and most importantly, the public, understand the effects of natural gas drilling on water quality."

Researchers believe the increased presence of metals could be due to a

variety of factors including: industrial accidents such as faulty gas well casings; mechanical vibrations from natural gas drilling activity disturbing particles in neglected water well equipment; or the lowering of water tables through drought or the removal of water used for the hydraulic fracturing process. Any of these scenarios could release dangerous compounds into shallow groundwater.

Researchers gathered samples from private water wells of varying depth within a 13 county area in or near the Barnett Shale in North Texas over four months in the summer and fall of 2011. Ninety-one samples were drawn from what they termed "active extraction areas," or areas that had one or more gas wells within a five kilometer radius. Another nine samples were taken from sites either inside the Barnett Shale and more than 14 kilometers from a natural gas drilling site, or from sites outside the Barnett Shale altogether. The locations of those sites were referred to as "non-active/reference areas" in the study.

Researchers accepted no outside funding to ensure the integrity of the study. They compared the samples to historical data on water wells in these counties from the Texas Water Development Board groundwater database for 1989-1999, prior to the proliferation of natural gas drilling.

In addition to standard water quality tests, the researchers used gas chromatography – mass spectrometry (GC-MS), headspace gas chromatography (HS-GC) and inductively coupled plasma-mass spectrometry (ICP-MS). Many of the tests were conducted in the Shimadzu Center for Advanced Analytical Chemistry on the UT Arlington campus.

"Natural gas drilling is one of the most talked about issues in North Texas and throughout the country. This study was an opportunity for us to use our knowledge of chemistry and statistical analysis to put people's concerns to the test and find out whether they would be backed by

scientific data," said Schug, who is also the Shimadzu Distinguished Professor of Analytical Chemistry in the UT Arlington College of Science.

On average, researchers detected the highest levels of these contaminants within 3 kilometers of natural gas wells, including several samples that had arsenic and selenium above levels considered safe by the Environmental Protection Agency. For example, 29 wells that were within the study's active natural gas drilling area exceeded the EPA's Maximum Contaminant Limit of 10 micrograms per liter for arsenic, a potentially dangerous situation.

The areas lying outside of active drilling areas or outside the Barnett Shale did not show the same elevated levels for most of the metals. Other leaders of the Texas Gas Wells team were Laura Hunt, who conducted her post-doctoral research in biology at UT Arlington, and Zacariah Hildenbrand, who earned his doctorate in biochemistry from the University of Texas at El Paso and performed post-doctoral research at UT Southwestern Medical Center. Hildenbrand is also the founder of Inform Environmental, LLC. Fontenot and Hunt work for the EPA regional office in Dallas, but the study is unaffiliated with the EPA and both received permission to work on this project outside the agency.

Scientists note in the paper that they did not find uniformity among the contamination in the active natural gas drilling areas. In other words, not all gas well sites were associated with higher levels of the metals in well water.

Some of the most notable results were on the following heavy metals:

- Arsenic occurs naturally in the region's water and was detected in 99 of the 100 samples. But, the concentrations of arsenic were significantly higher in the active extraction areas compared to

non-extraction areas and historical data. The maximum concentration from an extraction area sample was 161 micrograms per liter, or 16 times the EPA safety standard set for drinking water. According to the EPA, people who drink water containing arsenic well in excess of the safety standard for many years "could experience skin damage or problems with their circulatory system, and may have an increased risk of getting cancer."

- Selenium was found in 10 samples near extraction sites, and all of those samples showed selenium levels were higher than the historical average. Two samples exceeded the standard for selenium set by the EPA. Circulation problems as well as hair or fingernail loss are some possible consequences of long-term exposure to high levels of selenium, according to the EPA.
- Strontium was also found in almost all the samples, with concentrations significantly higher than historical levels in the areas of active gas extraction. A toxicological profile by the federal government's Agency for Toxic Substances and Disease Registry recommends no more than 4,000 micrograms of strontium per liter in drinking water. Seventeen samples from the active extraction area and one from the non-active areas exceeded that recommended limit. Exposure to high levels of stable strontium can result in impaired bone growth in children, according to the toxic substances agency.

"After we put the word out about the study, we received numerous calls from landowner volunteers and their opinions about the natural gas drilling in their communities varied," Hildenbrand said. "By participating in the study, they were able to get valuable data about their water, whether it be for household or land use.

"Their participation has been incredibly important to this study and has helped us bring to light some of the important environmental questions

surrounding this highly contentious issue."

The paper also recommends further research on levels of methanol and ethanol in water wells. Twenty-nine private water wells in the study contained methanol, with the highest concentrations in the active extraction areas. Twelve samples, four of which were from the non-active extraction sites, contained measurable ethanol. Both ethanol and methanol can occur naturally or as a result of industrial contamination.

Historical data on methanol and ethanol was not available, researchers said in the paper.

The paper is called "An evaluation of water quality in private drinking water wells near natural gas extraction sites in the Barnett Shale formation." A Just Accepted version is available here: http://pubs.acs.org/doi/abs/10.1021/es4011724.

Other co-authors include: Qinhong "Max" Hu, associate professor of earth and environmental sciences at UT Arlington; Doug D. Carlton Jr., a Ph.D. student in the chemistry and biochemistry department at UT Arlington; Hyppolite Oka, a recent graduate of the environmental and earth sciences master's program at UT Arlington; Jayme L. Walton, a recent graduate of the biology master's program at UT Arlington; and Dan Hopkins, of Carrollton-based Geotech Environmental Equipment, Inc.

Alexandria Osorio and Bryan Bjorndal of Assure Controls, Inc. in Vista, Calif., also are co-authors. The team used Assure's Qwiklite™ system to test for toxicity in well samples and those results are being prepared for a separate publication.

Many from the research team are now conducting well water sampling in the Permian Basin region of Texas, establishing a baseline set of data

prior to gas well drilling activities there. That baseline will be used for a direct comparison to samples that will be collected during and after upcoming natural gas extraction. The team hopes that these efforts will shed further light on the relationship between natural gas extraction and ground water quality.

More information: pubs.acs.org/doi/abs/10.1021/es4011724

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