Making gas out of crude oil

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An international team that includes University of Calgary scientists has shown how crude oil in oil deposits around the world – including in Alberta's oil sands – are naturally broken down by microbes in the reservoir.

Their discovery – published in the prestigious science journal *Nature* – could revolutionize heavy oil and oil sands production by leading to more energy-efficient, environmentally friendly ways to produce this valuable resource.

Understanding how crude oil biodegrades into methane, or natural gas, opens the door to being able to recover the clean-burning methane directly from deeply buried, or in situ, oil sands deposits, says Steve Larter, U of C petroleum geologist in the Department of Geoscience who headed the Calgary contingent of the research team.

The oil sands industry would no longer have to use costly and polluting thermal, or heat-based, processes (such as injecting steam into reservoirs) to loosen the tar-like bitumen so it flows into wells and can be pumped to the surface.

"The main thing is you'd be recovering a much cleaner fuel," says Larter, Canada Research Chair in Petroleum Geology. "Methane is, per energy unit, a much lower carbon dioxide emitter than bitumen. Also, you wouldn't need all the upgrading facilities and piping on the surface."

Biodegradation of crude oil into heavy oil in petroleum reservoirs is a

problem worldwide for the petroleum industry. The natural process, caused by bacteria that consume the oil, makes the oil viscous, or thick, and contaminates it with pollutants such as sulphur. This makes recovering and refining heavy oil difficult and costly.

Some studies have suggested that biodegradation could by caused by aerobic bacteria, which use oxygen. But Larter and colleagues from the U of C, University of Newcastle in the U.K., and Norsk Hydro Oil & Energy in Norway, report in Nature that the dominant process is, in fact, fermentation. It is caused by anaerobic bacteria that live in oil reservoirs and don't use oxygen.

"This is the main process that's occurring all over the Earth, in any oil reservoir where you've got biodegradation," Larter says.

Using a combination of microbiological studies, laboratory experiments and oilfield case studies, the team demonstrated the anaerobic degradation of hydrocarbons to produce methane. The findings offer the potential of 'feeding' the microbes and rapidly accelerating the breaking down of the oil into methane.

"Instead of 10 million years, we want to do it 10 years," Larter says. "We think it's possible. We can do it in the laboratory. The question is: can we do it in a reservoir""

Doing so would revolutionize the heavy oil/oil sands industry, which now manages to recover only about 17 per cent of a resource that consists of six trillion barrels worldwide. Oil sands companies would be able to recover only the clean-burning natural gas, leaving the hard-to-handle bitumen and contaminants deep underground.

Understanding biodegradation also provides an immediate tool for predicting where the less-biodegraded oil is located in reservoirs,

enabling companies to increase recovery by targeting higher-quality oil. “It gives us a better understanding of why the fluid properties are varying within the reservoir,” Larter says. “That will help us with thermal recovery processes such as SAGD (steam-assisted gravity drainage).”

The research team also discovered an intermediate step in the biodegradation process. It involves a separate family of microbes that produce carbon dioxide and hydrogen from partly degraded oil, prior to it being turned into methane. This paves the way for using the microbes to capture this CO2 as methane, which could then be recycled as fuel in a closed-loop energy system. This would keep the CO2, a greenhouse gas blamed for global warming and climate change, out of the atmosphere.

The petroleum industry already has expressed interest in trying to accelerate biodegradation in a reservoir, Larter says. “It is likely there will be field tests by 2009.”

Source: University of Calgary