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Superfund Sites Yield New Drugs/Tourist Attractions

In 1993, *Travel and Leisure* Magazine ran an article on the Continental Divide. It was tough on Butte: "the ugliest spot in Montana - despite a spirited historic district amid the rubble, the overall picture is desolate." It called nearby Anaconda "a sad sack mining town dominated by a smelter smokestack."[1] Today things are somewhat different for these two sites.

Butte, Montana - Lake Berkeley

Edwin Dobb reports, "At one time Butte provided a third of the copper used in the United States - all from a mining district only four miles square. Eventually open-pit mining was used and the pit became the world's largest truck operated mine, along the way displacing some Italian and Serbo-Croatian neighborhoods. Mining came to a halt in the early 1980s, as did the pumps that had been sucking groundwater out of the mines for a century. The flooding began."[2]

The 1.5-mile wide, 1,800-foot deep pit, part of the nation's largest Superfund site, has been filling for the last 20 years with a poisonous broth laced with heavy metals and arsenic - a legacy of Butte's copper mining days. When mining officials abandoned the pit and stopped the pumps that kept it dry, they opened the spigots to about 3 million gallons of water per day. Today, the lake is about 850 feet deep and contains more than 3 billion cubic feet of water.[3]

Lake Berkeley, also known as The Berkeley Pit, covers almost 700 acres of the former open-pit copper mine. It holds some 30 billion gallons of highly acidic, metal-laden water. It's the country's largest and most unusual body of contaminated water, with a pH of 2.6 and metals such as Al, As, Cd, Cu, Fe, Mn, Zn and others.[1] Yet as *New Scientist* reports, "Every cloud has a silver lining." The contaminated lake designated hazardous is turning out to be a source of novel chemicals that could help fight migraines and cancer.[4]

In recent years, more than 40 small organisms have been discovered in the lake and these hold much potential for agriculture and medicine. It's even thought that some of these organisms can be employed to reclaim the lake and other similarly contaminated waters by neutralizing acidity and absorbing dissolved metals.

Andrea and Don Stierle and their colleagues have found a strain of the pithomyces fungi producing a compound that bonds to a receptor that causes migraines and could block headaches, while a strain of penicillium fungi makes a different compound that inhibits the growth of cancer cells.[4] In July 2006, the Stierle team revealed that a novel Berkeley Lake compound called berkelic acid from another new strain of penicillium fungus reduced the rate of ovarian cancer cell growth by 50%.[5]

How is this possible? Essentially, some organisms actually flourish in the presence of acidity and make use of some of the dissolved metals in the lake. These are called extremophiles (liking extremes), because they not only tolerate, but even thrive in extreme conditions. As mentioned in a previous column,[6] extremophiles can tolerate heat, very cold climates, high pressure, low pH solutions and high pH solutions. Japanese scientist Koki Horikoshi has found a variety of chemically-tolerant extremophiles in the deepest parts of the ocean. Some of them can even degrade hydrocarbons while thriving in water containing up to 50% solutes such as toluene, benzene or kerosene.[7] A strain of mold has been reported that grows in a 270 g/L copper sulfate solution containing some sulfuric acid as long as some sugar is present.[8] Rich, blue bacteria have been found in potassium ferricyanide solution.[9]

Why do extremophiles show new antibiotic and anticarcinogenic activi-

Berkeley Pit Lake, circa 1984. The arrow shows the approximate lake level today *(User created public domain image - GFDL – Wikipedia, 2006).*

ties? The best guess is that some of them have evolved powerful toxins to attack an enzyme associated with a particular fungal growth phase. Another possibility is that they are particularly adept at sticking tightly to surfaces and this is one of the attributes researchers look for in anti-cancer drugs.[10]

Anaconda, Montana - The Old Works Golf Course

Twenty-five miles down the road from Lake Berkeley is the town of Anaconda, Montana, another Superfund site. The Anaconda smelter was once one of the shining stars of the American mining industry employing thousands of people. The facility first began copper smelting operations in 1884 and the smelter rose quickly to national prominence because of its noticeable annual copper production. However, this all came at a price to the environment. The land was left gouged with mines and extensively contaminated with heavy metals. The Anaconda smelter was demolished after its closure in 1981. However, the smelter stack, the tallest and possibly largest free standing masonry structure in the world, remains standing. The site is now a Montana State park.[11]

And speaking of parks and tourism, these days, the town of Anaconda has redefined itself, turning to tourism and recreational pursuits to attract visitors and provide jobs for its citizens. A major attraction is the Old Works Golf Course built on the site of the copper smelter. Jack Nicklaus, hired to design the course, reportedly called the site the ugliest he had ever seen. One of the most expensive golf course reclamation projects ever undertaken, the $15 million project included capping the entire area with crushed rock, clay, and topsoil. Lakes were created to catch and filter water, and plastic liners were installed to protect trees, greens and bunkers.[12]

The course includes capped slag and tailing pipes and some of the landscape's century old flues and smelting ovens. Sand traps are black, a clever use for more than 14,000 cubic yards of inert smelting slag ground to the texture of sand. Massive stone furnace walls line some of the fairways. As mentioned in an earlier column,[13] the course's 18th hole is called "Anode," for the smelter's final product, the copper anode bar. For the non-golfer, a historic hiking trail highlighting Anaconda's smelting heritage and giving hikers an insight into copper mining techniques of years past winds its way around the course.

Anaconda Smelter Stack (*User created public domain image – Wikipedia, 2007).*

Some other sites

The Homestake Gold Mine in South Dakota, site of a spill of six to seven tons of cyanide-laced tailings into a creek in 1998, has been selected as the preferred site for a $500 million Deep Underground Science and Engineering Laboratory.[14] Because of the up to 8000-foot depth of the mine, this would make it the best shielded laboratory in the world for neutrino studies and a major advance in sensitivity in the search for proton decay.

An artificial lake in El Salvador, brimming with sewage and industrial waste, is mystifying scientists by attracting thousands of migratory and sea birds. Built in 1974 to drive El Salvador's biggest hydroelectric project, the 33,360-acre Cerron Grande reservoir collects some 3,800 tons of excrement each year from the sewage pipes, as well as factory run-off and traces of heavy metals like chromium and lead, the government estimates. So scientists are puzzling over the fact that some 150,000 seabirds from more than 130 species have chosen to make the reservoir their home. At least 90 of the species are migratory birds arriving from as far away as Alaska.[15] Birds do not survive in Lake Berkeley. So what's the difference between the two lakes? Could it be the 3,800 tons/year of excrement? **P&SF**

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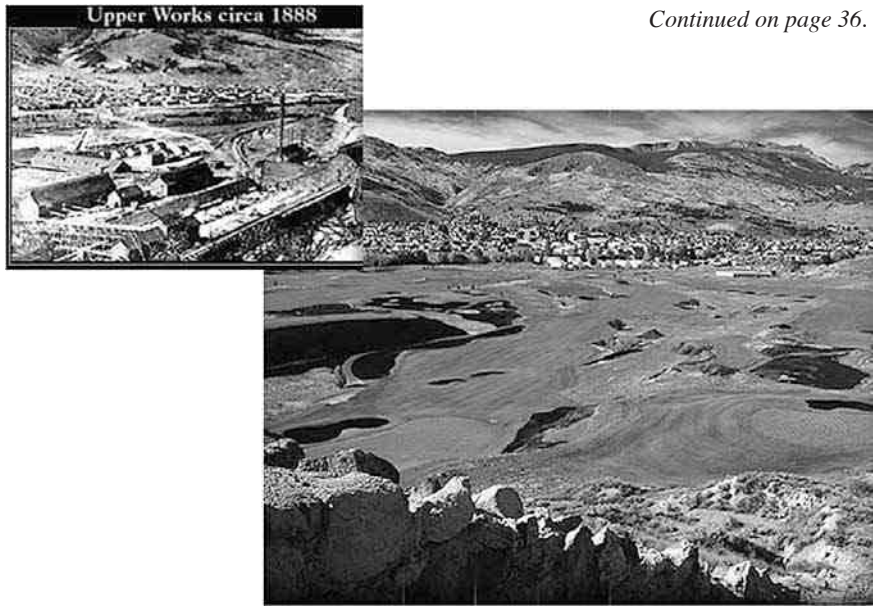

Old Works Golf Course built on the site of the copper smelter

COATING 2008 online registration opens

On-line registration for COATING 2008, the international conference and trade show for the end users of industrial coatings, is now available on the show website: www.thecoatingshow.com. Focusing on today's "hot topics," COATING 2008 will brings the latest on green technologies, energy efficiency, cost reduction and quality improvement in both its conference sessions and through its more than 150 exhibitors on the show floor. The three-day conference will feature more than 30 sessions covering everything from liquid to powder coating, electrocoating to IR curing and pretreatment to porcelain enamel.

Scheduled for September 23-25, 2008 at the Indiana Convention Center in Indianapolis, IN, COATING 2008 is sponsored by the industry's leading trade associations: The Powder Coating Institute, The Chemical Coaters Association International, The Electrocoat Association, The Porcelain Enamel Institute and the Industrial Heating Equipment Association's Infrared Div. This is the finishing industry's comprehensive conference and trade show that brings finishers a timely and important technical conference program along with a show floor filled with the latest technologies to help to turn operations green and become more energy efficient while cutting costs and raising quality. ***P&SF***

Answers to I.Q. Quiz #443

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1. Airborne dirt, air agitation, anode dissolution, bus bar deterioration (via chemical attack, corrosion), chemical additions, drag-in, undissolved additions (boric acid) and water replenishment.
2. 1.0 to 100 µm
3. False. Cellulose powders are more appropriate
4. Increase the chances that a particle will be picked up.
5. Microfiltration, reverse osmosis, ultrafiltration and nanofiltration.

Fact or Fiction?

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Editor's Note: *Don't forget to check out Mr. Dini's blog at http://myblogscience.blogspot.com for more of his provocative works that might not have appeared in* Plating & Surface Finishing.

Finishers' Think Tank

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ing for ease of installation, maintenance and replacement. Because of the dependable utility of equipment, one or two bath turnovers can be improved to two to four. More solution filtration over time improves clarity, plating quality and overall process performance. A superior filtration system with carbon would use a system rated to turnover the solution from two to ten times per hour. At the discharge point, 80 to 95% of the filtered solution returns to the plating tank, while 5 to 20% flows to a granular carbon bed, passes through, and back to the plating tank.

It is critical to note sources of contaminants in the plating bath that are preventable. For example, oils and grease dragged in would indicate poor cleaning and/or insufficient rinsing. Ripped anode bags are a continual source of plating deposit roughness. In the example of nickel plating, the process is 93% efficient, while closed looping may be up to 100% efficient. This unfortunate circumstance builds contaminants and also promotes a common ion effect, where precipitated salts coat the anodes, resulting in polarization. Parts dropped in the plating tank, depending on solution pH, may gradually dissolve, resulting in metallic contamination. These are problems that filtration is not a cure all for. There is no magic wand. But by practicing good maintenance, optimizing processes and staying the course, proper filtration adds that extra octane, supplying high performance to metal finishing processes.

I wish to thank Mr. Jack Berg and Mr. Charles Schultz of Serfilco for their technical expertise. ***P&SF***

Editor's Note: *Be sure and check out Charles Schultz's article on filtration in this issue.*