Uranium Mining in the Grand Canyon – Biting my Tongue in Front of Congress

As I sat before Congress in Washington DC last summer, I couldn't believe what the representative from the mining industry had just said. I had just testified on House Resolution 644, the Grand Canyon Watersheds Protection Act of 2009, and now the last member of the panel, the representative of the mining companies, was speaking. The mining representative had just stated to Congress, "A rock containing 1% natural uranium, 10,000 parts per million, or what is a maximum average grade of breccia pipes, can be held on a person's head for four hours, and the person will receive no more radiation than they would from a medical x-ray". I was thinking how best to respond a moment later when we would be questioned by members of Congress after the individuals on the panel finished their testimony.

I wondered if the mining representative's statement should be chided - "anyone who would make that argument has had uranium on their head too long" or "the reason I'm follicly challenged (lacking hair on top) is from balancing breccia". No, perhaps I should just explain the huge difference between putting unstable isotopes on your head, and ingesting them where internally the radionuclides accumulate, particularly in the proximal tubules of your kidneys. Build up of heavy metals in the human body can be manifest in many ways, from fatigue to central nervous system disruption, but often is a slow process that builds up over time. And it doesn't just go away quickly like when a rock is taken off your head after 4 hours or when the lead-protected, x-ray technician steps back in the room. Probably best to bite my tongue, stay on message, and ignore the comment from the mining representative, I thought.

I am profoundly concerned about mining in or near the Grand Canyon which I believe will damage the quantity and quality of Grand Canyon springs, and the plants and animals that depend on those springs. The lands in question include the Tusayan Ranger District and Federal land managed by the Bureau of Land Management in the vicinity of Kanab Creek and in House Rock Valley. The springs support a rich diversity of animals, birds, insects and plants, and provide water for backcountry hikers and Native Americans. My university research group was the first to study uranium concentrations in water from various springs in the Grand Canyon, including Horn Creek (which is below the site of the abandoned Orphan Uranium Mine on the Rim). In 1995 we discovered elevated uranium levels in Horn Creek (92.7 ppb), which is above the EPA Maximum Contaminant Level Goals (0 ppb), and in excess of the EPA Maximum Contaminant Levels (30 ppb). This provided part of the impetus for the Park Service to clean up the Orphan Mine site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund. The cost for remediation of the Orphan Mine's surface area is estimated at $15 million (Phase 1), but costs to remediate contamination in the underground portion of the mine and in Horn Creek are unknown (Washington Independent July 22, 2008). Elevated uranium concentrations in spring water below the Orphan Site relative to other Grand Canyon springs were later confirmed by a U.S. Geological Survey study. The Orphan Mine shut down in the late 1960s and early 1970s, yet decades later high uranium was showing up in springs below the mine site.

So this last summer, I sat and listened as Congress was addressed by representatives from the Havasupai tribe, from the Coconino County Board of Supervisors, from the Southern Nevada Water Authority, from the Grand Canyon Trust, and from the businesses in Tusayan who all voiced concerns about uranium mining near the Grand Canyon. I wasn't alone in support of H.R. 644 and my concern about mining operations. Two different panels testified with me before Congress that day, and each (except the two representatives of mining interests) expressed different reasons for their support of the House Resolution.

My own professional misgivings about mining operations around the Canyon, expressed in my Congressional testimony, centered on the potential degradation of both the quantity and the quality of Canyon spring flow that the mining operations would produce, and the subsequent impacts on the habitat and wildlife the springs support. It only takes a few hikes in the Grand Canyon for even the most rookie biologist to realize the importance of springs to the abundance and diversity of life in these verdant little pockets. And you don't have to be an expert to appreciate water value in arid lands. There are the hardcore scientists gathering information and statistics on springs, and then there is the backpacker or river runner, gathering his or her own data as a sundown frog symphony mixes with the sounds of their camp stove. If you've ever been thirsty in the backcountry, you know the importance of the Grand Canyon springs.

Breccia Pipes, Mining, and Groundwater Recharge

Over 10,000 mining claims have been staked in the region adjacent to the Colorado River and Grand Canyon National Park. It is important to understand geologic reasons why mining is proposed for the Canyon area, and how that might be detrimental to springs.

Uranium mines in the Grand Canyon area typically involve excavation of vertical and horizontal shafts into, or near, breccia pipes, which are geologic collapse features and zones of historical groundwater recharge. Breccia pipes are abundant in the region, and form vertical zones of angular clasts surrounded by a consolidated rock matrix originally formed by the caving-in of paleochannels in underlying rock. These pipes can also form ground surface depressions and sink holes (Huntoon, 1996). The way breccia pipes became collapse features was by dissolution cavities in the Redwall Limestone (halfway down the Canyon) falling-in, and chimneys of the rubble debris of broken up rock (breccias) propagating upward to ground surface on the Rim more than two thousand feet higher.

As mentioned, the ground surface expression of these pipes on the Rim was often a localized depression that could attract surface runoff waters. Surface runoff from rains and snowmelt eventually played connect-the-dots between many of these depressions. This made preferred pathways for surface flow on the Rim, and significant volumes of water passed in washes along the ground surface near these pipes, and were shunted underground to recharge

groundwater and eventually emerge as springs in the Canyon below. Water influx into the ground could be significant as evidenced during a 100 year flood event on the South Rim in August 1984 which wiped out U.S 64 - the road to Tusayan and Grand Canyon Village. The waters passed over the road and flowed down Little Red Horse Wash with a estimated peak flow of 2447 cubic feet per second but apparently dissipated in the large flat area some 4 miles downstream. There was no significant runoff reported beyond this area – the waters apparently disappeared and totally infiltrated into the ground (Canyon Uranium Mine EIS, 1986).

The reason the mining companies are so interested in these breccia pipes is because these same percolating and recharging waters also carried and deposited uranium as they moved downward through geologic history. Uranium was dissolved in surface waters in small amounts, and over the years it was carried to zones below the surface which were low in oxygen (like the Hermit Shale formation). In these anoxic conditions, uranium was chemically precipitated out of the dissolved phase, becoming a solid, minable rock in a breccia pipe environment.

This breccia pipe-type of uranium mine generates ore and waste rock which is typically stockpiled on the land surface until shipment to a mill takes place. Local precipitation and surface runoff waters can be in contact with this surface uranium ore. Certain mining activities, such as the interception of water by wells, creation of vertical shafts, the diversion of surface water, and the collection of surface water into holding ponds, has the potential to alter the amount and quality of water recharging the aquifers surrounding Grand Canyon National Park.

Diminishment of Spring Water Quantity – Part One, Mine Water Use

Uranium mines in the arid Southwest use water, which is usually supplied from wells or imported from springs. Water is necessary at mining operations to support drilling, potable water supply and sanitary needs. Wells in the Grand Canyon region typically are over 2000 feet deep, tapping the Redwall-Muav aquifer. This same Redwall-Muav formation is the level in the Canyon where the large majority of springs discharge (approximately halfway down the Canyon vertically). Previous uranium mining in the Grand Canyon region estimates that this water usage would be, at a minimum, over 2.5 million gallons per year for one mine (Canyon Uranium Mine EIS, 1986).

There are many springs and seeps in the Grand Canyon that, according to the US Geological Survey and other investigators, have discharge similar to these amounts, or even much less. Some of these springs and seeps are ephemeral, and the biotic communities associated with them are very vulnerable to the abstraction of water and reduction of flow. Multiplying potential water use of each mine by the number of potential mine sites gives a volume of water that if abstracted could eliminate and/or critically diminished a majority of springs and seeps in the Grand Canyon. The work of our research group at the University of Nevada, Las Vegas, (using environmental tracers including stable and radiogenic isotopes, trace elements, chlorofluorocarbons, and uranium isotope disequilibrium measurements,) shows compelling supporting evidence for existence of a hydrologic connection between the aquifers surrounding

the Canyon and the springs within the Canyon (Goings, 1985; Zukosky, 1995; Fitzgerald, 1996; Ingraham et al., 2001).

If all mining claims in the Grand Canyon region were turned into active mines and used the same amount of water as that projected by Canyon Uranium Mine (Canyon Uranium Mine EIS, 1986), the resulting water use would be over five times the use of the city of Flagstaff and would decimate Canyon springs. Fortunately, mining speculators typically stake many more claims than they will ever move into active mining sites. Even so, one mine alone could use water equivalent to several small Canyon springs or seeps.

Diminishment of Spring Water Quantity – Part Two, Piercing the Perched

The deep, drilled wells associated with projected mining operations throughout the Grand Canyon region, and the mine shafts themselves, have the potential to pierce smaller perched aquifers in the overlying Coconino Sandstone (approximately one-quarter of the way down the Canyon vertically), which supplies water to springs higher up on the wall of the Canyon. The Hermit Shale, which serves as a low permeability base holding up this aquifer, is unfortunately also the geologic unit in which much uranium is expected to have been emplaced, and which would necessarily be penetrated by vertical shafts.

In one uranium mine in the Grand Canyon region, a perched aquifer was encountered during exploratory drilling operations. Long-term downward drainage and water disruption potential of the mining operation was estimated to be over 1.3 million gallons per year (Canyon Uranium Mine EIS, 1986). Piercing a perched aquifer would have the effect of draining the perched aquifer, and disrupting flow to springs issuing from the Coconino Sandstone-Hermit Shale contact and the underlying Supai Group.

Diminishment of Spring Water Quantity – Part Three, Dam Surface Structures

The historical water recharge to the subsurface in potential mining areas could also be altered by surface mining structures. These structures include diversion channels, berms, dikes, or barriers to surface flow. These structures are designed, in part, to minimize contact of surface ore piles and waste rock with surface water runoff. Eventually this impoundment of surface water would manifest itself as diminished groundwater recharge and spring flow. Retention of surface water would unbalance the groundwater equilibrium between recharge and spring discharge, and could also affect the timing of downward water percolation, and eventually spring water quality.

Water Quality Impact

Throughout the U.S. and the world, valid claims by industry that their activities have not negatively impacted groundwater quality are buttressed by rigorous monitoring programs. These programs typically involve the emplacement of monitoring wells, regular sampling and chemical analysis of water, and hydrologic and hydrochemical mathematical modeling. No such industry program exists in the Canyon. There is no comprehensive system of monitoring wells

to support mining claims that prior mining in the Canyon region have had no impact. Testifying before Congress, the mining representatives were reduced to implying that the cosmetic fix of cleaning up a former mining site after mining operations to look nice at the surface, constituted evidence that there was no subsurface pollution. It is also important to realize that the effects of pollution on groundwater many take years, decades, or even centuries to be fully manifest. Groundwater movement is very slow compared to surface water flow.

The lack of clear and consistent monitoring of groundwater undercuts claims by the mines that previous mining in the Canyon has not harmed groundwater in the past. A friend once said, "standing in the middle of a busy freeway shouting 'I'm safe, I'm safe' because you haven't been hit with a car yet, doesn't really mean you're safe."

Biting My Tongue, Saying My Piece

The questions from the Congressmen and Congresswomen went about how I expected it. My experience as an "expert witness" in court proceedings had prepared me for supportive questions for the Representatives that supported H.R. 644, and for questions meant to undermine (pardon the pun) my testimony and my credibility from the other side. I did have to bite my tongue one more time, however.

When the Congressman who opposed H.R. 644 stated in the preamble to a question that I had "speculated" about groundwater flow in the Canyon, my mind flashed to the stalwart graduate students (particularly Jim Fitzgerald and Kim Zukosky), the great Park Service personnel, the good-spirited boatmen and women, and the many "sherpas" that had assisted our spring research through the years. We had carried heavy packs, endured and enjoyed all sorts of weather, hopped over snakes, and suffered bad jokes to get water samples in the Canyon. I looked around and thought that I might be the only one in the room who has carried 90 pounds of water samples out of the Canyon in one go, carried in ultra-pure nitric acid to preserve them, hiked in 120 degree heat to get them, slept with many liters of water in the bag at night in winter to keep them from freezing, did solo hikes, backed up chemical analyses with split samples to the U.S. Environmental Protection Agency on the campus of my university to make sure the samples gave accurate numbers, and published peer-reviewed articles in reputable journals and books which might capture the science, but none of the adventure and mystery. I bit my tongue, thinking he just wouldn't understand until he really experiences the Canyon, and quietly thanked the tremendous people with whom I'd shared the wonderful, wide, wild, grand, hole-in-the-ground.

What I did say, I'll write down now. I said that the science has shown that it is unreasonable to assume that the groundwater below the Rim of the Grand Canyon and in its breccia pipes does not have hydrologic connection with the Canyon's springs. It's unreasonable

to assume that water supply to mines is trivial, particularly if more than one mine begins operations in the Grand Canyon region. It's unreasonable to assume that the surface mining structures, the dams, berms, dikes won't reduce recharge to the Redwall-Muav aquifer, and that's if they don't fail and flood the subsurface with contaminated water. It's unreasonable to assume that mining in the Hermit Shale aquitard won't pierce the perched aquifer system in the Grand Canyon. It's unreasonable to assume that potential pollution to springs and drainages in the Canyon won't occur – we've already found it. And it unreasonable to assume that no potential huge cleanup costs will be associated with any pollution that does occur.

I then borrowed part of a wonderful quote that I had heard early in my environmental career. I said, by allowing uranium mining in the Grand Canyon region we were, like the sorcerer's apprentice, opening an environmental box, ignoring the precautionary principles that good scientists and responsible industry follow, principles that I teach to my students in the most basic environmental geology courses.

The Task Ahead

Scientific evidence suggests that the exploitation of uranium resources near the Grand Canyon will be intimately connected with the groundwater aquifers and springs in the region. The hydrologic impacts have a great potential to be negative to people and biotic systems. I believe that an assumption that uranium mining will have minimal impact on springs, people and ecosystems in the Grand Canyon is unreasonable, and is not supported by past investigations, research, and data. In my best professional judgment, I believe H.R. 644 will help preserve clean water and the sustainable natural resources that water supports, in this treasured region of our country. In my view, at the same time it will support recreational economic interests and indigenous peoples of the region.

This last summer, Secretary of the Interior Salazar temporarily placed 1 million acres of public lands surrounding Grand Canyon off limits to development of existing, unpatented claims. The order also halts new mining claims and exploration, in compliance with a June 2008 Congressional House Resolution by the Committee on Natural Resources. Much of the effort to enact protections across this area have been spearheaded by Congressman Raul Grijalva of Arizona. Unfortunately, the protections are not permanent, and do not affect the exploration of existing patented claims, or three existing mines in the area scheduled to reopen.

Responsible industry works hard to account for the long-term effects of its activities. Conscientious miners do this, not only with realistic projections of what those long term effects will be, but also with credible and continuing monitoring, accountability for past mistakes, and true adherence to a precautionary principle that does not allow short-term gain to outweigh public and ecological safety. Unfortunately, not all businesses are dependable, diligent, and answerable to this principle. Aldo Leopold once wrote, "One of the penalties of an ecological education is that one lives alone in a world of wounds". For every environmental battle won,

there appear more threats, often from unreliable, unknowledgeable, and/or unscrupulous individuals and companies.

In Greek mythology, King Sisyphus was condemned by the Gods for eternity to roll a rock up a hill in Tartarus, only to watch it roll down the hill, and start the task again. And so, the Sisyphean Grand Canyon environmentalist pushes the rock containing 1% uranium up the hill, with shoulders and head to the mineral. I wonder if the Greek King would have made a good shoe-tapper in an underground mining operation? Perhaps Camus said it best: "The struggle itself...is enough to fill a man's heart. One must imagine Sisyphus happy." So - Joy, Environmental Shipmates, Joy!

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