A PERCHLORATE PUZZLE

Andrew Jackson, Ph.D. is part of a team that focuses on perchlorate and its implications, putting the university in the forefront of research about the subject.

A routine analysis of water samples during the summer of 2002 detected trace levels of perchlorate in drinking water supplies in Midland, Texas, and 100 miles away in Levelland, Texas. The Texas Commission on Environmental Quality (TCEQ) could not readily determine the origin of the perchlorate and turned to researchers at Texas Tech University for help in investigating this contamination. Andrew Jackson, Ph.D., associate professor in the Department of Civil Engineering, had been doing research on perchlorate for a number of years, and readily agreed to assist the TCEQ. Jackson’s research team continued collecting samples, ultimately revealing the presence of perchlorate in more than 80 percent of the wells over a 60,000 square mile area that includes 54 counties in Texas and two counties in New Mexico. Although the levels of perchlorate varied, some of the wells contained amounts that surpassed those generally considered safe.

The project involved contributions from civil, environmental and chemical engineering, chemistry and biochemistry, and the Institute for Environmental and Human Health (IEHH). The team collected groundwater samples and began to investigate potential sources of perchlorate. Researchers at IEHH were measuring perchlorate in West Texas groundwater samples, but they soon found that, due to the high salinity of the water, the methods recommended by the U.S. Environmental Protection Agency were not sensitive enough to detect perchlorate. Purnendu Dasgupta, Ph.D., former Horn Professor in the Department of Chemistry and Biochemistry, was called upon to help develop a more sensitive measure.

He had been working with ion chromatography, which allows for the separation of ions and polar molecules based on the charge properties of the molecules. His work in this field has earned him the distinguished Ion Chromatographer Outstanding Achievement Award not once, but twice. His particular technique proved to be a highly selective and sensitive measure of perchlorate.

by Monica Munoz
photography: Artie Limmer
For a long time, people believed that significant amounts of natural perchlorate were confined to these nitrate deposits in the Atacama Desert while, over recent years, researchers have discovered other deposits of naturally occurring perchlorate in New Mexico, California, Canada, and Bolivia. The anthropogenic origin of perchlorate lies in the manufacture of ammonium perchlorate. Ammonium perchlorate has been produced in the United States since the 1980s, in the 1940s and 1950s, perchlorate was used in the production of explosives and propellants. Military sources of ammonium perchlorate include solid rocket fuel and signal flares, and road flares, sewage treatment, fireworks, and paint and enamel manufacturing, ammunition batteries, rocket engines, and even methamphetamine laboratories. perchlorate contamination in groundwater often can be attributed to run-off from irrigated crops that were treated with fertilizers containing Chilean nitrates, or to leaks at the hands of industries from the manufacture of or the improper disposal of chemicals that contain perchlorate.

Researchers decided to test these hypotheses with groundwater samples from Lubbock, Texas, and analyzes them for perchlorate, which was detected in 70 percent of the samples. This initially supported the idea that atmospheric processes play a role in the production of natural perchlorate. To supplement these findings, researchers correlated perchlorate levels in rain and snow samples with several compounds and found that the highest correlations occurred with iodate, a compound that is known to have atmospheric origins. Researchers decided to simulate in the laboratory several of the processes that occur in the lower atmosphere or on surfaces such as sand. They theorized that natural perchlorate forms through aerosol oxidation of sodium perchlorate with chloride in aerosols and sands, and possibly, through electric discharge or lightning. Experiments involving high energy electrical pulses were carried out in the Texas Tech Pulse Laboratory. AFTER SONICATION, A PROCESS OF DISRUPTING biological materials through the use of sound waves, produced no perchlorate in water samples, researchers began investigating surface oxidation in the form of ozone and UV reactions with sodium chloride. Glass dishes containing a single layer of sand and sodium chloride dissolved in water were exposed to four UV lights and various concentrations of ozone. Although no significant amounts of perchlorate were produced during the UV exposure experiments, researchers found that perchlorate is formed at high concentrations of ozone. These processes simulated desert conditions, such as those in New Mexico and West Texas.

The research on perchlorate has managed to put Texas Tech University at the forefront of a great deal of interest in the topic because perchlorate currently is a highly charged political issue. "The research on perchlorate at Texas Tech University has helped inform many of the questions that surround current water issues. Certainly, the findings from the research will have far-reaching implications unconfined to water problems in West Texas and New Mexico. Texas Tech researchers have carried out ecological risk assessments, investigations of toxicity, work on treatment of perchlorate contaminated water, analyses of the natural perchlorate deposits, and measured plant uptake of perchlorate and the exposure for people, plants, and animals of four full days. All of these findings and research have been really great for Texas Tech," Jackson says. "If someone mentions perchlorate, everybody knows that Texas Tech has a hand in the research."