Oil-dwelling bacteria are social creatures in Earth's deep biosphere, new study shows

December 12 2014

Oil reservoirs are scattered deep inside the Earth like far-flung islands in the ocean, so their inhabitants might be expected to be very different, but a new study led by Dartmouth College and University of Oslo researchers shows these underground microbes are social creatures that have exchanged genes for eons.

The study, which was led by researchers at Dartmouth College and the University of Oslo, appears in the *ISME Journal*.

The findings shed new light on the "deep biosphere," or the vast subterranean realm whose single-celled residents are estimated to be roughly equal in number and diversity to all the microbes inhabiting the surface's land, water and air. Deep microbial research may also help scientists to better understand life's early evolution on Earth and aid the search for life on Mars and other planets.

Some scientists support a "burial and isolation" scenario in which bacteria living in oil reservoirs are descendants of isolated bacterial communities buried with sediments that over time became oil reservoirs. "Instead, our analysis supports a more complex 'colonization' view, where bacteria from subsurface and marine populations have been continuously migrating into the oil reservoirs and influencing their genetic composition since ancient times," says co-author Olga Zhaxybayeva, an assistant professor at Dartmouth.

Since the 1980s, a growing number of microbial life forms have been

discovered deep underground, but many questions remain, including when and how these microorganisms came to inhabit places where temperatures and pressure are extreme and nutrients and energy can be scarce. Microorganisms are the oldest form of life on Earth and continue to play a crucial role in the planet's ecosystem. Those bacteria dwelling underground live not off sunlight energy but the Earth's inner heat, chemicals and nutrients.

In their new paper, researchers asked a number of questions, including: do buried bacteria adapt to living in oil reservoirs as they form from sediments? Do bacteria evolve in isolation, or do they migrate to oil reservoirs and exchange genes with surrounding bacteria, including surface ones introduced through drilling fluids used in oil production? The researchers analyzed 11 genomes of Thermotoga, an ancient lineage of heat-loving bacteria, taken from oil reservoirs in the North Sea and Japan and from hot water vents on the ocean floor near the Kuril Islands north of Japan, Italy and the Azores, an island chain west of Portugal. They also analyzed Thermotoga community DNA from the environment (so-called metagenomes) from North America and Australia that are available in public databases.

The results reveal extensive gene flow across all the sampled environments, suggesting the bacteria do not stay isolated in the oil reservoirs but instead have long migrated to and colonized the reservoirs and contributed to their genetic make-up. "The pathway of the gene flow remains to be explained, but we hypothesize that a lot of the gene flow may happen within the subsurface," says co-author Camilla Nesbø, a researcher at Centre for Ecological and Evolutionary Synthesis at the University of Oslo. Zhaxybayeva and Nesbø's previous research showed that Thermotoga and its close relatives have exchanged small pieces of genome with Archaea, an ancient single-celled life form different from bacteria, and with another distant group of bacteria, Firmicutes.

Provided by Dartmouth College