New Mexico Bureau of Mines and Mineral Resources Excellence in Geoscience Award
New Mexico Science and Engineering Fair 2001

New Mexico Geology congratulates the students from across the state who participated in the 49th annual New Mexico Science and Engineering Fair held April 6–7, 2001, at New Mexico Tech. Over 500 students traveled to Socorro to present their original research and to compete for hundreds of awards. Employees of the New Mexico Bureau of Mines and Mineral Resources sponsored their 2nd annual "Excellence in Geoscience" award. This year the judges were treated to nearly 50 geoscience exhibits, primarily in the categories of Earth and Space Science and Environmental Science. The exhibits covered a range of geological discoveries:

1) Water-quality problems ranging from natural to human-introduced toxins
2) Water-resource questions ranging from desalinization to increasing groundwater recharge, reducing evapotranspiration, and preventing runoff
3) Controlling erosion, flooding, and sedimentation of reservoirs
4) Earthquake prediction and soil engineering in earthquake-prone areas
5) Energy resources: natural gas and geothermal energy
6) Ancient life from Pennsylvanian, Permian, and Jurassic time
7) Remediation of oil spills and mine tailings
8) Remote sensing and computer simulations

The task of choosing one winner in the Junior and Senior Divisions was daunting. All these students are winners; however, the state of New Mexico is the real beneficiary of the accomplishments of these very talented young people and the dedicated adults that continually encourage them. In the hands of these young scientists, our future looks bright. *New Mexico Geology* is pleased to introduce a few of these talented students to our readers.

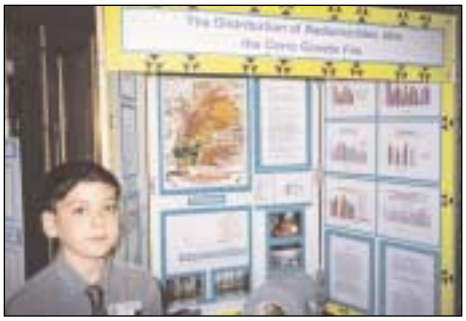
The Effects of Acid Rain on Common Building Materials, by *Katharine G. Dahm*, Rio Rancho High School, Rio Rancho

First Place, Senior Division

Corrosion from acid precipitation is a growing problem for stone structures worldwide. Five stone building materials were tested for their susceptibility to acid deposition. An acid solution with equal amounts of hydrogen ion from sulfuric and nitric acid was used to mimic the effects of acid precipitation. The solution was made to a final pH of 0.8. This solution is approximately two or three orders of magnitude stronger than actual acid precipitation. A stronger solution was used so the effects could be seen after ten days of exposure.

The general hypothesis was that German limestone would be the most susceptible to acidity. All samples with large amounts of carbonate were severely corroded by the acid solution. The effect of the acid on marl and limestone also caused large amounts of gypsum crystals to form. In some places, the growth of gypsum and calcite were so extreme it was impossible to see the surface. Both granite and gabbro were more resistant to acidity, although their surfaces also were mildly corroded. Some parts of the granite and gabbro corroded faster than others.

By analyzing the rocks with the electron microscope, it was possible to identify the parts that had been corroded. On both the granite and the gabbro, the feldspar eroded away leaving outcroppings of quartz. Although this change could be seen with the electron microscope, it wasn't enough to produce a significant weight change.



The Distribution of Radionuclides after the Cerro Grande Fire, by *Jason A. Castillo*, Bernalillo Middle School, Bernalillo

First Place (tie), Junior Division

The Cerro Grande fire reportedly had a higher radiation count than the average fire because of Los Alamos National Labs testing in the area.

After a high-intensity wildfire, how are radionuclides distributed into the soil and how does this compare to a non-burn area?

It is believed that there will be a higher amount of radionuclides at the bottom of arroyos. The isotopes will be carried by winds and mud into the sediments at the bottoms of washes and arroyos.

Soil samples are dried and weighed to 56.69 grams, then tested in a lead-lined test chamber using an ASP-1 geiger counter with a thin-window GM tube calibrated for strontium-90. The average background count in the test chamber is deducted from the total count of each sample.

Test results reveal that the Cerro Grande fire zone had a much higher radiation count than the control area. Counts were lower at the bottom of the arroyos and increased as samples were tested near the top of the arroyos. Control arroyos indicated the same test results. This region had just undergone some heavy rain storms, so it is possible that radionuclides in the sand and silt were washed away by wind and water. Most importantly, all CPM counts were at low levels not posing any health hazards. Future testing in the same areas at yearly intervals may reveal how radionuclides disperse in time through the environment.

Sources of Arsenic in Surface Water along the Jemez River System, by *Ben C. Gutzler*, Taft Middle School, Albuquerque

First Place (tie), Junior Division

The U.S. Environmental Protection Agency has proposed to reduce the allowable arsenic concentration in drinking water from 50 parts per billion (ppb) to 10 ppb because arsenic in water is a documented human carcinogen. This measure is on hold as per Presidential order but may still become law.

Arsenic is found in water in volcanic locales and some aquifers, and it has been measured in Albuquerque's drinking water. I wondered exactly where the arsenic is added to water along a river system flowing through volcanic rocks.

I hypothesize that samples from volcanic hot springs will have both high arsenic levels and high electrical conductivity. In particular, hot spring water will have higher arsenic than surface water that comes from rain or snow. I believe this is likely because hot water can dissolve and carry more buried minerals than cold water can.

I chose the Jemez River because it has a number of hot springs to test my hypothesis. I went up into the Jemez Mountains and collected samples of water from above, at, and below several hot and cold springs along the Jemez River and its tributaries.

I analyzed all of the samples for both electrical conductivity and arsenic content. A high electrical conductivity reading indicates that there is a high concentration of dissolved metals in the water. High amounts of dissolved metals indicate a ground-water source. I used an atomic adsorption spectrophotometer at UNM to analyze arsenic content, and a conductivity meter to measure electrical conductivity.

Samples that were upstream of the hot springs had low arsenic content (<2 ppb) and electrical conductivity (<270 µmhos). Samples collected at hot springs had very high arsenic (500–2100 ppb) and conductivity

(1300–1600 µmhos). Samples downstream of hot springs had fair to moderate arsenic contents (70–175 ppb). A sample of Albuquerque tap water (from my home) had 5 ppb arsenic.

The data support my hypothesis in that hot springs seem to introduce a lot of arsenic to the river water. Since the hot springs bring up ground water, the data may also indicate that aquifers can contain a significant amount of arsenic. Although arsenic levels decrease quickly below the hot springs analyzed, the levels that remain may still be hazardous to human health.

Earthquake Prediction, by *Ian J. Montaño*, Rio Rancho High School, Rio Rancho

Honorable Mention, Senior Division

Interested in earthquakes at an early age, I began developing an earthquake prediction method in 1997. My theories are based on the concept that the sun and moon exert fluctuating tidal forces on the earth. It has been proven that these forces are capable of increasing seismic strain under certain circumstances. My goal is to accurately predict earthquakes with highly precise date and location ranges.

My research consists of searching online earthquake databases in conjunction with computer astronomy applications. Intimate understanding of the sun-earth-moon relationship is required. The most commonly used lunar events in my prediction method are eclipses. By finding past large earthquakes occurring at Saros eclipse intervals, similar future seismic patterns can be forecasted.

One recent development is the analysis of fault planes and their configuration in relation to the moon at the moment of and the months prior to an earthquake. One intriguing development is the discovery of a three-synodic month "non-eclipse conjunction" interval. However, the knowledge of most fault planes comes only after the occurrence of such large earthquakes, rendering this method somewhat questionable, unless a fault has a similar conjugate. One possible application of this information is the forecasting of large aftershocks.

In an effort to share my predictions with people around the world, I have created a website that displays my long-term predictions. I have received over 1,600 e-mails and 160,000 visitors over the past two years. The location of this site is http://www.eqpredict .com, and I can be reached through e-mail at ian@eqpredict.com.

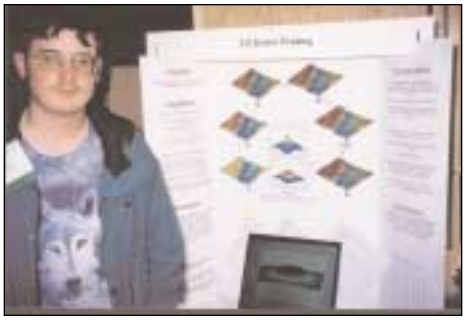
Sediment Build-up in Reservoirs, by *Gabriel Chavez* and *Javier O. Jasso*, Carlsbad High School, Carlsbad

Honorable Mention, Senior Division

Lake McMillan was constructed in the late 1800s and was completed by 1884. The reservoir was used by Carlsbad and the surrounding communities for irrigation. The purpose of this project was to find out how and why Lake McMillan filled up with sediment so quickly.

In the late 1800s, Carlsbad and the surrounding area had approximately 8 feet more topsoil than it does now. Due to early settlements along the arroyos leading to the reservoir and inefficient farming techniques, massive erosion occurred. In addition to inefficient farming, cattle were allowed to overgraze large areas of land, thus killing the vegetation and loosening the soil. Due to both of these anthropogenic activities working together, data from Water Resources Data books of New Mexico 1915–1985 showed that during times of drought came enormous floods, which caused most of the erosion and sedimentation of the lake within three to four floods.

With the data collected from the Carlsbad Irrigation District (CID) and Water Resources Data books, we were able to find the approximate amount of sediment that was deposited in the lakebed over the time span of 80 years. Using soil particle analysis, GPS data, and small-scale modeling, we were also able to show how the sediment accumulated within the reservoir.



3-D Erosion Modeling, by *Mark S. Hargreaves, David C. Hunter (pictured),* and *Sergey S. Kurennoy*, Los Alamos High School, Los Alamos

Honorable Mention, Senior Division

Our project objective is to construct a three-dimensional model of a given landscape and simulate its transformation by erosion. We are also using this project in the New Mexico High School Supercomputing Challenge. The result of our project will be an accelerated time animation of the eroding landscape that shows how sediment is transported by simulated rainfall to lower altitudes.

For input, the program needs a landscape map (fractally generated or specific landscape) containing altitudes and map of the resistance to erosion of the involved types of geologic materials (various soil compositions). The program will analyze the ground surface to calculate slope, to find river paths, to calculate the amount of material transported downstream by water, and to modify the landscape accordingly.

We plan to start with a simple model and advance toward a more realistic one. To revise the landscape we will look at geology books and talk to geologists in order to find problems with the program. Then we will try to modify our program accordingly. The results of this simulation could be applied to predict fluvial erosion patterns in real environments.

The Rio Peñasco: Healthy or Unhealthy?, by *Ashley M. Hester*, Alamogordo High School, Alamogordo

Honorable Mention, Senior Division

This project is to determine whether the Rio Peñasco is safe for use as drinking water. This project was chosen because nearly one year ago, Alamogordo had an E-coli scare, which led to the question: "How healthy are the rivers from where cities get water?"

The hypothesis is some areas of the Rio Peñasco will contain unhealthy contaminants, but most areas of the river will contain safe contaminant levels. Unhealthy amounts of contaminants will be found where animals feed or drink directly from the river, or where the river has been disturbed.

First the Internet was searched for water regulations of the United States Environmental Protection Agency (EPA) and, "What to Test Drinking Water For and Where to Get it Tested in Montana," (carikf@montana.edu). Mr. Tinguely ordered the LaMotte Green Earth Water Monitoring Kit after a conference. This kit allows relationships between land-use and water quality to be studied, enables collecting and measuring data on the physical, chemical, and biological factors of the selected local river, the Rio Peñasco, to be collected.

A map of the Rio Peñasco was obtained from the Forest Service. The watershed location was identified, major landmarks were located, and 16 collection sites were selected. Coliform bacteria, nitrate, dissolved oxygen, pH, phosphate, and turbidity water quality tests at 16 sites and one control were performed two times in January 2001, two times in February 2001, and one time in March 2001. I concluded my hypothesis was correct.

After analyzing test results, the quality of the Rio Peñasco was fair to good in the nitrate, dissolved oxygen, pH, phosphate, and turbidity tests. The coliform bacteria and E-coli tests were positive (the EPA allows ZERO E-coli in drinking water) and the water from the river **should not** be used for drinking without treatment to eliminate E-coli.

Rock of Ages, by *Daniel D. Clark* and *Brett J. Phelps*, Farmington High School, Farmington

Honorable Mention, Senior Division

The purpose of this project was to determine the age and depositional environment of an outcrop of Ojo Alamo Sandstone located adjacent to the entrance of Ladera del Norte Elementary. It was hypothesized that the outcrop was deposited in a fast-moving salt-water environment. This was tested by observing the outcrop, reading available literature that described techniques for interpretation of depositional environments, and comparing results from observation of the outcrop with the literature. It was found that the Ladera outcrop was two-dimensional. It was decided another outcrop located along the edge of Farmington Glade would be described to find strike and dip measurements of cross-bedded strata.

It was found that the Ojo Alamo Sandstone is Paleocene in age, making it 57–66 million years old. Based on the investigation, it was concluded that the Ojo Alamo Sandstone located at Ladera del Norte Elementary was deposited in a fast-moving fresh water environment. It is believed that the sediment was deposited in braided streams within an alluvial fan. Sediment source was most likely highlands to the north-northwest of Farmington. Flow direction was to the south-soiutheast. Therefore, the hypothesis was not supported.

The Pecos River Project, by *Michael Jaco*, Carlsbad High School, Carlsbad

Honorable Mention, Senior Division

The U.S. Geological Survey (USGS) studied the Pecos River's water flow, pH, conductivity, and temperature in 1953 and 1984. This project researched the Pecos River using the same parameters, type of equipment, and location as did the USGS.

The Pecos River may have lower water flow than it did in 1953 because of Brantley Dam. Other parameters may also have been affected.

This project's purpose is to determine if the Pecos River has changed since 1953.

The experiment proceeded as follows:

1. Calibration of the pH and conductivity meters occurred regularly.
2. The length and diameter of the culverts were measured.
3. Each day water volume and velocity were determined by measuring water height in the culverts and timing water flow through the culverts.
4. The water pH and conductivity were measured each day.
5. This information was analyzed and graphed using a computer.

The USGS showed that the Pecos River water flow diminished from 1953 to 1984. The project data showed that the Pecos River water flow has returned to near 1953 levels. Other parameters measured were the same as in 1953. During the testing period, the draining of the upper lake increased water flow and affected other parameters as well.

There is no indication of any significant change in the Pecos River since 1953. Further study is needed to determine if the river returns to normal when the upper part of Carlsbad Lake is fully drained.

Natural Gas Quality vs. Gas Well Operation, by *Thomas G. Lambdin,* Farmington High School, Farmington

Honorable Mention, Senior Division

The purpose of this project is to determine if the natural gas quality varies significantly when the well is flowing or not flowing.

The hypothesis is that natural gas quality will be better when the well is not flowing.

The procedure was to collect three natural gas samples while the well is operating and not operating at several different well sites. Also to obtain samples from a control that is a well that operates all the time. The gas quality will be measured in BTUs (British Thermal Units), which is the heat content. This will be analyzed using a gas chromatograph.

In the natural gas industry, a variance of ten BTUs or greater is considered a significant difference. All of the wells in this study had variations greater than ten BTUs, with well number one showing the least variance of twelve BTUs and well number three showing the greatest variance of 109 BTUs.

Wells number 4, 7, 8, and 9 supported the hypothesis. They all had a higher BTU value with the well not flowing.

Wells number 1, 2, 3, 5, and 6 failed to support the hypothesis. They all showed higher BTU values while the well was flowing.

I concluded that the hypothesis was not fully supported. In four out of nine wells the gas quality was better while the well was not flowing.

However, in five out of nine wells the gas quality was better while the well was flowing. Some possible explanations for these surprising results could be any or all of the following reasons: absorption of CO_2 by moisture in the well, condensation of heavier hydrocarbons in production equipment, residual hydrocarbons in meter tubing, and hydrocarbon enrichment due to down-hole temperature differences.

It can be concluded that gas quality is affected by the timing of the sampling. For most representative results, the gas wells should be sampled while flowing.

Can a Stream's Sinuosity Be Restored by Using Simple Baffles?, by *Matthew S. Dent-Coleman*, Roosevelt Middle School, Albuquerque

Honorable Mention, Junior Division

A problem for many Western steams is that they have severely down-cut their channels and have lost much of their sinuosity. Many of these streams have either been channelized or have problems in their watershed. Some of the most common problems include overgrazing from livestock, logging, and urban development. These impacts can cause much more water to come into the stream, causing flooding and erosion. If a stream is like this and has lost its sinuosity, the resulting effects can be disastrous. These effects could consist of devastating floods, loss of habitat area, and continued erosion of the stream banks. Streams that keep their natural sinuosity are more stable, and generally have much more habitat area. If there is a flood in the stream, it will be much less devastating compared to a flood in a channelized stream.

In my experiment, I was testing to determine if there was a way to restore channelized streams to their natural sinuosity by using simple structures called baffles. Baffles are used to force the oncoming water to the opposite side of the stream. This causes erosion of the opposite stream bank. After a while, the stream channel will start to become more sinuous. Sediment eroded from the banks of the stream is deposited behind baffles downstream, forming new point bars. To test the baffles in my experiment, I made a model of a channelized stream and then placed baffles at specific spots in the streambed. After the baffles were placed, I ran water through the model for a certain amount of time and recorded the results. I tested two different types of baffles (pea gravel and cobblestones) on two different types of streambed substrates (soil and sand). The baffles worked to restore the stream's sinuosity in all cases. The pea gravel was most effective on both substrates, and the sand had the largest resulting sinuosity.

Do Sediment Sizes Vary in a Streambed?, by *Desirae M. Brown*, Wilson Middle School, Albuquerque

Honorable Mention, Junior Division

The purpose of my project is to find out if the sizes of sediments vary with distance in a streambed. The project I came up with was to go to three different locations (one near the river, one near the mountains, and one in between), to collect a sample from each place.

Once I got the sample, I would take each and put it in a sieve. When I was through sieving, I weighed the amount of sediments in each container and put these results in a table. The results were: near the river were relatively fine sediments, near the mountains were coarser sediments, and at the in-between location was a little bit of everything.

From this information, I was able to come to the conclusion that sediment sizes do vary with distance. They were just as I suspected: coarse near the mountains, fine near the river, and a small amount of everything in between.

The Magnetic Mountain, by *Joshua Kapsner*, Holy Ghost School, Albuquerque

Honorable Mention, Junior Division

The purpose of my experiment was to investigate the effect of weathering and erosion on the movement of magnetite, a magnetic mineral, from the granite on the west side of the Sandia Mountains, down through Albuquerque. My hypothesis was that there would be more magnetite in the soil closer to the Sandia Mountains.

Soil samples were collected from four sites each in the foothills, Heights, midtown, and valley areas. I dried and sieved the soil and removed the magnetite from the soil with a magnet, placed it in sample bags, and weighed it. This process was repeated three times on each soil sample to validate the results.

My results showed that soil samples obtained from the foothills closest to the Sandia Mountains did contain the most magnetite. However, one site in the foothills had much more magnetite than the other foothill sites, and one site in the Heights had almost as much magnetite as the foothill sites.

In conclusion, my hypothesis was partly correct, and the samples with the most magnetite were those that were closest to the source Sandia granite from which magnetite is released by the process of weathering. Samples from one of the foothills sites had more magnetite than the other foothills sites. This may have been because there was more granite there, the granite had more magnetite, or there was more weathering in that area. Samples from one of the Heights sites has more magnetite than the other Heights sites. This may have been because there was more magnetite at the source for that area, that more magnetite was transported there by water erosion, or that the soil came from elsewhere. My results support that the processes of weathering and erosion are active on the west side of the Sandia Mountains.

New Mexico's Waves: A Comparison of Pennsylvanian Period Marine Fossil Assemblages, by *Katelyn A. Turnbow*, Taylor Middle School, Albuquerque

Honorable Mention, Junior Division

The purpose of this project is to find out what differences occur from marine fossil assemblages from two separate Pennsylvanian Period (286 to 320 million years ago) outcrops in northern New Mexico. According to my research, no noticeable extinction took place during the Pennsylvanian Period. Therefore, I think that the fossils should be similar. Differences may occur due to variability in environmental conditions, like depth of the ocean floor and distance from shore.

Two fossil localities from the Pennsylvanian Period were examined in the study. The outcrops included the Madera Formation in the southern Jemez Mountains and the Flechado Formation of the Sangre de Cristo Mountains. These locales were about 75 miles apart. A sample of the fossil assemblage from each locality was collected, and analysis was conducted in order to compare the marine life.

The Madera Formation outcrop consists of limestone and shale. Fossils found in these rocks are numerous and well preserved. They include brachiopods, crinoids, bryozoans, gastropods, sea urchins, and trilobites. Such fossils indicate a shallow ocean floor.

The Flechado Formation outcrop is mostly shale. The fossils found were well preserved but extremely fragile. The assemblage included brachiopods, crinoid stems, a horn coral, marine plant fossils, and at least five different types of gastropods.

The data collected during this experiment supports my hypothesis that fossil assemblages from this geologic time period are similar. These similarities are most likely due to the close time relation and no severe change in environment.

Soil Engineering: On Which Soils Should Engineers Build in Earthquake-Prone Areas?, by *Terrin Hoffmann*, Sierra Middle School, Las Cruces

Honorable Mention, Junior Division

While conducting research for last year's science fair, I noticed that smaller earthquakes sometimes caused greater damage and fatalities than larger earthquakes. One explanation for this difference was the type of soil in the area in which the earthquakes occurred. I wondered, which types of soils are best to build on in areas prone to earthquakes? Is it clay, silt, sand, or gravel, or a combination of various types of soil?

For this study, I collected samples of the four basic soil types (clay, silt, sand, and gravel) and also created three soil mixes (clay with silt, sand with gravel, and a combination of the four basic soil types). Next, I made a board on which I could model the vibrations of an earthquake. I placed each of my seven soil types in a cup fastened to the board and then placed a popsicle stick (modeling a structure) into the soil. I tested each soil type's ability to hold up the stick/structure during vibration. I ran five tests on each soil, threw out the highest and lowest scores, and then averaged the three remaining results.

I found that the best soils were: 1) the sand/gravel mix; and 2)the mix of all four basic soils. The gravel performed the worst. I concluded that soil engineers should build on combinations of sand and gravel or all four basic soils in earthquake-prone areas whenever possible. When these types of soil are not found in construction areas, then engineers should bring in these soil mixes and compact them over the existing soils.

—More Honorable Mention Abstracts can be found on page 67.

NMSEF Honorable Mention Abstracts continued from page 41.

Grasslands vs. Woodlands: Change During the Last Century Using Remote Sensing, by *Sue Andra White*, Manzano High School, Albuquerque

Honorable Mention, Senior Division

It is perceived that piñon-juniper woodlands increased at the cost of grasslands during the last century, but there is little quantification of vegetation change. From aerial photographs taken in 1935, 1952, and 1996, and a 1996 satellite image, total acreage of six vegetation types was determined for an area south of Edgewood, New Mexico. The purpose was to determine the extent of change in piñon and juniper woodlands over that time period.

Ground truthing and image processing was used for the classifications. Three methods were used to classify the images: (1) the Manual Mapping Method (Heads-Up or On-screen Digitizing), (2) Texture Mapping, and (3) Spectral Mapping. Vegetation classes were divided into three groups: (1) grassland dominant (grasslands, shrubs and grass, and piñon-juniper savanna); (2) woodland dominant (light woodland cover, medium woodland cover, and heavy woodland cover); (3) man-made Disturbances (including barren ground, roads, etc.)

Grassland-dominated classes decreased (1,889 acres) with the greatest decrease between 1952 and 1996 (1528 acres). Woodland-dominated classes and man-made disturbances increased (1,777/113 acres) with the greatest increase between 1952 and 1996 (1,411/117 acres).

This analysis provides quantified support for the perception that piñon-juniper woodlands have increased and grasslands have decreased in cover since 1935.

Greater woodland cover could have greater evaporative and transpirational loss of water, which could lead to decreased ground-water recharge given the same precipitation regime.

Does Water Hardness Have an Effect on the Coagulation/Microfiltration Method of Arsenic Removal?, by *Kelly N. Jaffa*, Sandia High School, Albuquerque

Honorable Mention, Senior Division

A new maximum contamination level standard of 10 parts per billion (ppb) for arsenic in drinking water will affect many water systems in the Southwest. Ferric chloride coagulation and microfiltration may be one method that utilities choose to remove arsenic. The purpose of my project is to determine if water hardness has an effect on this method of arsenic removal.

For my experiment, I collected water from several different sites. I used two different HACH portable test kits to test this water for arsenic, water hardness, and pH. I preserved samples that contained 20 ppb arsenic but had different hardness levels. Next, I measured 1 liter of the sample water into a jar and mixed in 100 milligrams of ferric chloride. This water was then gravity filtered through a 0.5-micron filter. The filter was preserved, dried, and weighed. The filtered water was retested for arsenic, pH, and water hardness. Also, to serve as a control, a 1-liter sample of the water only was filtered. The experiment was repeated several times, and the results and averages were analyzed.

I found that the water hardness did affect arsenic removal by this method. The arsenic was effectively removed; however, more precipitate was generated as water hardness increased. This result may have been caused by other particles “sorbing” into the iron. Or, more particulate was created because the equilibrium of the water was disturbed by the treatment. In a large processing plant this might cause microfilters to become clogged more often. To avoid this problem, filters might need more frequent backwashing, which might wear them out sooner. Also, more solid waste would be generated, which might create disposal problems.