New method could help quantify untapped natural gas reservoirs

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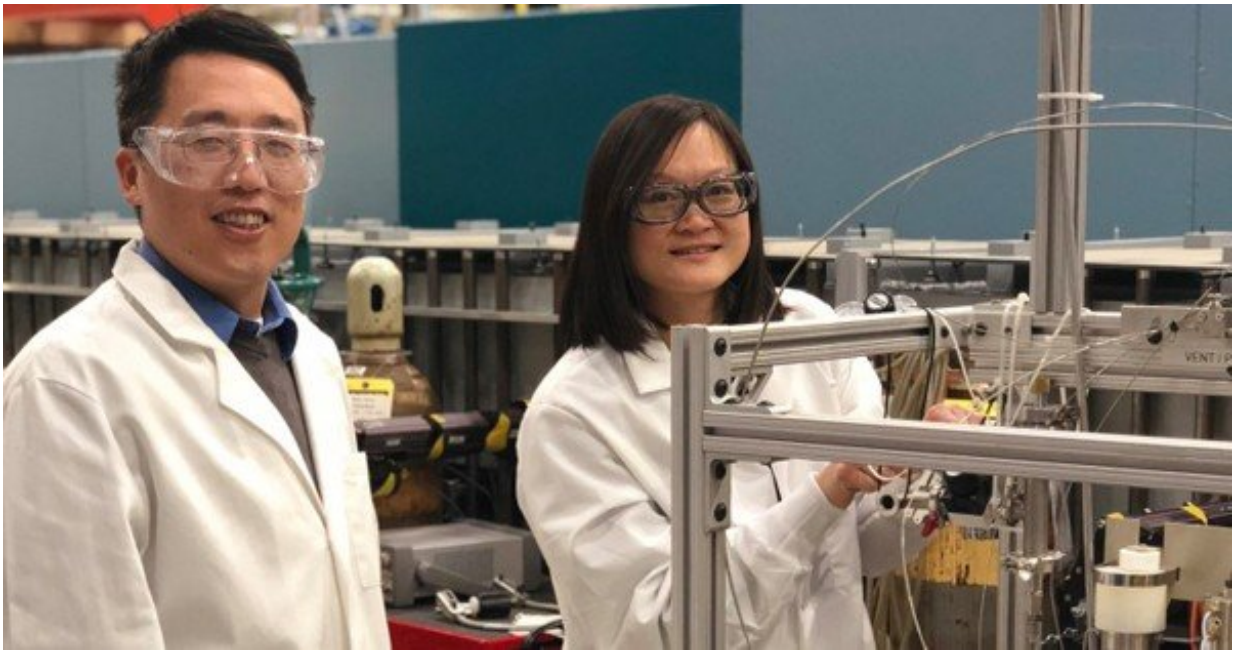

Yun Liu (left) and Wei-Shan Chiang adjust a syringe pump used to control gas pressure. Credit: University of Delaware

More than 30 states have shale formations that harbor natural gas underground, according to the Energy Information Administration. But industry experts can't agree on exactly how much fuel is inside. That's because natural gas and other hydrocarbons lie inside nano-scale, difficult-to-measure pores in shale rocks, which have properties that are not yet understood.

"If you want to estimate the storage capacity of shale gas, you need to understand materials that store them," said Yun Liu, an affiliated associate professor of chemical engineering at the University of Delaware and a physicist at the National Institute of Standards and Technology (NIST) Center for Neutron Research.

Now, using neutron scattering, Liu and a team of researchers from UD, NIST and Aramco Services Company have developed a novel non-invasive method to measure the variation of surface properties deep inside porous materials.

This method can help natural gas experts to better understand shale samples by examining the compositional distribution on porous surfaces inside the shales that directly influences the storage and transport of hydrocarbons. This would eventually help them decide whether to invest time and resources to extract gas from the formation the samples came from. The findings of this study, published Thursday, Feb. 22 in the journal *Nature Communications*, could also be used to understand many other different types of porous materials using neutron scattering or X-ray scattering.

Investigating pores

It's not just the size of pores that matters, but the surface structure and surface chemistry, since natural gas interacts with the outer edges of each tiny pore in the rock. The properties of the pores also determine how gas will flow out of the formation.

To understand these pores, the research team started with samples of isolated shale kerogen, an organic matter that stores the majority of hydrocarbons such as natural gas in shales. To peer inside the kerogen, they used small-angle neutron scattering, shooting a beam of subatomic neutrons through a substance and collecting information on the neutrons'

behavior to determine the properties of the pores. Neutron scattering is non-destructive, unlike electron microscopy, another common method used to investigate porous materials.

Next the group measured the change of neutron scattering signals with gas sorption at different pressures. The change of neutron intensity reflects the compositional distribution on the surfaces inside a sample.

This new method can reveal new information that other methods do not, such as the surface heterogeneity. Put simply, it provides information that helps researchers better understand what they are working with. When added to other information collected from a site, it can aid decision-making.

"Most of the other techniques used in the petroleum field provide the 'average' values of sample parameters," said study author Wei-Shan Chiang, a postdoctoral researcher in chemical and biomolecular engineering at UD who does work onsite at NIST Center for Neutron Research and at Aramco Services Company. "Our method provides both 'average' and 'deviation' (the width of distribution) of the material properties."

This method should also work on many other materials, such as cement, and maybe even biological materials such as blood, said Liu. The team looks forward to applying their method to new systems.

More information: Wei-Shan Chiang et al. A non-invasive method to directly quantify surface heterogeneity of porous materials, *Nature Communications* (2018). DOI: 10.1038/s41467-018-03151-w

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