



PHYTOREMEDIATION APPROACHES FOR ORGANIC AND INORGANIC CONTAMINANTS

Presented by

MICHAEL COIA

PhytoWorks, Inc.

Teaching Plants to Improve Our Lives™

Gladwyne, Pennsylvania

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We will convene on Thursday, December 10, at the Glen Loch Restaurant. The evening will conclude with an open question and discussion period with Mr. Coia. We look forward to seeing you then!

**C N Y A P G
welcomes members
of ASCE!**

After more than five years of conferences, scientific papers, trade review articles, and high expectations, how is phytoremediation "stalking up?" Phytoremediation has been implemented on more than 100 commercial sites. Although completed projects are still rare, available data from ongoing projects and demonstration sites show significant progress toward achieving cleanup and containment goals. Scientific research has also expanded the suite of contaminants that phytoremediation can address to include mercury, explosives, pesticides, chlorinated solvents, PAHs, and PCBs. In the intensely competitive environmental industry, phytoremediation technologies are demonstrating benefits to all stakeholders by decreasing costs to responsible parties, increasing margins for environmental consultants, garnering community support, and meeting or exceeding regulatory standards.

Michael Coia, director of Remediation at PhytoWorks, Inc., will present the state of the phytoremediation industry at CNYAPG's December meeting. Mr. Coia will discuss available phytoremediation approaches for organic and inorganic contaminants, including PhytoWorks' patented transgenic plants which detoxify methylated and ionic mercury contamination. Drawing on over 18 years of experience in environmental management and engineering, Mr. Coia will compare phytoremediation with competing technologies and demonstrate how phytoremediation can be implemented as an alternative or complement to mechanical approaches. Mr. Coia, who also lead the interactive workshop at Central Business Intelligence's (CBI's) November Phytoremediation Conference in New Orleans, will answer questions about phytoremediation and looks forward to a stimulating and interactive evening with CNYAPG.

Michael Coia has more than 18 years of experience in all phases of environmental remediation, including system design, engineering staff line management, contracting, project management, and fiscal planning. Most recently, he directed the Technical Services Group of 130 engineers and technicians for the Northern Region of OHM. Mr. Coia was one of four founding partners and Program Director for Environmental Resource Management's (ERM's) remediation affiliate, where he was responsible for developing and implementing remediation solutions and directing 25 engineers and project managers. Previously, he was a project manager and field engineer at Roy F. Weston, where he participated in some of the first laboratory and field demonstrations of innovative soil vapor extraction and lagoon stabilization/closure technologies. Mr. Coia was awarded his B.S. and M.S. from Duke University.

PRESIDENT'S PAGE

I, for one, am looking forward to December's talk on Phytoremediation. The concept of using plants as a remedy seems an obvious one. Having worked on many classified hazardous waste sites, it is clear that plants manage to grow, despite the surrounding air, soil, and groundwater quality. Railroad tracks are a good example. Plants, berries, and moss grow quite well in soil that potentially, when characterized on an environmental site, needs to be excavated for off-site disposal. The local Solvay beds are another good example of plants growing where we would least expect them, based on office-calculated risk assessments.

Being a perennial gardener and herbalist, I understand that it is declared that plants turn into weeds when they grow where one does not want them. It is the observation of plants and weeds growing where we do not want them or where we would not expect that needs to be paid attention to. Going back to the railroad track example, certain plants I have harvested from railroad tracks and restored to the garden showed indications of "detoxification." I have observed black oily-like liquid discharging from stems and flowers in only those plants taken from railroad tracks and not the regular garden variety. These observations entice me to believe the plants are processing the soil constituents from the shallow railroad beds. And if they are, how can this process benefit us?

I was noticing the trademark phrase from PhytoWorks, "Teaching Plants to Improve Our Lives." Although I fully agree, plants have been used throughout history to remedy and improve our lives. Their use was, and still is, primarily in the remedying of human ailments; as medicine.

By observing and studying their actions on the body and environment, they are actually our teachers. Then, when we understand their physical and chemical behavior, they become our

tools. By altering their naturally-occurring processes, we enhance the tools to meet specific objectives.

It is interesting to observe that plants and herbs are also growing in popularity as a remedial medicine for common and complicated human body impacts. The cover of the November 28, 1998 issue of Time magazine reads, "The Herbal Medicine Boom...It's great business, but is it good for what ails us?" Even Robitussin has come out with an herbal-based children's remedy sold over the counter for coughing. Only a few years back, the use of herbs as a chosen remedy in the U.S. was limited to "alternative" lifestyle people. Will phytoremediation cultivate into good environmental business in the future? In the beginning, applications of environmental phytoremediation will propagate with the few innovative parties willing to risk and pay for furthering the development of an alternative technology.

An attorney once made the analogy between the goals of an environmental geologist and a medical doctor; the difference being the remedied media - human vs. environment. A medical doctor completes an exam on a human client in much the same way a geologist/scientist/engineer completes a remedial investigation. There are both intrusive and non-intrusive methods of obtaining required samples and data to determine the physical and chemical nature of a system. Once the system/site is characterized/diagnosed, the remedy is selected based on considered criteria, including effectiveness, time, and cost. If increased environmental use and profitability of plants parallels the historic medical use, I suspect there will be a few "snake-oil treatments" being "petaled" at the remedial market place.

The trend is there, plants are gaining ground as a recognized remedy for human bodies and the environment. As plants expand into environmental remedies, I suspect a lag time between daring few voluntary employments to being an accepted remedy in a feasibility study.

Phytoremediation can be considered as a secondary remedy, used in association with other physical and chemical methods to reduce risk. Of course, with any remedial technology, pilot tests and studies will need to be conducted to prove effectiveness. Responsible parties will have to decide the cost effectiveness of using plants vs. implementing a proven technology. Although, the use of plants to remediate surface soil and reduce risk would appear to be an inexpensive remedy, the extended costs of operation and maintenance (planting and harvesting) and confirmatory sampling may increase the costs in the long run. The long run may be too long to justify the commercial worth and liability of the property. The role of project managers will require an understanding of more processes and how they interact (and what the real cost is).

As plant remediation grows into the feasibility study status, also will the role of biologists in environmental remediation. The table will continue to be expanded as resolving environmental issues evolves to include more disciplines. Will there be a time when biologists hire a lobbyist to push forward their need for Professional Biologist (P.B.) registration?

All said, it is still amusing and pleasing to envision a fenced off area with a sign indicating, "no public access - hazardous waste area," and inside is a fully vegetated area of flowering plants. Add two Tyvek-suited samplers with monitoring equipment for effect.

Maybe the proclamation for the new millennium should be *Carpe Phyto*.

Happy Holidays and New Year,

Vita DeMarchi P.G.

GEOLOGIC NEWS

A New Gold Rush?

from Jon S. Fox

Geoscientists in New Zealand have reportedly induced certain plants to accumulate relatively large concentrations of gold from ores through application of ammonium thiocyanate (Chemical and Engineering News, 12 October 1998). The plants include members of the mustard family and chicory. This implies that "biomining" of gold and possibly other elements may be possible, even profitable, under certain environmental conditions. These so-called "bio-ores" have reportedly contained gold at a concentrations up to 150 parts-per-million (ppm) after incineration of the biomass. Research suggests that the economic "break even" point is realized at a gold concentration of only 17 ppm.

For more information on the utilization of plants to manage levels of organics in soil, come to the CNYAPG December meeting (see Calendar).

News from the Net:

Boning Up on The Basics

Phytoremediation is a system whereby certain plants, working together with soil organisms, can transform contaminants into harmless and, often, valuable forms. This practice is increasingly used to remediate sites with heavy metals and toxic organic compounds.

Phytoremediation takes advantage of plants' nutrient utilization processes to take in water and nutrients through roots, transpire water through leaves, and act as a transformation system to metabolize organic compounds, such as oil and pesticides. Or they may absorb and bioaccumulate toxic trace elements, such as the heavy metals, lead, cadmium, and selenium. In some cases, plants contain 1,000 times more metal than the soil in which they grow. Heavy metals are closely related to the elements that plants use for growth.

This affordable technology is most useful when contaminants are within the root zone of the plants (top 3 to 6 feet). For sites with contamination spread over a large area, phytoremediation may be the only economically feasible technology. Adding to it's affordability is the usage of the same equipment and supplies used in agriculture.

Ilya Raskin and his interdisciplinary team at Rutgers AgBiotech Center were the first to demonstrate the utility of certain varieties of mustard plants in removing such metals as chromium, lead, cadmium, and zinc from contaminated soil.

Plants can accelerate bioremediation in surface soils by their ability to stimulate soil microorganisms through the releases of nutrients from and the transport of oxygen to their roots. The zone of soil closely associated with the plant root, the rhizosphere, has much higher numbers of metabolically active microorganisms than unplanted soil. The rhizosphere is a zone of increased microbial activity and biomass at the root-soil interface that is under the interface of the plant roots. This symbiotic relationship between soil microbes is responsible for the accelerated degradation of soil contaminants.

Compounds are frequently transformed in the plant tissue into less toxic forms or sequestered and concentrated so they can be removed (harvested) with the plant. For example, mustard greens were used to remove 45% of the excess lead from a yard in Boston to ensure the safety of children who play there. The sequestered lead was carefully removed and safely disposed of. Besides mustard greens, pumpkin vines were used to clean up an old Magic Marker factory site in Trenton, NJ. Hydroponically grown sunflowers were used to absorb radioactive metals near the Chernobyl nuclear site in the Ukraine and a uranium plant in Ohio. The mustard's hyper-accumulation results in much less material for disposal. The composting of plant material can be another highly efficient stage in the breakdown of contaminants removed from the soil.

When trees are used, such as poplars, the idea is to move as much water through them as possible, so that they take up as much of the contaminants as possible. Once the heavy metals are absorbed, they are sequestered in the trees' roots. Any organic compounds that are absorbed wind up being metabolized.

Cleaning the top 15 centimeters (6 inches) of contaminated soil with phytoremediation costs an estimated \$2,500 to \$15,000 per 2.5 acres, compared to \$7,500 to \$20,000 for on-site microbial

remediation.

Plants effectively remediate soils contaminated with organic chemical wastes, such as solvents, petrochemicals, wood preservatives, explosives, and pesticides. The conventional technology for soil clean-up is to remove the soil and isolate it in a hazardous waste landfill or incinerate it.

Salt-tolerant plants, called halophytes, have reduced salt levels in soils by 65% in only two years in one project involving brine-damaged land from run-off from oil and gas production in Oklahoma. Perhaps it should be a consideration for Onondaga County roadsides in the Spring.

The establishment of vegetation on a site also reduces soil erosion by wind and water, which helps to prevent the spread of contaminants and reduces exposure of humans and animals.

Further Proof That Trees are Our Friends

The growth rate of Loblolly pines in a North Carolina forest increased by 12% when the trees were exposed for one growing season to carbon dioxide levels projected for 50 years in the future, according to initial data gathered in a study by a team of scientists from the University of Illinois, Duke University, the Brookhaven National Laboratory, and West Virginia University.

Evan DeLucia, of the U. of I., remarked, "We may need to put more focus on the issue of soil management so carbon dioxide can be stored in the ground. The key is long-term, locked-up storage below ground. Everything we see aboveground will end up back in the atmosphere in one or a few human lifetimes. All of it will die and decompose. Trees are short-term carbon storage. Carbon must go into soil to remove it from the atmosphere."

According to DeLucia, trees can use higher levels of carbon in photosynthesis, but the question is how much more can they use and ultimately store. For further info, refer to the following Web sites:

<http://www.admin.uiuc.edu/NB/98.09/TreesCO2.html> and <http://www.sciencedaily.com/releases/1998/09/9807115650.htm>.

Hybrid Poplars Thirsty for Heavy Metals and Solvents

The Associated Press reports that cleaning up polluted industrial sites may not require billion-dollar government programs. Instead, scientists are suggesting that we plant poplar trees.

Laboratory-designed hybrids of the fast-growing poplar tree have been found to act like 100-foot straws, sucking contamination from soil and groundwater.

In turn, the tree either safely stores the chemicals in its tissues or metabolizes them into less volatile compounds. The tree then releases these byproducts into the atmosphere through its leaves as vapor.

Although it takes several years to complete, this natural cleanup method is inexpensive and may work as well as high-tech soil roasting and groundwater filtering, while maintaining green space.

Researchers even believe that phytoremediation may transform industrial and government agency treatment of long-term pollution problems, which currently are estimated at more than \$200 billion nationwide.

The drawback is that it is still unknown whether the chemical byproducts generated by the poplars are, in fact, less harmful, or if diluting them in the atmosphere only creates another hazard. David E. Salt, an environmental chemist at Northern Arizona University, stated, "We may soon be using trees to heal the hurt inflicted on the Earth, but would we simply be exchanging soil pollution for air pollution?"

However, one study, published in the October issue of *Nature Biotechnology*, showed that research for a team at the University of Georgia were able to genetically engineer the yellow poplar to a tenfold increase in mercury resistance and its ability to transport it through its root system and tissues, reduce it to a less volatile form, and release it into the air. The hybrid has not yet been planted in field tests, however.

The yellow poplar, which grows primarily east of the Mississippi River, is one of the largest and most commercially valuable hardwood trees. It is favored for phytoremediation for the same reasons that make it popular with commercial foresters, plywood manufacturers, and neighborhood landscapers.

The yellow poplar, also known as the tulip poplar, grows up to 15 feet per year and absorbs 25 gallons of water per day. With broad green leaves measuring up to 6 square inches, there is plenty of leaf surface available to release processed contaminants. The poplar also has an extensive root system and is very resistant to everything from gypsy moths to toxic wastes. The poplar gives every appearance of being a true survivor and a major asset in aiding the earth in cleaning itself up.

Lithoprobe in Canada Answers More Questions

Geologist and geochemists from the University of British Columbia, the University of Calgary, and the Centre de Recherches Petrographiques et Geochimiques in France (GSA Today, Vol. 8, No. 10) have been involved with the Lithoprobe project, a geological research project of respectable scope and funding sponsored by the Canadian government (bless our knowledgeable neighbors to the north). The primary goal of the Lithoprobe project is to investigate continental evolution over extended periods of geologic time. A comprehensive synthesis of the project is tentatively scheduled for publication in 2003. Data collected suggest the southeastern Superior province of the Canadian shield in Quebec (adjacent to New York) developed through tectonic accretion in a subduction zone, which progressively stepped south through Late Archean time (approximately 3.6 to 2.4 billion years ago).

Meanwhile, on the Homefront: Membership Renewal Time is Here

CNYAPG Members: it is time to renew your memberships. Renewals are still a low **\$20 per year**.

As you may recall, all CNYAPG memberships expire on December 21st. All current members should be receiving renewal forms with this newsletter. The forms will contain the information we currently have on file for you and your membership expiration date. Please make the necessary additions or changes to the forms and return them with your \$20 dues, made payable to CNYAPG.

Those of you who previously paid multi-year memberships will also receive a renewal form. Please check the expiration date and make corrections to your personal information as may be necessary. If all information is current, and you are paid up, you need not return the form.

If you do not receive a form, or know of a potential new member who needs a membership application form, you may download it from our Worldwide Web Site at www.dreamscape.com/cnyapg or call Gerry Gould (CNYAPG Secretary) at 437-1142 (feel free to fax a request to Gerry at 437-1282 also).

What Next?

Do you have any ideas for a CNYAPG sponsored Spring Field Trip or Seminar? Let us know at www.dreamscape.com/cnyapg.

Keep the newsletter input coming. Send ideas, articles of interest, requests, and questions for the newsletter to Vita DeMarchi at vdemarchi@secor.com.

Special Note: We need a short course/seminar committee to work on a program for Fall 1999. Your input and volunteer time will be greatly appreciated by all members!

✳ CONTRIBUTIONS TO THIS MONTH'S CNYAPG NEWSLETTER WERE MADE BY:
Vita DeMarchi Jon. S. Fox
Gerry Gould
Buck Gabriel Georgia Popoff

December 10, 1998

CNYAPG Meeting @ the Glen Loch Restaurant in Jamesville. Mr. Michael Coia, Director of Remediation at Phytoworks, Inc. will be our guest speaker. He will discuss utilization of plants to reduce concentrations of organic and inorganic constituents, including mercury, in soil and water. He will present applications of this innovative treatment technology. Check out the PhytoWorks Web site in advance at www.phytoworks.com.

January 14, 1999

CNYAPG and ASCE join to welcome Kevin Bernstein, Esq., with Bond, Schoeneck & King, will discuss the professional working relationship between geologists, engineers, and attorneys. Dr. Bill Kelly, president of the New York State Council of Professional Geologists (NYSCPG) will give an overview of professional geologist licensing status. The meeting location will be announced next month.

February 12, 1999

CNYAPG will host a **Geology Student Poster Session** (location to be announced). Meg Harris is coordinating with regional colleges and universities to bring up-and-coming geologists for the opportunity to meet and mingle with CNYAPG professionals. Dr. Bill Kappel of the USGS will give an update on Tully's Bear Mountain Study and set forth an offer to be involved (as a volunteer) in future research.

March 11, 1999

CNYAPG will host a series of short technical presentations. The prospective agenda includes "Practical Considerations for Well Design, Installation, and Development," by Bill Morrow of Parratt-Wolff, Inc., and a new method in PCB, dioxin, and PAH screening techniques by Columbia Analytical Services, Inc.

April 8, 1999

Members of CNYAPG have voiced an interest in an update on **Onondaga Lake**. We are coordinating speakers to accommodate this request. Tentatively, the evening will include a viewing of a slide show produced by Atlantic States Legal Foundation to generate new excitement about the lake's future and trace the history that created one of the most polluted bodies of water in the U.S.

May 1999

CNYAPG Walking Tour with Mr. Bob Preyer of the MOST. Tour downtown Syracuse, reflecting on the geologic origins of local building materials and stone work. The tour will conclude with dinner and end-of-year party at a downtown pub location.

Directions to the Glen Loch



**CUT & PASTE
MAP HERE**

TAKE NOTE: Due to an increase in dinner costs, dinner is now \$15.00 if reserved 24 hours in advance and \$17.00 at the door. Make your reservations today by calling O'Brien & Gere Engineers at (315) 437-6100, extension 2656.

The Board Members would like to thank all of the corporate and individual supporters of CNYAPG throughout the past year. We would like to encourage you to continue your pledge of support throughout the upcoming year. Contact Steve Crook at (315) 437-1429 or (518) 827-5720 details.

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CNYAPG MISSION STATEMENT

The CNYAPG was founded in 1993 to strengthen and advance the geologic sciences as a profession and to provide an open forum for the exchange of ideas; to promote the protection of public welfare through the professional practice of geologic sciences; to inspire and maintain the highest standards of professional conduct, business ethics, and personal honor of the membership; to foster the spirit of scientific research throughout the membership; to publish and otherwise disseminate information related to the geologic sciences and associated technologies; to maintain and encourage intra- and inter-association activities, to enhance the association's programs, and to encourage the affiliation of individual members with other scientific and technical organizations.

