Our Mercury Mining Legacy

A Naturally Occurring Element

Mercury ore is often formed along fault lines associated with serpentine rocks. Serpentine was originally part of the ocean crust that was hydrolyzed and thrust to the surface in the plate tectonic process. Hot liquids carrying mercury, gold and other metals traveled along the fault lines between the serpentine and other rocks to form ore bodies. Cedar Roughs, Knoxville and Walker Ridge have large serpentine rock areas.

The Mining Process

Historically, to produce elemental mercury "quicksilver", mined ore was heated in "retorts" (furnaces that vaporized the mercury) and then condensed. During this refining process, mercury was spilled on the ground and lost to the air. The waste rock and tailings (processed ore) were simply dumped downhill— often directly into streams—where they conveniently eroded away in winter storms. These contaminated materials were deposited downstream, and now slowly leach and erode back into local creeks.

Today's Problems

There are about 100 abandoned mercury mines in the Cache Creek and Putah Creek watersheds. Some of the more well-known sites include Knoxville, Oat Hill, Aetna, and Helen mines in the Putah Creek watershed and the Sulphur Bank, Abbot-Turkey Run, Wide Awake, Elgin and Petray-Rathburn mines in the Cache Creek watershed.

Mercury is a powerful neurotoxin when converted to methylmercury (MeHg). Inorganic mercury is converted to MeHg by certain bacteria prevalent in creek sediments, lakes and wetlands. The concentration of MeHg in water is controlled in part by the concentration of total mercury in the underlying sediment and the rate at which the total mercury is converted to MeHg. MeHg "bioconcentrates" up food chains, magnifying in fish up to 10 million times more concentrated than in their water. Eating contaminated fish can result in neurological damage particularly in fetuses and children. This risk can be particularly dangerous to subsistence fishing families who rely on fish for both cultural and economic reasons.

Abandoned mine sites in the upper watersheds and their legacy contamination downstream are a significant contributor to water quality impairments in our region. This mining legacy contributes to the listing of the following waterbodies as impaired: James Creek (nickel and mercury), Lake Berryessa (mercury), and lower Putah Creek (mercury and boron). James Creek has been identified as prime trout habitat. Lower Putah Creek is a wild trout stream that drains into the Yolo Bypass, a nationally recognized fish rearing, wildlife habitat, farming, and flood control area with some of the highest mercury concentrations in the Bay- Delta. Fish consumption advisories are posted for Lake Berryessa and for lower Putah Creek because of fish mercury contamination.

More Information About Corona and Twin Peaks Mines

The Corona and Twin Peaks Mines are inactive mercury mines located in the northwest corner of Napa County, in the East Mayacmas Mercury District. Runoff and drainage water flows downstream to James Creek, Lake Berryessa, and beyond.

Mining claims at the Corona were initially made in the 1860s, but the first phase of mining was undertaken by the Vallejo Quicksilver Mining Company from 1895 to 1906. The towering furnace alongside Oat Hill Rd was constructed during that early period. The second phase of mining from 1928 until the early 1940s included excavating a drain tunnel, constructing and operating newer processing equipment, and processing old ore from the previous mine dumps. The third phase of mining from 1957 to 1972 included additional explorations, installing and operating a third generation of ore processing equipment, and processing ore from nearby mines. Similar but smaller-scale operations occurred at the Twin Peaks site from 1904 to 1943.

A Partnership for Cleanup

The Corona and Twin Peaks Mine Drainage Treatment Project began in 2012, stalled, and then restarted and finished in 2016-2019 with grants from the State of California's Ecosystem Restoration Program. The non-profit organization Tuleyome acted as a Good Samaritan and organized a project team of experts that has worked to:

- Address all applicable environmental regulations
- Obtain external peer review of the in-situ treatment methodology
- Revise the project scope and budget based on knowledge gained and to address peer review comments along the way
- Finalize a land transfer options agreement between the current landowner and the Napa County Regional Park and Open Space District to complete the public land donation component of the project.
- Coordinate with concerned neighboring land owners.
- Monitoring water quality in drainage waters before and during treatment
- Select, propagate, and transplant local native plants to revegetate erodible areas.

This project serves as an example mine site cleanup promoted through a Brownfields Assessment Project funded by US EPA. Tuleyome also obtained matching funding through Napa County's Measure A (Napa Flood Protection and Watershed Improvement Expenditure Plan). This project also demonstrates how non-profit organizations can work with private landowners and government agencies to address our legacy of abandon mine sites. Furthermore, this project is documenting the use of semi-passive biogeochemical technologies to address mine drainage.

Corona and Twin Peaks
Mine Drainage Treatment Project
~ Treatment Process Description ~

Natural geologic processes created an unusual pyrite and cinnabar ore body at the site. The rock also contains naturally elevated nickel concentrations. Mining excavations have allowed air and water to circulate through the remaining rock and generate acid. The acidic water drains through the rock and dissolves nickel and iron.

Acid drainage flows out of the mountainside at three locations: Boilerhouse Adit, Twin Peaks Adit, and Corona Drain Tunnel. Acid drainage from the Boilerhouse Adit and Twin Peaks Adit is collected and piped into infiltration trenches. These trenches prevent the drainage from flowing to nearby creeks. Drainage from the Corona Drain Tunnel flows directly into Kidd Creek.

Tuleyome's project includes three treatment components: (1) improve the infiltration trenches, (2) inject subsurface chemical amendments to reduce the concentrations of acid and metals draining from the mountainside, and (3) treat remaining discharges from the tunnel.

(1) Infiltration Trenches: Sand filter basins are being constructed to allow collection and storage of iron oxides that form as the acid drainage oxidizes. Trench piping systems are being improved to allow better distribution of flowing water, and the trenches are being realigned.

(2) Subsurface Chemical Amendment: Two wells were constructed to allow injection of bacteria, nutrients and chemicals near Corona Mine's known ore bodies (**Figure 1**). Tracer tests confirmed that chemicals released at the injection wells would flow out at the drain tunnel and infiltration trench. These components are being injected in a controlled manner via IW-1:

- **Bacteria**: Sulfate-reducing bacteria will hopefully create a biofilm to prevent the contact of oxygen and water with pyrite. This will prevent acid creation by circulating water and oxygen. The sulfate reducing bacteria will also create sulfide to precipitate iron and nickel.
- **Ethanol**: Provides carbon to feed the bacteria.
- **Nutrients**: Feed the bacteria.
- **Sodium Hydroxid**e: Raise the pH to optimal level for bacteria, and precipitate any extra manganese and iron that could be mobilized by the bacteria.

(3) Drain Tunnel Treatment: After the effects of subsurface chemical amendment are quantified, the remaining drain tunnel discharge should be collected and treated. That treatment would likely include pH adjustment, settling, and redox adjustment to remove the remaining metals.

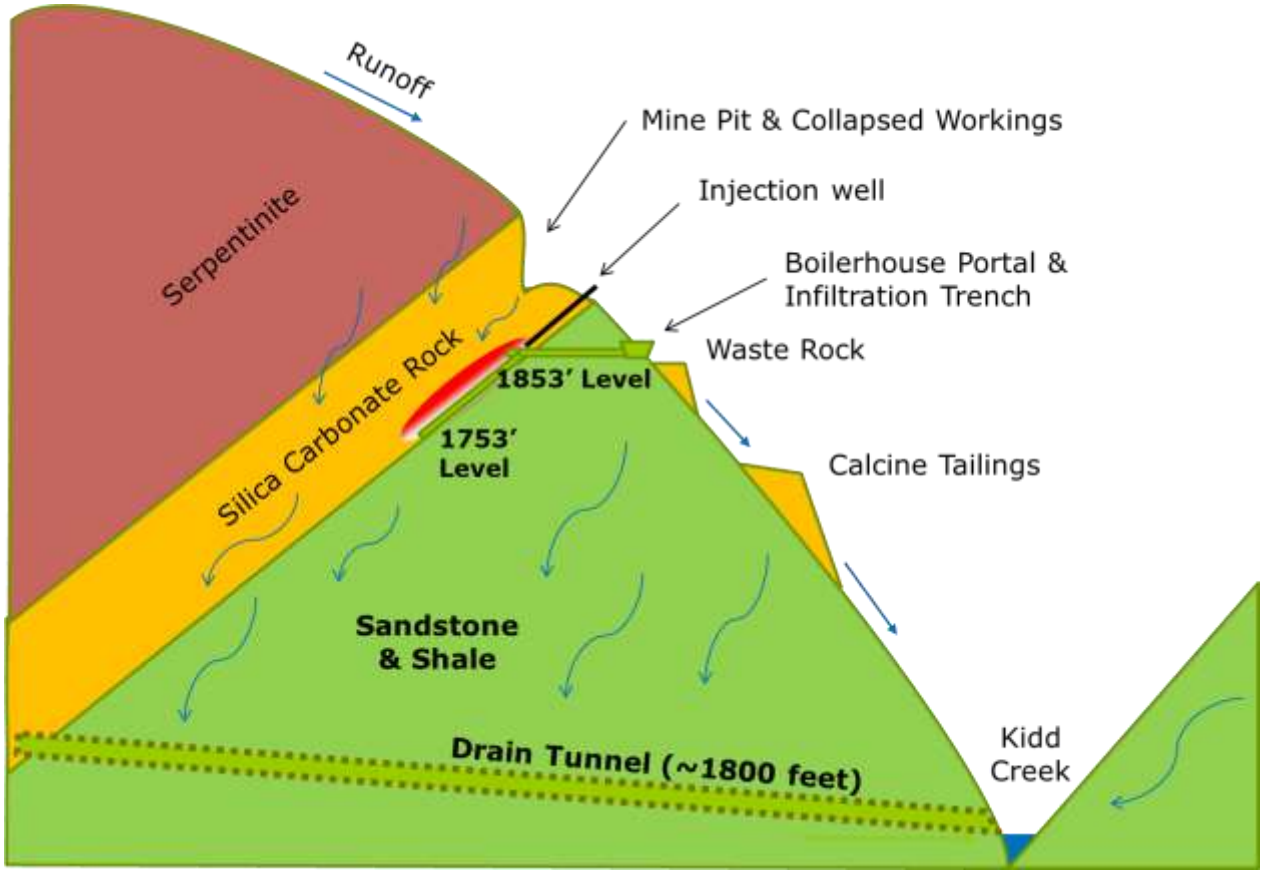

Figure 1: Conceptual Model of Corona Mine Workings and Injection Well. Pyrite-rich ore in the silica carbonate rock is exposed to oxygen and water in underground mine workings, creating iron- and nickel-enriched acid drainage. Subsurface chemicals are being added to neutralize acid and encourage bacterial growth on the ore body.