



THE LEGACY OF THE GRAND VIEW MINE

Grand Canyon National Park, Arizona

By Ray Kenny, Ph.D., PG

Small isolated mines in Grand Canyon National Park stand as mute testimony to the early days of mining. Remote mine locations, the daunting task of hauling supplies to mine sites, and removing ore out of the canyon for processing led to the limited and meager success of 19th and early 20th century mining in what is now Grand Canyon National Park. Some miners did manage to extract a significant amount of ore, however. In their wake, the miners left behind conspicuous heaps of waste rock that spread out like aprons in front of mine openings (fig. 1).

Today, many of the mines remain relatively inaccessible. However, improved travel corridors in the park have made some of these mines easy destinations. Moreover, the dramatic boost in backcountry use has increased the probability of visitors encountering these mines. In addition, many abandoned uranium mines that once lay outside the park are now within the recently established Parashant National Monument. These changes have raised important resource management questions about public safety, including waste rock cleanup, public exposure to contaminants and hazardous materials, and control of public access to mine shafts and adits. In an effort to attain the baseline data necessary to tackle these management challenges, researchers from Ft. Lewis College in Durango, Colorado, and New Mexico Highlands University in Las Vegas, New Mexico, measured radioactivity levels in contaminated waste rock piles at the abandoned Grand View Mine. After analyzing the data, we proposed recommendations for public safety.

Figure 1 (above). Beginning in 1890, mule teams hauled copper from the Grand View Mine up the Grand View Trail to the South Rim of the Grand Canyon. The National Park Service acquired the mine in 1939.

Background

In general, abandoned mines are found only in isolated pockets and limited areas of the Grand Canyon; the Grand View Mine is one of the more accessible mines, however. It is located about three miles from the South Rim at Grand View Point along the remarkably well-constructed and accessible Grand View Trail (fig. 2). A tenacious prospector named Pete Berry located the rich copper deposits of the Grand View Mine in April 1890. Berry and other miners worked the claim and constructed the steep Grand View Trail (see fig. 2) in the early 1890s (Billingsley et al. 1997, Anderson 1998). In 1895, Berry and others formed the Grand Canyon Copper Company and continued to work the mine—and improve the trail—until 1901. The mine produced high-grade copper ore with one notable specimen ending up on display in the famous 1893 Columbian Exposition in Chicago, Illinois. Berry later sold the mine and the president of a new mining concern, John Page, accelerated

Figure 2. The Grand View Trail leads to the Grand View Mine, one of the more accessible and hazardous mines in Grand Canyon National Park. Construction of the trail began in the late 1890s and the trail crosses a mine waste area that has elevated levels of uranium.



copper ore production. In 1907 the price of copper plummeted and mining activity gradually tapered off and eventually ceased by 1916. The mine was again sold and eventually the National Park Service acquired it in 1939.

The Grand View Mine is associated with a distinctive geologic phenomenon called “solution-collapse breccia pipes” (fig. 3). These features are unusual worldwide but are quite abundant in northern Arizona and southern Utah (Sutphin and Wenrich 1989). Literally thousands of breccia pipes are scattered across the region. Many of the breccia pipes contain relatively low-grade, widely disseminated uranium ore near the surface, but some pipes have

small pockets of ore that are more highly concentrated. Natural weathering and erosion processes can concentrate ore (Kenny and Vigil 1999), but past mining activity is primarily responsible for the elevated concentrations of uranium in surface and near-surface soils and waste rock.

Study methods

An initial step in the baseline study was to systematically record the radioactive contaminant levels in the soils and waste rock around the various entrances to the mine. Where possible, we established a grid pattern along the surface of the waste rock piles. We used an Exploranium GR-320 gamma-ray spectrometer (fig. 4) to record radioactive potassium, thorium, and uranium. We established local background soil levels by averaging numerous field readings collected on nearby soils not associated with the breccia pipe mine spoils. We also collected surface and outcrop samples for laboratory analyses and independent verification of the field results. We prepared the samples according to established EPA regulations. A private, independent laboratory, Energy Labs, analyzed the samples.

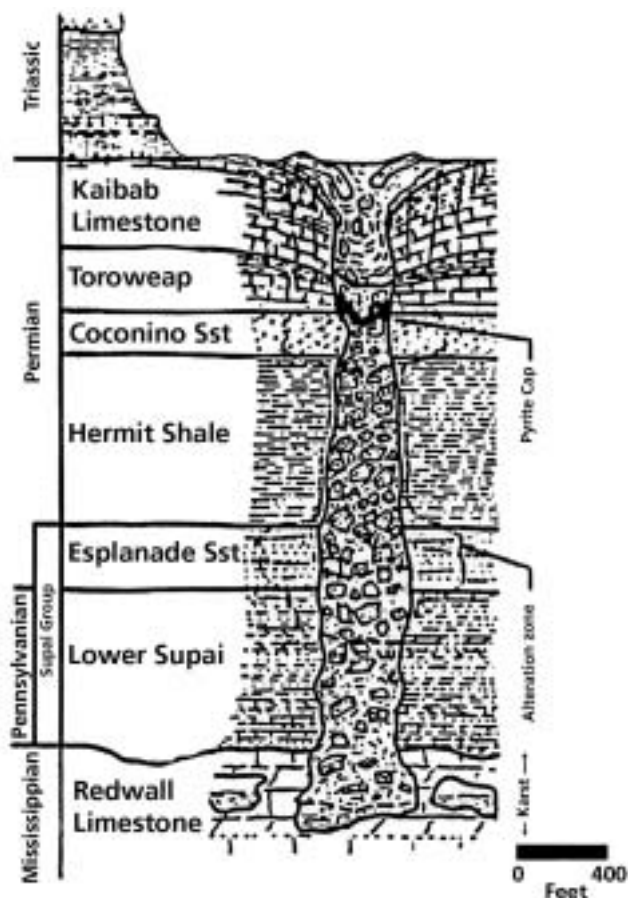


Figure 3. Solution collapse breccia pipes are relatively rare worldwide but are abundant in northern Arizona and southern Utah. Scientists interpret four basic stages of pipe formation (Bowles 1977). Stage 1: The development of an extensive cave system in the Mississippian Redwall Limestone 325 million years ago (McKee and Gutschick 1969, Kenny 1998, Kenny and Knauth 1992). Stage 2: Intermittent collapse of the caves over geologic time (from the weight of overlying rock layers that accumulated on top of the Redwall Limestone) resulting in thousands of feet of vertical pipe elongation. Stage 3: Concentration of metals and dissolved particles from the influx of water directed to the pipes. Most of the metal and uranium was dissolved by surface waters and precipitated in the pipes from groundwater under oxygen-poor, subsurface conditions. Stage 4: Erosion, exposure, and modification of the pipes during uplift of the Colorado Plateau (beginning about 65 million years ago); uranium enrichment was further enhanced by increased precipitation during the great ice ages (from about 2 million to 10,000 years ago).



Figure 4. Using a portable gamma-ray spectrometer (arrows), researchers from Ft. Lewis College in Durango, Colorado, and New Mexico Highlands University in Las Vegas, New Mexico, collected data on radioactivity levels in contaminated waste rock piles at the abandoned Grand View Mine. The mine waste rock levels were up to 125 times more than the local mean background uranium levels.

Field and laboratory data

The portable gamma-ray spectrometer (see fig. 4) recorded 144 field readings for uranium, potassium, and thorium that were taken in the vicinity of the Grand View Mine. The mine waste rock adjacent to the Grand View Trail registered the highest uranium levels. A portion of the trail crosses the mine waste rock. Field values for uranium were as high as 233 parts per million (ppm); local background uranium levels were about 1.8 ppm. The mine waste rock levels were as high as 125 times greater than the local mean background uranium levels (Kenny and Diaz 2000).

We performed 18 lab analyses for natural uranium, polonium, and radioactive lead. Like the field readings, lab analyses showed elevated uranium values in samples collected from the mine waste rock area. The laboratory data indicated that the radioac-

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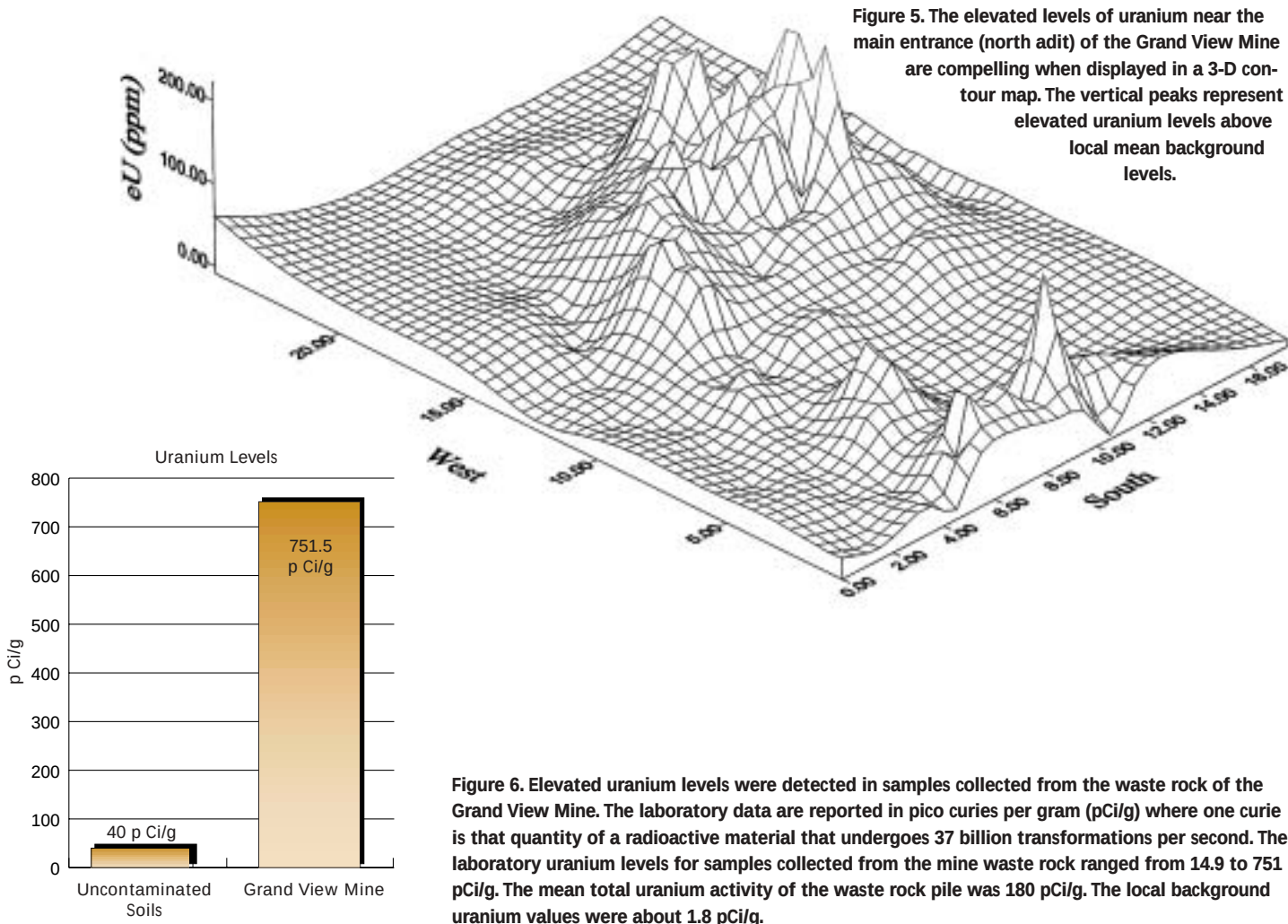
tivity associated with the mine waste rock was 100 times greater than the mean total background radiation levels (figs. 5 and 6).

Both field and laboratory results indicate that the radioactivity in the mine waste rock is significantly higher than the natural background levels in

the area. Both data sets indicate that pockets or “hot spots” within the mine waste rock are at least 100 times

greater than local background values. The difference between the laboratory and field results may be explained by the relatively large number of samples taken in the field compared to the small number of samples analyzed in the lab.

The size of the waste rock piles varies considerably (fig. 7). Uranium hot spots are primarily restricted to the waste rock areas around the north and south adits (see fig. 7); each of these has a surface area comparable to that of a



football field. The closest park facility to the Grand View Mine is the campground on Horseshoe Mesa. Extensive field data collected at this site indicates that the campground does not have elevated uranium levels.

Field observations

The shafts, entrances, and adits around the Grand View Mine remain open and accessible to the public. Ore hoists, glass, dilapidated buildings, and other abandoned mine equipment scattered about the area are reminders of early mining days. In an effort to reduce the temptation to enter the mines, park staff includes information with every backcountry permit that emphasizes the dangers of entering old mines. However, little information is prominently displayed at the trailhead to discourage hikers from entering the mine, and, unfortunately, the mine openings make an attractive place to find shelter from the searing heat that is common to this area. As such, the mine still poses a public health risk.

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As part of the study, we compiled information on the behavior of backcountry travelers around the mine. A substantial number of hikers and backpackers entered both the upper and lower mine adits. Only one in 50 did not stop at the main mine entrance (“north adit” in fig. 7) located along the main trail to eat, rest, get out of the sun, or explore for minerals. These observations represent an informal and random sampling. Nevertheless, it appears that the main mine entrance is regularly visited. Significantly, the area around the main mine entrance, including the mine waste rock, has substantially elevated uranium levels. Therefore, these data show and we suggest that this part of the mine should be managed as a restricted area.

Health risks

One of the principal concerns associated with uranium is the production of radon gas. Radon is a natural product of uranium decay and is found in relatively low levels in many soils (Dueñas-Parshley and Kenny 2000). Usually uranium concentrations in soils are dependent upon the original uranium concentrations in the rocks from which the soils weathered. Typically, radon concentrations in soils are lower than in rocks because oxidizing surface

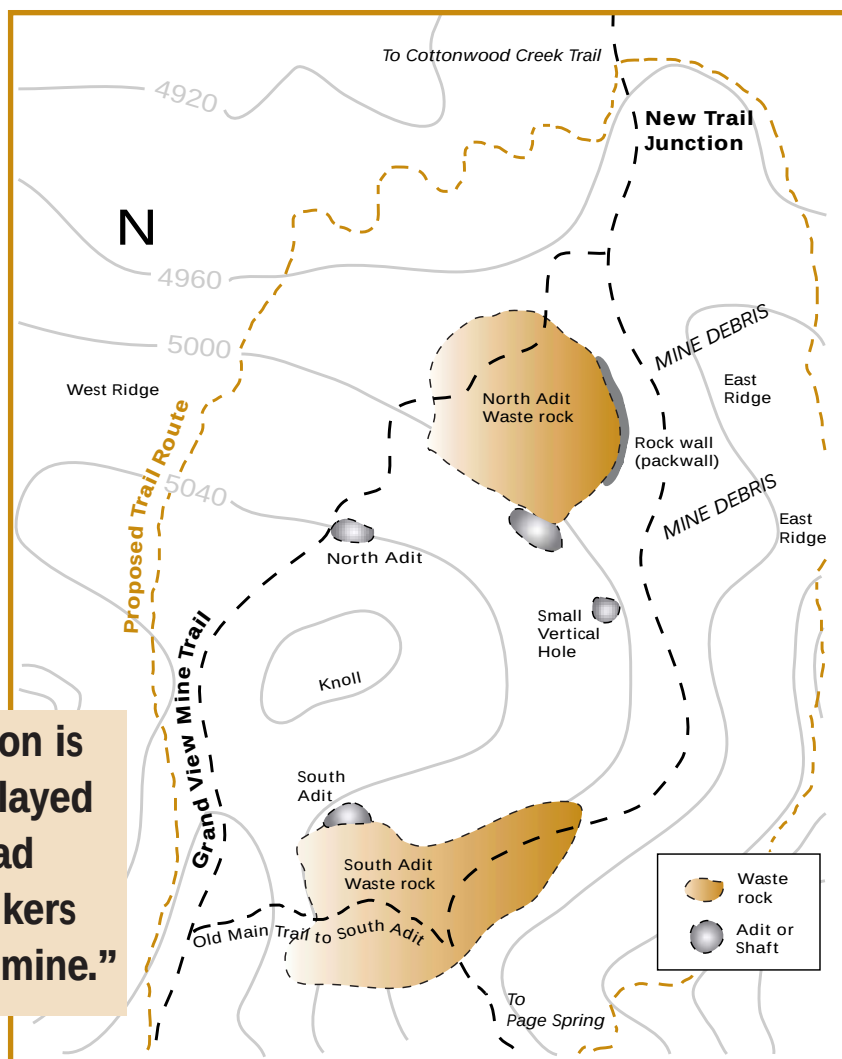


Figure 7. Collection and analyses of data from the study resulted in a recommendation that the trail be routed away from a hazardous waste rock pile where the highest levels of uranium were detected. The proposed trail route is marked on the map. One inch on the map represents about 125 feet on the ground. Adit openings are not to scale.

conditions associated with near-surface weathering usually leach some of the uranium and carry it away. The world crustal average for uranium is about 2.7 ppm (Smith 1993), which is only slightly higher than the local background levels obtained during this study (about 1.8 ppm). Relatively low uranium levels in soils similarly produce relatively low radon levels. However, if the soils were derived from rocks with significantly higher concentrations of uranium, or if natural or human-induced factors concentrated the uranium in a given location, then higher concentrations of radon and related decay (daughter) products may also be found in the soils.

High concentrations of radon gas can accumulate in enclosed environments such as homes and other structures (Spencer 1993) or mine shafts and adits. Prolonged (chronic) exposure can cause lung cancer. The primary health concern related to radon is the inhalation of radioactive daughter products of radon attached to dust particles. These short-lived particles (the daughter prod-

ucts of radon) decay further while still in the lungs. The decay is so rapid that it occurs before exhalation, causing damage to human tissue.

An important health concern, therefore, occurs in areas where elevated uranium activity is found and where daughter products can accumulate. The effect of short-term or acute exposure on hikers and backpackers is difficult to determine with any accuracy. Certainly, health risks will increase with

1. increased temporal contact with the mine waste rock,
2. prolonged contact with dust particles entrained in the air entrapped in mines (stirred up from walking and other disturbance activities),
3. increased activity and physical exertion in and around the mine waste rock, and
4. increased wind activity and subsequent contact with fine particulate matter stirred up by the wind.

Of all these factors, prolonged contact with dust particles wafted into the air during entry into the mine is potentially the most damaging. This is because the mine is a restricted environment, has elevated radioactive particles, and has a local atmosphere that may become choked with dust particles that can be readily inhaled.

Recommendations

Based on field and laboratory data and field observations, we made several recommendations to improve public safety around the Grand View Mine:

1. Reroute a relatively short segment of the Grand View Trail to avoid crossing the main waste rock pile where the highest uranium concentrations were detected (see fig. 7)
2. Update and distribute information to backpackers and hikers
3. Post warning signs at the trailhead and along the portion of the Grand View Trail that must cross waste rock

Reroute a portion of Grand View Trail

As one approaches the Grand View Mine from the south, the trail crosses the main mine spoils at a constructed rock wall below the north adit (see fig. 7). Significantly elevated uranium levels characterize the waste rock in this area. This portion of the Grand View Trail could be rerouted to the west, beginning just south

of the south adit (see fig. 7). The proposed trail would continue west of the mine and switchback into the minor drainage north of the mine before rejoining the old trail south of the campground area. At this new junction, the trail to Page Spring and Hance Canyon would continue east of the present trail, bypass the old mine debris, and join with the old trail south of the south adit (see fig. 7). A portion of the proposed trail would still have to pass the mine adit near the head of Page Spring Canyon. Warning signs could be posted to alert backcountry travelers of the potential danger.

Update and distribute information to backpackers and hikers

Information distributed or posted at the trailhead needs to alert backpackers and hikers about elevated uranium levels at the Grand View Mine. Flyers given to all backcountry travelers should provide information about the

health hazards of uranium contamination, warn of the dangers of entering abandoned mines, explain the results of the recent study, identify the areas to be avoided, and provide alternative routes of travel.

Post warning signs

Even after rerouting a portion of the trail, at least two of the mine adits will continue to be easily accessible. This is because the topography of the area dictates, to a large degree, where the trail must be routed in order to accommodate ready access to the springs, the lower canyon trails, and Hance Canyon.

Where the Grand View Trail must cross the waste rock and pass near mine entrances, warning signs should be posted to remind backpackers and hikers that public access to the mine is hazardous. Signs should include a brief description of the hazard, locations to avoid, and where to receive additional information.

Alternatively, the mine entrances could be sealed off with steel bars to allow access for birds and bats but not humans. This option is costly and may not be necessary if the appropriate warning signs are placed and maintained at the trailhead and mine entrance.

Conclusions

The results of this study show that both the waste rock piles and mine tunnels at the Grand View Mine are radioactive and visitor contact with these areas should be discouraged. Proposed management actions should help mitigate the potential risk to visitors. Additional studies may be needed to verify the effectiveness of the proposed mitigation actions.

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