ENVIRONMENTAL IMPACT OF URANIUM MINING IN THE VICINITY OF THE GRAND CANYON NATIONAL PARK

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INTRODUCTION

The area around the Grand Canyon is rich in uranium mineralization, with many of the deposits existing as unique breccia pipe formations located about 300 meters below the surface. The pipe deposits average 0.75% uranium, but concentrations in excess of 4% to 20% are not uncommon. Each deposit is capable of providing a 30 year supply of electricity to a city of one million people. Figure 1 is a diagram of the Colorado River watershed and identifies the important areas where uranium may be found.

At present there are three active underground mines, another four breccia pipes in various stages of development, and thousands of registered claims. One of the mine sites is located on the south rim of the canyon, while the others are located on the north rim in the vicinity of Kanab Creek.

The Grand Canyon National Park borders the Colorado River. Although no mining is currently allowed inside the Park boundaries, there is one abandoned uranium-copper mine located on the south rim near the headwaters of the normally dry Horn Creek wash. Erosion caused by wind and the Colorado River and its tributaries has exposed several breccia pipe deposits inside the canyon.

There are numerous surface and near surface deposits of lower grade uranium along the Little Colorado River. They are not breccia pipe formations.

The Colorado River is a major source of water for a variety of public uses. The water is used for irrigation in Arizona and southeastern California. The recently completed Central Arizona Project canal diverts a considerable amount of the water to the Phoenix metropolitan area. Finally, the river itself and Lake Mead, which is fed by the Colorado River, are both major recreational areas.

In order to assess the impact from existing exposed deposits and the increased uranium mining of breccia pipe formations around the Park, a rigorous environmental assessment program is being conducted by the ASU Radiation

Measurements Facility. Assessments include routine sampling of air, water, and soil, and measurements of direct radiation and radon releases from the mine vents and ore piles. The monitoring will be used to quantify local changes in the natural radiation environment, to quantify any cumulative effects of radon releases from multiple mines, and to provide baseline measurements for use in the final decontamination and decommissioning of the mine site. Each mine has an individualized radiological assessment program which is reviewed and approved by the U.S. Forest Service or the U.S. Bureau of Land Management and other appropriate state and federal agencies. (Li 86)

MEASUREMENT, FINDINGS AND CONCLUSION

Monitoring stations which measure the background gamma radiation are established at a minimum of four locations around each mine site. Each station is about 500 meters from the center of the mine yard. Additional stations are located along the ore haulage routes. All information is being collected using identical detection methods and since the entire region has similar characteristics, any changes from existing background will be obvious.

Data will be collected quarterly using a suite of radiation detectors. Panasonic UD-802 passive thermoluminescent radiation dosimeters are placed at each site and measure the cumulative exposure. When dosimeters are exchanged, additional measurements are obtained using two Ludlum micro-R scintillometers. Annually, data is collected using a Reuter-Stokes RSS-111 Pressurized Ion Chamber. Background gamma radiation at all sites is on the order of 75 to 110 mR/yr.

During mine operation the radiation levels in the vicinity of the uranium ore stockpile will be on the order of 1 to 3 mR/hr. Levels decrease to background within a few hundred meters from the pile. It is anticipated that gamma radiation will remain unchanged at the monitoring stations during mine operation.

Radon gas will diffuse from the ore piles and be exhausted from the mine vent. Terradex track etch detectors are placed at most environmental stations and continue to measure normal background radon concentrations. Background radon gas concentrations are on the order of 0.2 pCi/L in the environs surrounding the Grand Canyon. The radon cups are exchanged quarterly. MILDOS code calculations indicate that increases will be minimal at distances in excess of about 2 km from the mine vent and the uranium ore piles. (St 85)

The breccia deposits are located about 500 meters above the water table so the mines are very dry. Nevertheless, a well is drilled at each mine site and samples are collected to obtain baseline data and to monitor for changes in trace element concentrations which might be the result of mining operations.

Average rainfall in the areas where the mines are located is generally less than about 38 cm per year. The amount of rainfall is about the same in the summer and winter, while the spring and fall are relatively dry. Summer precipitation usually is the result of thunderstorms which form over the heated canyon walls almost every afternoon from early July until the end of August. Since the thunderstorms may produce local sheet-flooding, each mine site is surrounded by a berm which is designed to protect against a potential 500 year flood event.

In order to assess the potential impact on the Colorado River from previous and present uranium mining activities and erosion from exposed deposits, routine radiological assays are performed on samples taken from the river and its tributaries as well as from several springs inside the canyon itself. Table I summarizes the significant results and reveals the definite increase in both uranium and Ra-226 in the Colorado River downstream of the confluence with the Little Colorado River. The radioactivity in the Little Colorado River is from exposed deposits which are not breccia pipe formations and from abandoned uranium concentrators located along the river. There is no impact on the waters of the Colorado River from current mining operations. A complete discussion of the water survey is published elsewhere. (St 87)

REFERENCES

Li 86 Lindquist, L.A., "Final Environmental Impact Statement, Canyon Uranium Mine," U.S. Department of Agriculture, Forest Service, Kaibab National Forest, August 1986.

St 85 Stewart, B.L.,"Air Quality Impact Analysis of the Canyon Project," 1985.

St 87 Stewart, B.D., McKlveen, J.W., and Glinski, R.L., "Determination of Uranium and Radium Concentrations in Waters of the Grand Canyon by Alpha Spectrometry," to be published in the Journal of Radioanalytical Chemistry, 1988.

Table I. Radionuclide Concentrations in the Colorado River and its Tributaries

mBq/L (+-2sigma)

Location	Date	U-238	U-235	U-234	Ra-226
1km upstream of Little Colorado	8/85	59 (15)	7 (4)	85 (22)	9 (5)
	7/86	67 (13)	12 (5)	140 (20)	13 (2)
Little Colorado (Cameron)	*7/86*	*890 (10)*	*33 (14)*	*1150 (150)*	*366(15)*
Little Colorado at confluence with Colorado	*9/86*	*560 (70)*	*48 (15)*	*460 (60)*	*67 (4)*
1km downstream of Little Colorado	8/85	85 (2)	6 (4)	110 (20)	36(10)
	9/86	96 (19)	<4	130 (20)	63 (4)
100km downstream of Little Colorado	8/85	74 (15)	2 (2)	96 (15)	35(10)
Kanab Creek	7/86	67 (15)	9 (6)	85 (22)	41 (6)

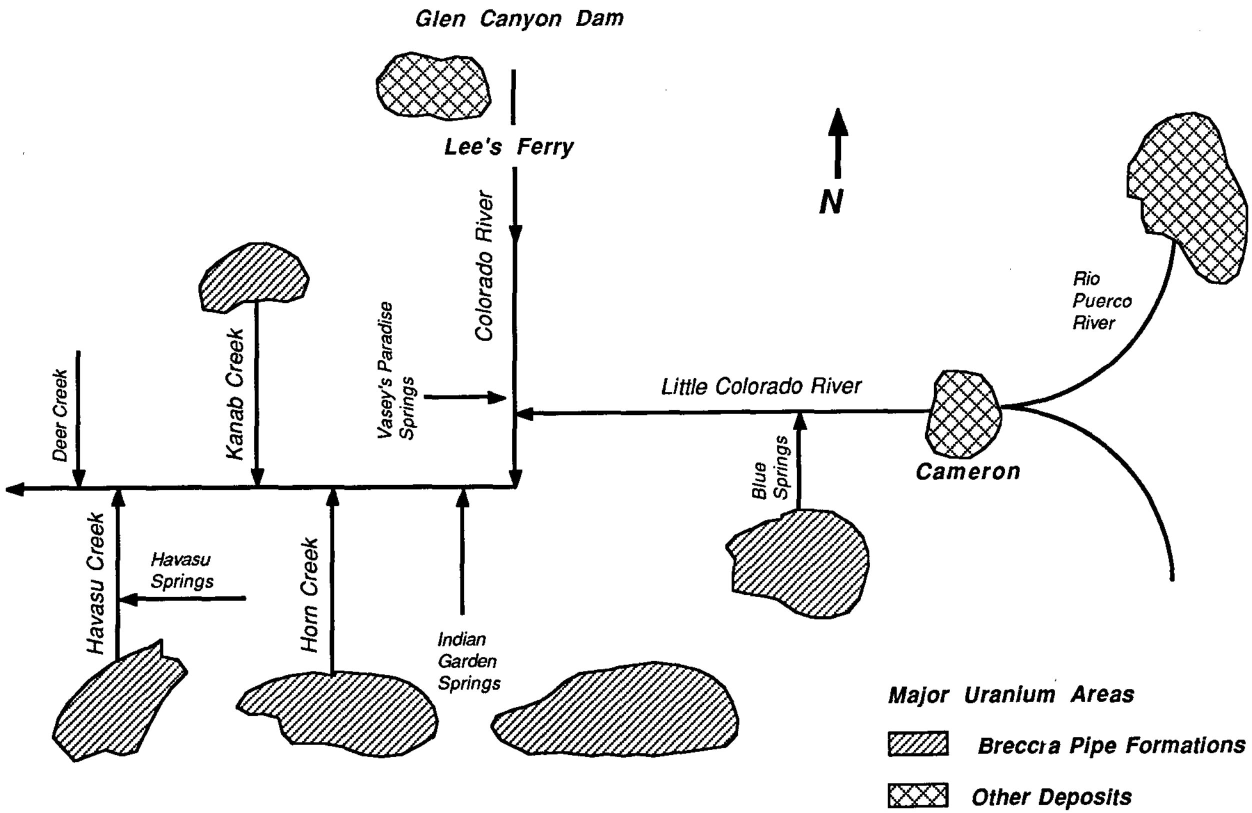

Figure 1 Uranium Mineralization Around the Grand Canyon