The Pit of Life and Death

Written by Richard Solensky on 01 July 2008

Just outside Butte, Montana lies a pit of greenish poison a mile and a half wide and over a third of a mile deep. It hasn’t always been so – it was once a thriving copper mine appropriately dubbed “The Richest Hill in the World.” Over a billion tons of copper ore, silver, gold, and other metals were extracted from the rock of southwestern Montana, making the mining town of Butte one of the richest communities in the country, as well as feeding America’s industrial might for nearly a hundred years. By the middle of the twentieth century, the Anaconda Mining Company was in charge of virtually all the mining operations. When running underground mines became too costly in the 1950’s, Anaconda switched to the drastic but effective methods of “mountaintop removal” and open pit mining. Huge amounts of copper were needed to satisfy the growing demand for radios, televisions, telephones, automobiles, computers, and all the other equipment of America’s post-war boom. As more and more rock was excavated, groundwater began to seep into the pit, and pumps had to be installed to keep it from slowly flooding.

By 1983, the hill was so exhausted that the Anaconda Mining Company was no longer able to extract minerals in profitable amounts. They packed up all the equipment that they could move, shut down the water pumps, and moved on to more lucrative scraps of Earth. Without the pumps, rain and groundwater gradually began to collect in the pit, leaching out the metals and minerals in the surrounding rock. The water became as acidic as lemon juice,
creating a toxic brew of heavy metal poisons including arsenic, lead, and zinc. No fish live there, and no plants line the shores. There aren’t even any insects buzzing about. The Berkeley Pit had become one of the deadliest places on earth, too toxic even for microorganisms. Or so it was thought.

In 1995, an analytic chemist named William Chatham saw something unusual in the allegedly lifeless lake: a small clump of green slime floating on the water’s surface. He snagged a sample and brought it to biologist Grant Mitman at the nearby Montana Tech campus of the University of Montana, where Mitman found to his amazement that the goop was a mass of single-celled algae. He called in fellow Tech faculty Andrea and Don Stierle, experts in the biochemistry of microorganisms. The Stierles had recently been trekking about the northwest, looking for cancer-fighting compounds in local fungi with great success. Coincidentally, the Stierles’ funding had just run out, and they needed a new project. They leapt at the opportunity to study these bizarre organisms.

After examining the slime under a microscope, the researchers identified it as *Euglena mutabilis*, a protozoan which has the remarkable ability of being able to survive in the toxic waters of the Berkeley Pit by altering its local environment to something more hospitable. Through photosynthesis, it increases the oxygen level in the water, which causes dissolved metals to oxidize and precipitate out. In addition, it pulls iron out of the water and sequesters it inside of itself. This makes it a classic example of an extremophile.

Extremophiles are organisms that can tolerate and even thrive in environments that will destroy most other living things. Some can even repair their own damaged DNA, a trait which makes them extremely interesting to cancer researchers. The Stierles reasoned that where there’s one extremophile, there may be others – most likely blown in by the wind. Given their previous successes with strange microorganisms, the researchers believed that the Berkeley Pit and its fledgling extremophile population could produce some medically useful chemicals.

The Stierles were so intrigued by the possibilities that they started work even before securing funding. A squadron of expert researchers was recruited from the undergrads at Montana
Tech, and even from a local high school. They collected water samples, isolated microorganisms, and cultured them. The team eventually identified over 160 different species, but they lacked the equipment needed to isolate the interesting chemicals from the microorganisms. Shlepping around western Montana, the Stierles begged and borrowed time at other facilities while they doggedly processed the cultured organisms. Their tenacity led to the discovery of a number of promising chemicals. Three of these, berkeleydione, berkeleytrione, and Berkeley acid, came from species of the fungus Penicillium that had never been seen before, and were therefore named after the Berkeley Pit.

The next step was to see what effect these chemicals had, if any, on other living cells. Thanks to modern biochemical assay techniques, dozens of chemicals can be tested against one organism— or one chemical against dozens of organisms— in a single pass. For reasons that are not entirely clear, many compounds which attack cancer cells are also harmful to brine shrimp, therefore most modern assay tests include the brine shrimp lethality test as a standard procedure. The Stierles exposed swarms of tiny crustacean volunteers to the Berkeley Pit chemicals, and to their delight, five of the chemicals showed anti-cancer properties. Further tests revealed that berkeleydione helped slow the growth of a type of lung cancer cell, and Berkeley acid went after ovarian cancer cells. All five were passed along to the National Cancer Institute for further study.

Other researchers are looking into the Pit as well — not for cancer-fighters or other drugs, but simply for ways to help clean the place up. In 1995, a flock of migrating snow geese stopped at the massive pond for a rest, and at least 342 of them died there. Authorities now use firecrackers and loudspeakers to scare away migrating waterfowl, but there have been a few smaller die-offs nonetheless. Also, on certain mornings, a sinister mist creeps out of the Pit and wraps its tentacles around the streets of Butte. Citizens are understandably anxious about this potentially poisonous fog of doom. The water level is rising at a rate of several inches a month, and if unchecked it will spill over into the area’s groundwater in twenty years. That danger has earned the area the dubious distinction of being one of the EPA’s largest Superfund sites. Normally such water is treated by adding lime to the water to reduce the acidity and remove much of the metal, however the Berkeley Pit is so saturated with undesirables that this process would produce tons of toxic sludge every
day. Other methods are safer, but are prohibitively expensive. Currently, the EPA’s plan is to focus on containment.

Grant Mitman believes that the best way to clean up the Pit is to use the algae that already live there. E. Mutabilis, for one, tends to grow in clumps. These clumps clean up their neighborhoods enough for other extremophiles to move in. These organisms would collect the metals within their own cells, and upon dying they would sink to the bottom and drag the metals with them. To Mitman, it’s all a matter of finding the right mix of extremophiles for a self-sustaining algal colony. Once the right mix is found, there are many other mine-contaminated waters awaiting treatment that could use a similar biology-based cleanup.

With metals concentrated at the bottom, and cleaner water at the top, the Pit could conceivably be reopened. The bottom sludge could be collected and processed for its ever-more-valuable metal content, and the water could be used for industry or agriculture. While it might not be safe to drink, the water could still be worth a quarter million dollars a year in a water-hungry West. In the meantime, the Pit has become a popular tourist attraction. There’s a small museum and gift shop located well above the water level. A number of National Historic Landmarks related to mining are in the area, which has prompted some people to call for the creation of a National Park centered on the Pit. With luck, what was once the Richest Hill in the World could eventually provide riches of a different sort.

Further reading:

- Pitwatch
- Visit the Pit!
- WIRED Magazine
- New York Times

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