Low concentrations of oxygen and nutrients slowing biodegradation of Exxon Valdez oil

January 17 2010

Oil from the Exxon Valdez spill continues to be found in the beaches along Alaska's Prince William Sound. Temple University researchers have found that the low concentrations of oxygen and nutrients in the beaches, along with the water flow in the beach's lower layer, have hindered the aerobic biodegradation of the remaining oil. Credit: Michel Boufadel/Temple university

The combination of low concentrations of oxygen and nutrients in the lower layers of the beaches of Alaska's Prince William Sound is slowing the aerobic biodegradation of oil remaining from the 1989 Exxon Valdez spill, according to researchers at Temple University.

Considered one of the worst environmental disasters in history, the Exxon Valdez spilled more than 11 million gallons of crude oil into Alaska's Prince William Sound, contaminating some 1,300 miles of

shoreline, killing thousands of wildlife and severely impacting Alaska's fishing industry and economy.

In the first five years after the accident, the oil was disappearing at a rate of about 70 percent and calculations showed the oil would be gone within the next few years. However, about seven or eight years ago it was discovered that the oil had in fact slipped to a disappearance rate of around four percent a year and it is estimated that nearly 20,000 gallons of oil remains in the beaches.

The researchers, lead by Michel Boufadel, director of the Center for Natural Resources Development and Protection in Temple's College of Engineering, have been studying the cause of the remaining oil for the past three years.

Their study, "Long-term persistence of oil from the Exxon Valdez spill in two-layer beaches," was posted Jan. 17 in advance of publication on *Nature Geoscience*'s Web-site.

Boufadel said the beaches they studied consisted of two layers: an upper layer that is highly permeable and a lower layer that has very low permeability. He said that, on average, water moved through the upper layer up to 1,000-times faster than the lower layer, and while both layers are made up of essentially the same materials, the lower layer has become more compacted through the movement of the tides over time.

These conditions, said Boufadel, have created a sort of sheltering effect on the oil, which often lies just 1-4 inches below the interface of the two layers.

Boufadel said that oxygen and nutrients are needed for the survival of micro-organisms that eat the oil and aid in aerobic biodegradation of the oil. But without the proper concentrations of the nutrients and oxygen

along with the slow movement of water, anaerobic biodegradation is probably occurring, which is usually very slow.

Boufadel, who is also chair of the Department of Civil and Environmental Engineering at Temple, said that an earlier study, published in 1994, had already established a low concentration of nutrients was affecting the remaining Exxon Valdez oil.

He said that because of Alaska's pristine environment, you would expect to find a low concentration of nutrients and this recent study confirmed the earlier findings. What Boufadel and his team found was, on average, that the nutrient concentration in the beaches was 10 times lower than what is required for optimal aerobic biodegradation of oil. They also found that the oxygen levels in the beaches are also insufficient to sustain aerobic biodegradation.

Using groundwater hydraulic studies, the researchers found that the net movement of water through the lower layer of beach was outwards, so it is preventing oxygen from diffusing through the upper layer to where the oil is located.

"You have a high amount of oxygen in the seawater, so you would like to think that the oxygen would diffuse in the beach and get down 2-4 inches into the lower layer and get to the oil," said Boufadel. "But the outward movement of the water in the lower level is blocking the oxygen from spreading down into that lower layer."

Boufadel and his team are now exploring ways to deliver the much needed oxygen and nutrients to the impacted areas in an effort to spur aerobic biodegradation of the remaining oil.

More information: http://www.nature.com/ngeo/index.html

Provided by Temple University