Investigate 'comminution' as an alternative to fracking

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(Phys.org) —Hydraulic fracturing, popularly known as fracking—a method used to extract oil and natural gas from rock deep within the earth—has great economic benefits for the U.S. but not without environmental costs. While much less severe than those of coal technology, the costs include the danger of possible contamination of groundwater.

Instead of pumping deep underground enormous amounts of water to fracture shale, Northwestern University professor Zdeněk P. Bažant proposes exploring another possibility: using the kinetic energy of high-rate shearing generated by an underground explosion to reduce the rock to small fragments, so as to release the gas trapped in its pores.

"We have verified that this method of fragmentation, broadly called comminution, works for predicting the effects of high-rate shearing of concrete under impact, and in principle it also should work for shale," said Bažant, the Walter P. Murphy Professor of Civil and Environmental Engineering at Northwestern's McCormick School of Engineering and Applied Science.

"The mathematics is similar. And the amount of contaminated water produced by comminution would be negligible—a significant advantage," he said. "What is not clear yet is whether a sufficiently large zone of shale could be fragmented and whether the fragmentation would suffice to release the gas trapped in the pores."

He evaluated computationally the comminution of solids with possible application to shale, and he outlined his theory in a paper published recently by the *Proceedings of the National Academy of Sciences* (*PNAS*).

"This theory is not proven for fracturing shale—we don't know whether it would work—but it is an idea that is worth investigating," Bažant said. "An oil company or a national laboratory would need to conduct experiments and learn how to handle the practical issues."

Bažant will discuss this research Jan. 16 at a seminar hosted by McCormick's Theoretical and Applied Mechanics Program. The seminar will begin at 11 a.m. in the ITW classroom of the Ford Motor Company Engineering Design Center on the Evanston campus.

Recent advances in drilling technology have resulted in an increased emphasis on tight shale gas, natural gas locked in joints and pockets within low-porosity rock. This source rock can be found deep underground in vast regions of the U.S., making hydraulic fracturing a national issue.

In fracking, a hole is drilled several kilometers down to the shale layer and then diverted for several kilometers horizontally. Water is pumped down under high pressure. The ingress of pressurized water from the horizontal bore creates cracks in the shale, releasing natural gas from its pores. But the process also returns to the surface highly contaminated water, which must be dealt with properly, something that is expensive and requires strict quality control, which can't always be guaranteed.

In his PNAS paper, Bažant mentions an intriguing new alternative already thought of by some oil companies: instead of forcing water down, an electrical pulse arc could be used to generate sufficiently powerful explosions.

It remains to be verified whether the resulting shock waves would suffice to fracture a large enough region of shale and release the gas. Bažant's method would allow analyzing it computationally. Should comminution succeed, virtually no contaminated water would come out of the well, Bažant said.

More information: Zdeněk P. Bažant and Ferhun C. Caner. "Comminution of solids caused by kinetic energy of high shear strain rate, with implications for impact, shock, and shale fracturing." *PNAS* 2013 ; published ahead of print November 11, 2013, DOI: 10.1073/pnas.1318739110

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