The AquAeTerian

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Aqua Aer Terra

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The President's Corner

Indeptus Longe Lateque: Reaching Far and Wide

This fall finds our dedicated **AquAeTerians** traveling to the far reaches of the earth. Sean Muller recently returned from Kazakhstan, where he assisted with environmental issues involving uranium leaching. Cathryn Stewart and Trey Lewis are currently in Adak, Alaska again this year conducting groundwater monitoring for the Navy. Dr. Ram Ramaswami has been working in Silver Bay, Minnesota on removal of mercury down to the ng/L level. Dr. Wes Eckenfelder and Paul Marotta have been working on a design of a wastewater treatment facility in the U.S. Virgin Islands. Our river rats have also been busy working on total maximum daily load determinations, mixing zone studies, stormwater and sediment sampling, and permitting in Florida, Georgia, Illinois, Mississippi, Oklahoma, and Texas.

Steve Wampler and Cathryn Stewart recently were congratulated by our client, Waste Management, for their work on a municipal solid waste landfill in Colorado. **AquAeTer** provided a groundwater characterization that the State accepted, which will save our client several million dollars with an alternative liner system.

This issue of our newsletter features a selenium stabilization project being conducted by Sean Muller of our Centennial office. Chris Green from our Brentwood office has also written an article about his implementation of a software system that has been tailored to the ASTM format for Phase I Environmental Site Assessments.

Finally, I would like to introduce a new company that has been jointly formed by Frank L. Parker, Ph.D., P.E., DEE, James H. Clarke, Ph.D., and **AquAeTer**. Risk-Informed Solutions (R-IS) will be working primarily in the specialized market of nuclear and chemical waste management and environmental risk. Dr. Parker is considered one of the foremost experts in nuclear waste disposal in the world and has a broad background in water resources. Dr. Clarke has extensive experience in risk assessment for chemicals and radionuclides and is a member of the Nuclear Regulatory Commission Advisory Committee on Nuclear Waste. You can e-mail Dr. Clarke or Dr. Parker at jclarke@riskinf.com or fparker@riskinf.com.

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Selenium Attenuation at Phosphate Mine Sites

Selenium is a pseudo-metal that can be found in mineral deposits and various process wastes throughout the western United States. Although selenium is an essential nutrient at low levels, it may have adverse short- and long-term health effects for people who are exposed to levels above the EPA Maximum Contaminant Level (MCL). The current standard is 0.05 ppm for drinking water systems. Selenium can also cause acute toxicity effects in animals and aquatic life. A mining facility in Idaho has experienced ongoing problems with elevated selenium concentrations from their phosphate operations. Sheep and horses were acutely exposed to selenium-enriched water and vegetation at the mining facility's reclaimed mines.

The pathways for exposure to selenium include ingestion of: indigenous vegetation, pit water, and vegetation used for reclamation. The current EPA-approved treatment technologies for removal of selenium include: activated alumina, coagulation/filtration, lime softening, and reverse osmosis. The Idaho mining company was searching for a low cost amendment for the treatment of their selenium-bearing waste rock and tailings that would not require a high level of O&M. Subsequently, **AquAeTer** presented an alternative technology that involved the utilization of readily available material (from the mining process) to attenuate selenium release either by precipitation or sorption.

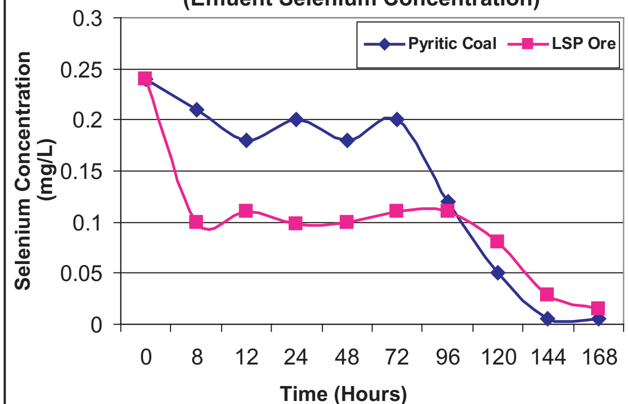
Initially, a feasibility study was performed to determine the ability of specific mining byproducts to attenuate selenium. Samples of mine pitwater containing elevated levels of selenium were collected at the Idaho mine facility for the study. A low-selenium phosphate (LSP) ore from another mine site and a waste pyritic coal were also selected for the study. The LSP ore was chosen for testing based on the ability of the phosphate mineral, apatite, to sorb metals.

Activated carbon is well known for its ability to remove organic and inorganic contaminants from wastewater. Recent research has shown that pyritic coal exhibits similar properties. Due to the low cost and availability of pyritic coal at the Idaho mining site, a test was conducted to determine the ability of this pyritic coal to remove selenium. The success and rate of removal of selenium by these two materials (pyritic coal and LSP ore) were evaluated and compared.

Two separate column tests were undertaken using the mine pitwater and pyritic coal or LSP ore. In each case, the solid medium was placed in a 4-inch internal diameter cylindrical humidity cell that was 12 inches in length. Glass wool was used to prevent plugging of the influent port at the base of the cylinder. Three liters of pitwater were re-circulated in each cell at a rate of 6.5 mL per minute for a total of seven days. An effluent port was placed at the top of each cell for sampling at 8, 12, 24, 48, 72, 96, 120, and 144 hours. At each sampling interval, a 3 mL sample was taken and filtered through a 0.45 µm filter. The filtered sample was then analyzed for selenium using a graphite furnace. At the same time, another 10 mL sample of effluent was taken for Eh (redox potential), pH, and electrical conductivity analysis.

The initial selenium concentration in the mine pitwater was 0.24 mg/L. After 168 hours, the LSP ore reduced the selenium level to 0.015 mg/L, below the drinking water standard (0.05 mg/L). The coal had similar success in reducing the selenium level in the mine pitwater to <0.005 mg/L after 120 hours. Results of the column test are shown here in Figure 1. In both column effluents, cadmium levels were reduced to below the detection limit (0.0017 mg/L). Vanadium and nickel levels in the pitwater were reduced to below detection limits by the pyritic coal. Calcium carbonate, naturally occurring in both the LSP ore and

Figure 1. Selenium Column Testing Results (Effluent Selenium Concentration)



coal, increased the alkalinity and pH levels in the pitwater, reducing the potential for acidic discharges during treatment.

The success of the column tests led to another series of tests using a vegetative medium. A known selenium accumulator, Medicago sativa (alfalfa), was chosen for the testing. The objectives of this series of tests were: (1) to determine the potential for desorption of selenium from the test material and the subsequent accumulation of selenium in the plant material; and (2) to observe the uptake of selenium by the vegetation

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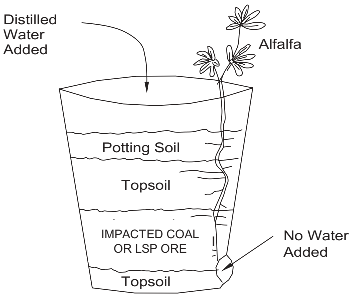
when a layer of non-impacted LSP ore or coal is added to the soil column.

To achieve the first objective, the selenium-impacted material from the column tests (the only source of selenium in this test) was added to a soil profile and alfalfa was planted to determine selenium uptake by the plants. The setup for this test is presented in Figure 2-a. A control series layer with no coal or LSP ore was also prepared for comparison. In the test using the impacted LSP ore, essentially no desorption of the selenium occurred since the concentration of selenium in the alfalfa was comparable to the concentration in the alfalfa grown in the soil control series. However, the concentration of selenium in the alfalfa from the pyritic coal test exhibited four times the level of selenium in the alfalfa grown in the control unit, indicating that desorption of selenium from the pyritic coal was occurring.

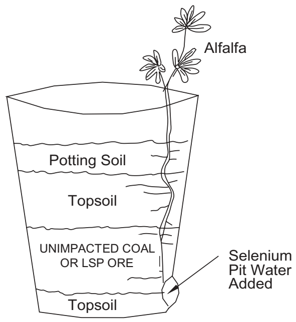
Figure 2-a
Test For Objective 1



TAILS REJECT FROM COLUMN TEST

The second objective entailed taking non-impacted (selenium-deficient) LSP ore and pyritic coal and adding selenium-containing pitwater to the base of the planter as shown in Figure 2-b. Neither the LSP ore nor the coal was mixed with the soil, but was added as a layer in the soil profile. A soil control with no LSP ore or coal addition was also watered from the base with the selenium-enriched pitwater. After two weeks, the selenium concentration in the vegetation in the LSP test unit was an order of magnitude lower than the level detected in the control sample. However, the selenium concentration in the vegetation in the coal test unit was only slightly lower than the control sample. These results indicate that the layer of non-impacted test material could successfully attenuate the selenium and prevent the uptake of selenium by the alfalfa.

Figure 2-b
Test For Objective 2



HEAD REJECT FROM COLUMN TEST

Although a pilot field test has not yet been conducted, the preliminary data indicate that both the LSP ore and pyritic coal have the ability to remove selenium from water. It was found that, once removed by the pyritic coal, selenium has a tendency to be released. In contrast, the selenium removed by the LSP ore remained in place. However, because of the initial selenium concentration in the pitwater, it was not possible to determine the mechanism of selenium removal, i.e., sorption or precipitation by the coal or LSP ore. The test results also indicate that the LSP ore has better attenuating properties for selenium than the coal, in that accumulation did not appear to occur in the alfalfa in the LSP ore during the second set of tests.

Due to this promising performance, laboratory-scale testing using the LSP ore to treat the leachate from the selenium-rich tailings from the Idaho mining facility will be undertaken later this year.

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Christopher Green is a Hydrogeologist and Project Manager at **AquAeTer's** Brentwood office. He is a registered Professional Geologist in the State of Tennessee with an M.S. in Hydrogeology from Illinois State University and a B.S. in Geology from Austin Peay State University. Chris has worked on a variety of projects during his 6 years in environmental consulting. His experience includes several RCRA, CERCLA, and UST projects for industrial, commercial, and governmental clients. His projects have included geologic interpretation, aquifer modeling, soil characterization, site assessments, and tracer testing. While at **AquAeTer** he has also been involved with Phase I and Phase II ESAs. Chris has implemented a Geographic Information System (GIS), as well as, a new web-based software program for streamlining Phase I ESA reporting. Chris is also experienced with a wide range of computer modeling software including MODFLOW, MODPATH, Surfer, and ArcGIS 9.1. He is also a member of the American Institute of Professional Geologists (AIPG) and is very involved in the local chapter in Tennessee.

Utilizing the Latest Technology for Streamlining Phase I Site Assessments

Many of our environmental projects begin with an industrial or commercial real estate transaction and the requirement for a Phase I Environmental Site Assessment (ESA). Site assessments have always been an important part of **AquAeTer's** services. Many of our engineers and scientists have traveled throughout the United States to perform site inspections for various clients. Clients who typically require an ESA include financial institutions, real estate developers, insurance companies, commercial and industrial property owners, and venture capitalists.

During **AquAeTer's** 14-year history, we have prepared a large number of ESAs for a wide variety of industrial and commercial properties. In recent years we have also worked with new and existing cellular tower sites for telecommunications carriers. Regardless of the type of property, the site inspection and final report usually have to be completed within a short turn-around time (typically 30 days). For multi-site projects that require a large number of site assessments to be conducted concurrently within a short turn-around time, **AquAeTer** has incorporated a new web-based system created specifically for Phase I ESAs. This system has made it possible to complete a large number of projects within 2-3 weeks, depending on the availability of additional information required for the report.

Previously, when site inspections were conducted, report preparation would not begin until the inspector returned to the office. Now the inspector can upload site sketches, checklists, and photographs and begin writing the report from the field while support staff at the office compiles additional documentation for the report. Upon return to the office, the site inspector can finalize the report within a short time following the site visit.

In addition to the implementation of the web-based system, **AquAeTer** has undergone a company-wide computer network upgrade including new servers and workstations, wireless internet access, and remote access through a virtual private network (VPN). These technology upgrades allow us to improve our response time to our clients with information that is accessible to our field crews at any time.

AquAeTer's combination of this innovative computerized approach, together with our qualified professional's work experience, and regulatory expertise which includes, federal, state, local regulations, and ASTM standards, allows us to provide efficient, accurate results to our clients in a timely manner.

In closing, **AquAeTer's** professionals continue to streamline the ESA process while continuing to provide quality work to our clients. We have dedicated considerable training, time, and equipment upgrades to provide the best service possible in an economical package for our clients. This technology is now being applied to all of our site assessment projects, including commercial and telecommunication properties.

Christopher Green conducting a recent site inspection of a collocation cellular tower site.