Casting a Broader Net–Using Art to Communicate Environmental Effects of Mining

23 September 2021
San Juan Mining and Reclamation Conference

Katherine Walton-Day, Benjamin Siebers, Jo Ellen Hinck, Kate Campbell, Marie-Noele Croteau, JoAnna Wendel, and David Naftz

Outline

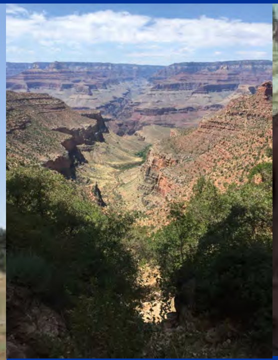
- Background
  - 20-year moratorium
  - USGS Science to support decision making
- Problem:
  - Is our science being understood?
- Solution: Find better, more engaging ways, to communicate the science
  - Radon graphic/comic/geonarrative
  - USGS "Fact Sheet"
  - New effort including social science and scientists

Background

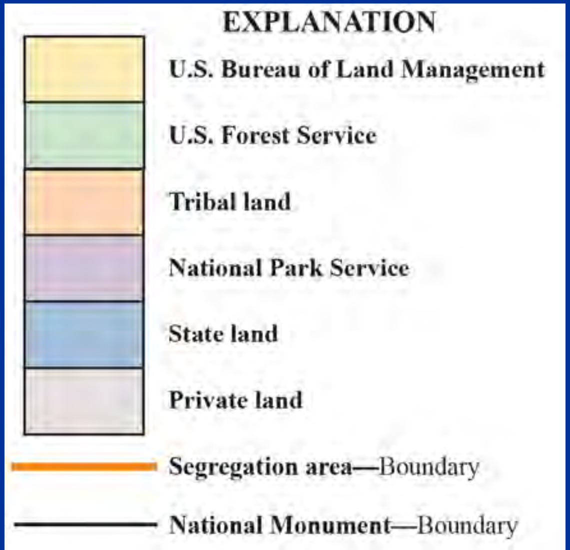
- **Record of Decision (ROD) Jan. 2012– withdrawal of 1M acres**
    - **"*The uncertainties of effects to water quantity and quality, also leads to uncertainties of effects to animals and humans.* The *effects of exposure* of native plants and animals to increased levels of radionuclides *are unknown*." (ROD p. 10).**
    - **"The EIS states that impacts are possible from uranium mining in the area, including, in particular, impacts to water resources. It also expresses uncertainty with respect to hydrology and groundwater flow in the area as well as the potential effects of increased radionuclides to plants and animals." (ROD, p. 12).**
- **Tasked with closing these data gaps--existing permitted mines**

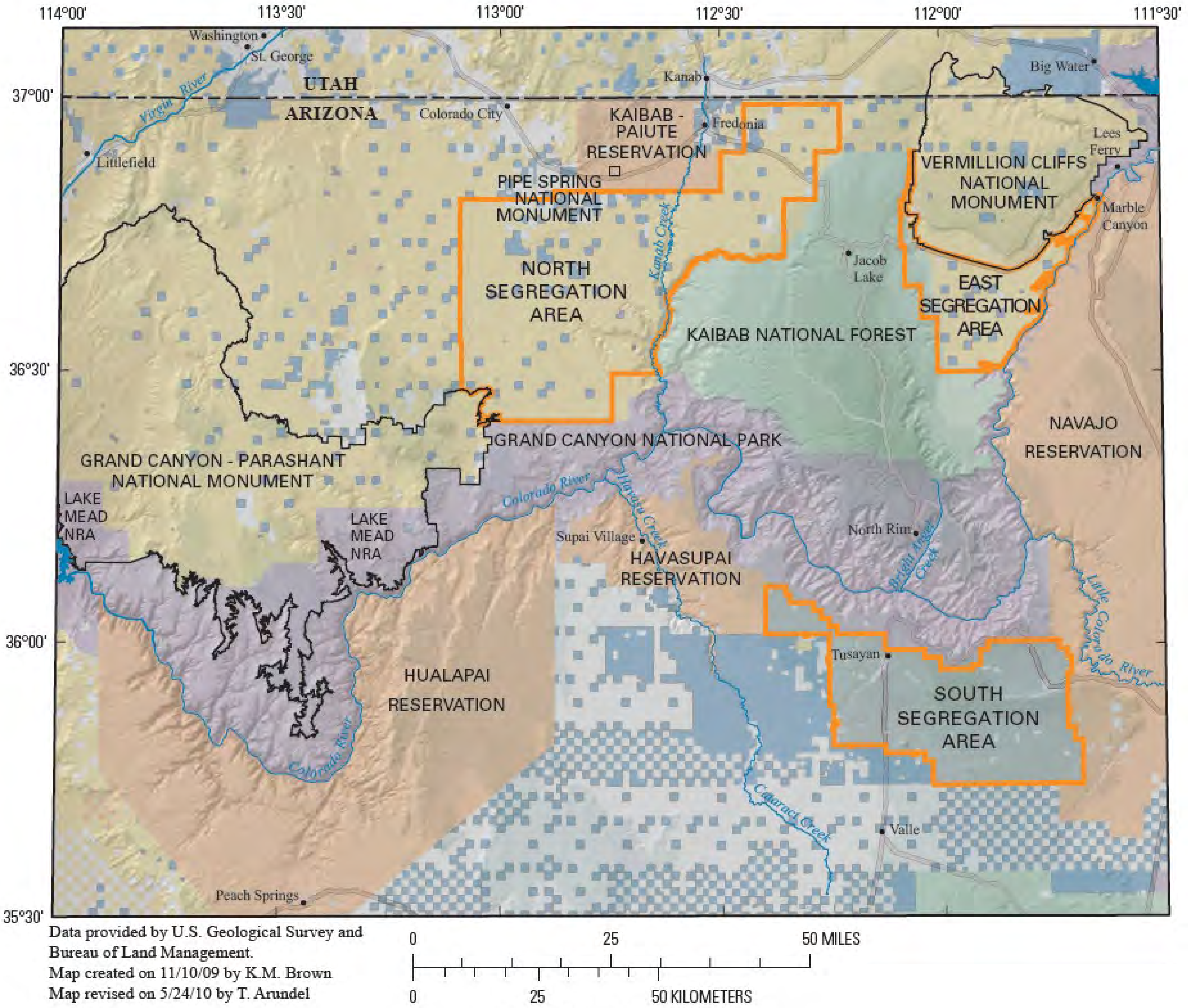







Study Area

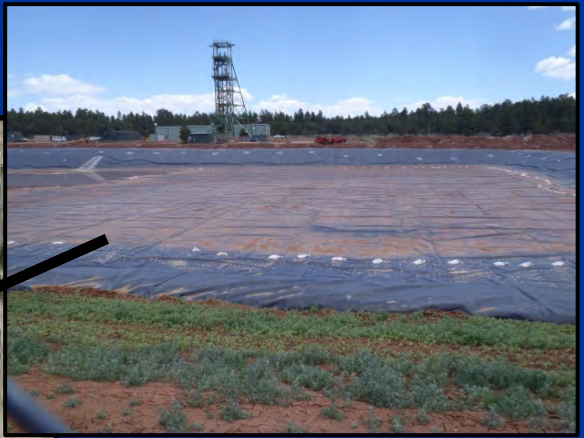




SEGREGATION AREAS
(Proposed mineral withdrawal areas)

Mine features

- Small footprint, underground mine, small deposits
- Head frame
- Detention pond
- Ore storage
- Waste rock/
  overburden storage
- Peripheral berm,
  internal drainage



USGS

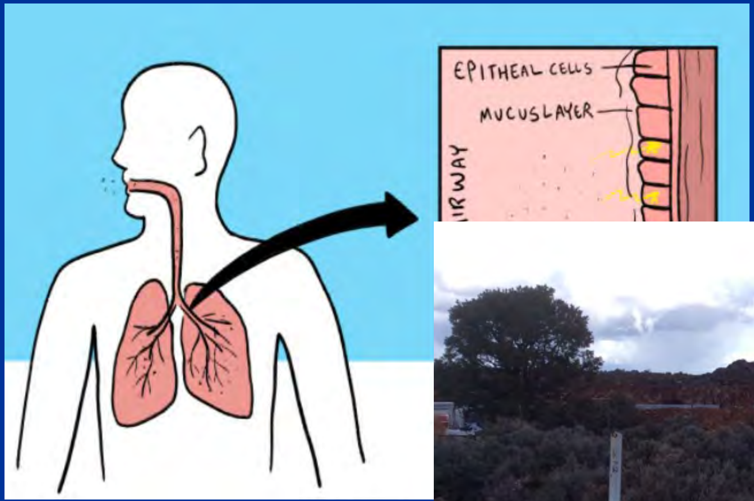
The Problem:

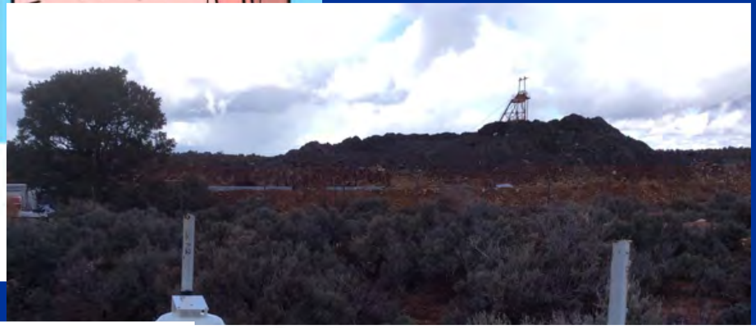
- *"I just sat through 3 hours of your presentations, and I did not catch most of it. Can I have your powerpoint slides? "*
- Member non-government organization: "*there are USGS studies documenting higher U concentrations in soils around the mines north of Grand Canyon…[other studies] documenting movement of material from uranium mines during flash floods in the 1980s.*" The speaker was using these statements as evidence of the effects of uranium mining on the environment.
- Mining company replies by quoting from USGS report: "*No scientific evidence of adverse environmental impacts.*"

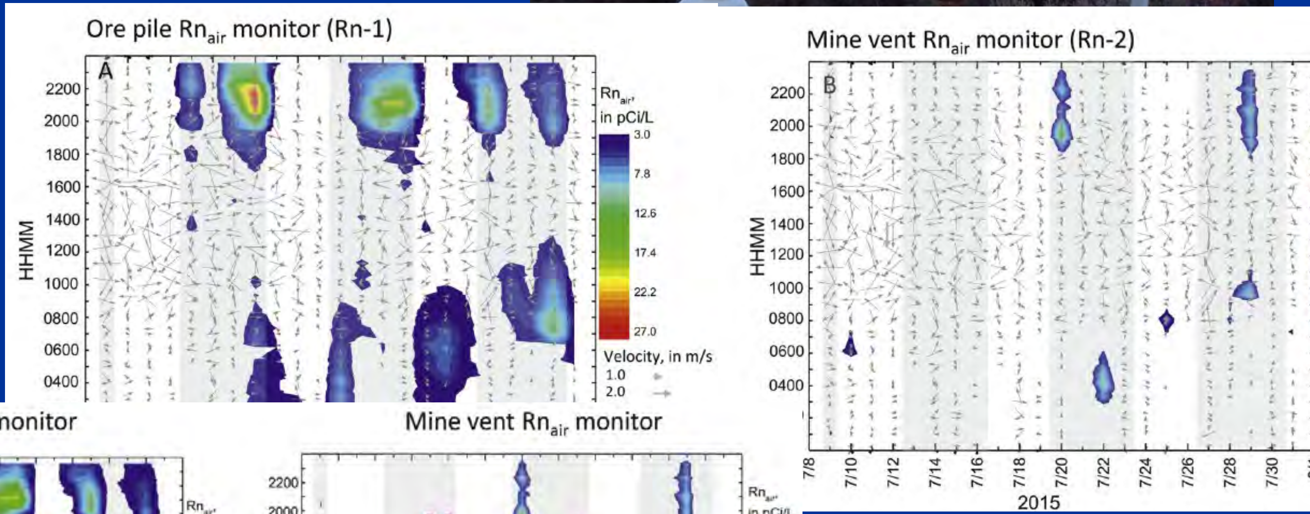
USGS

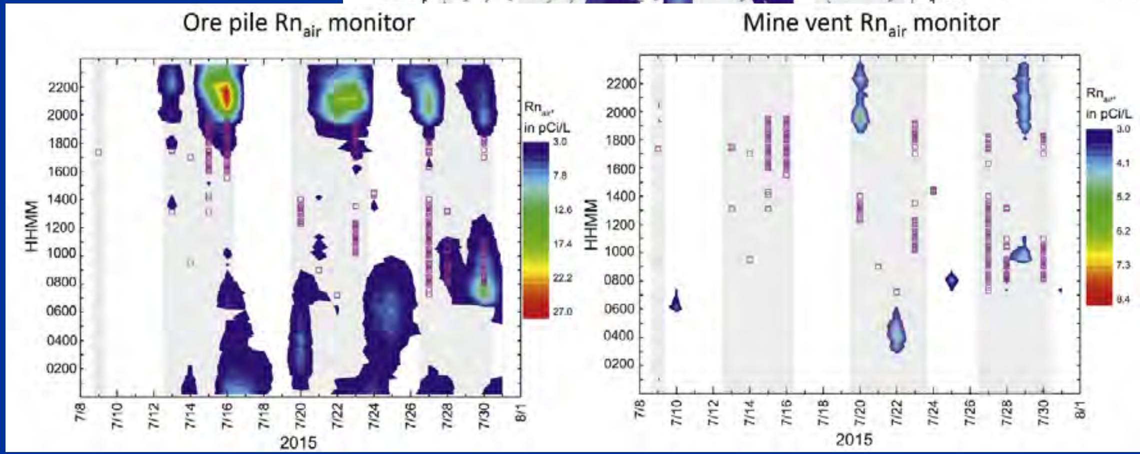
Radon-Active Mining

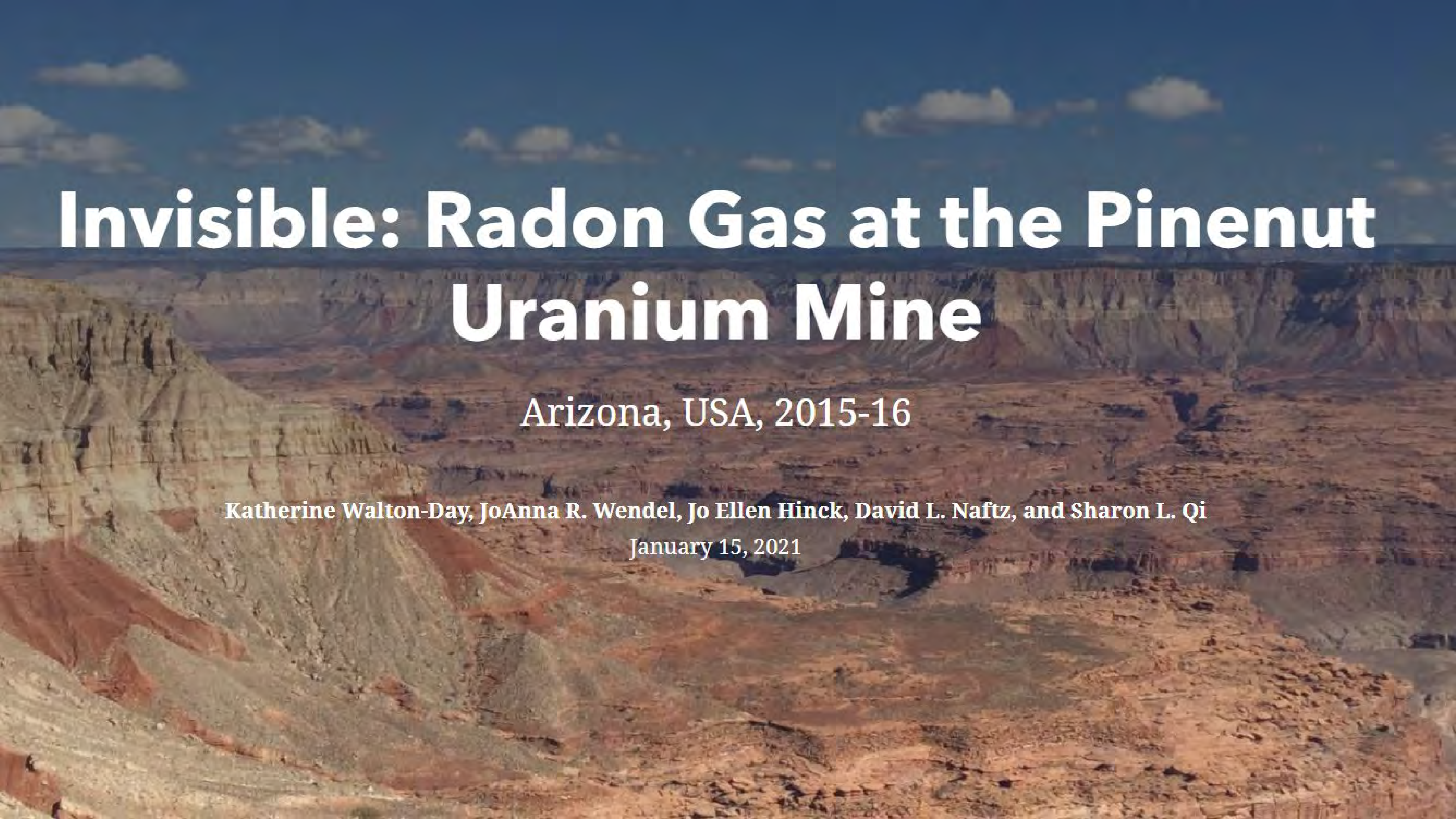
- Rn health hazard to biota if inhaled
- Two radon monitors and time-lapse camera
- $Rn_{ore\ pile} > Rn_{ventilation\ shaft}$
- Rn lower on windy and rainy days.
- Physical disturbance of ore pile did not affect Rn concentrations.









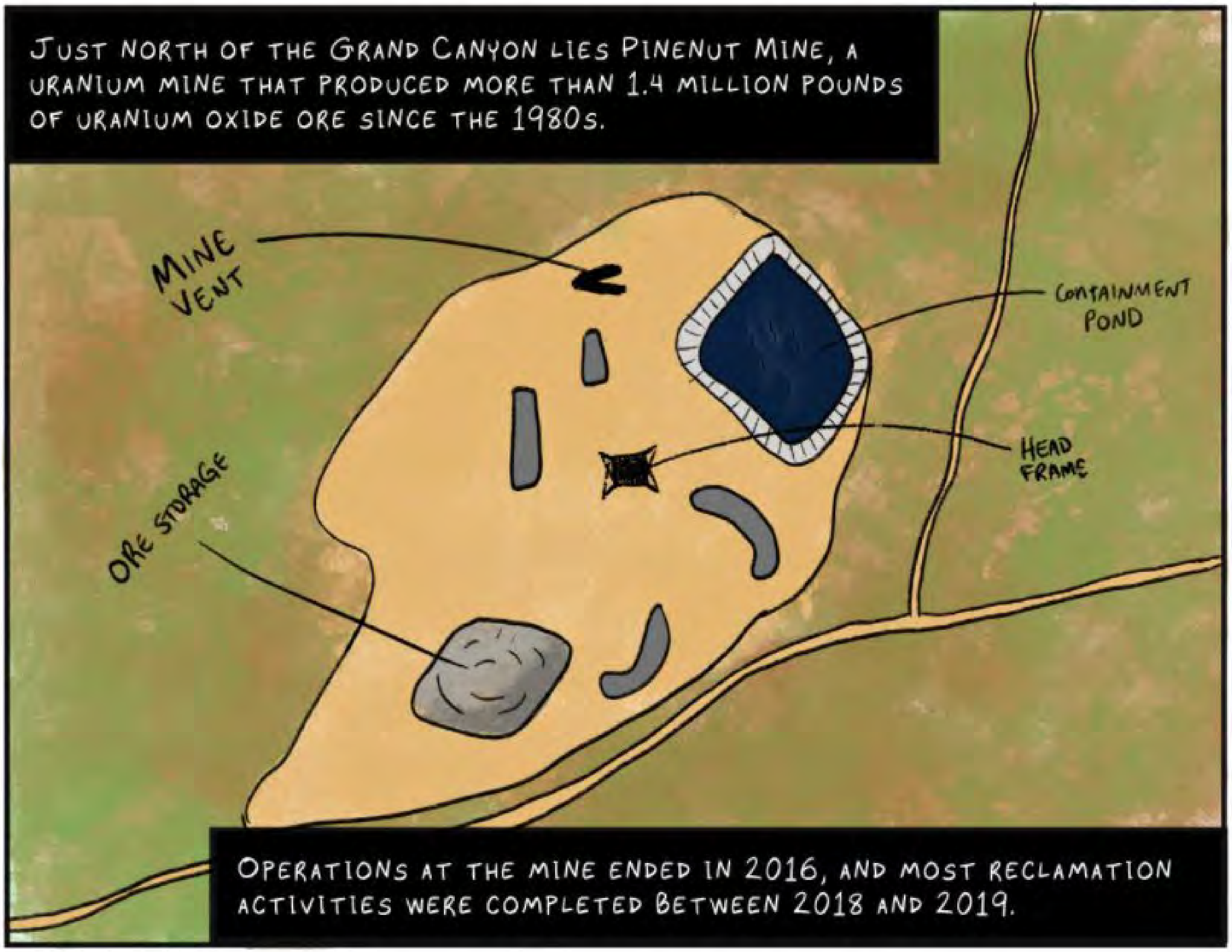


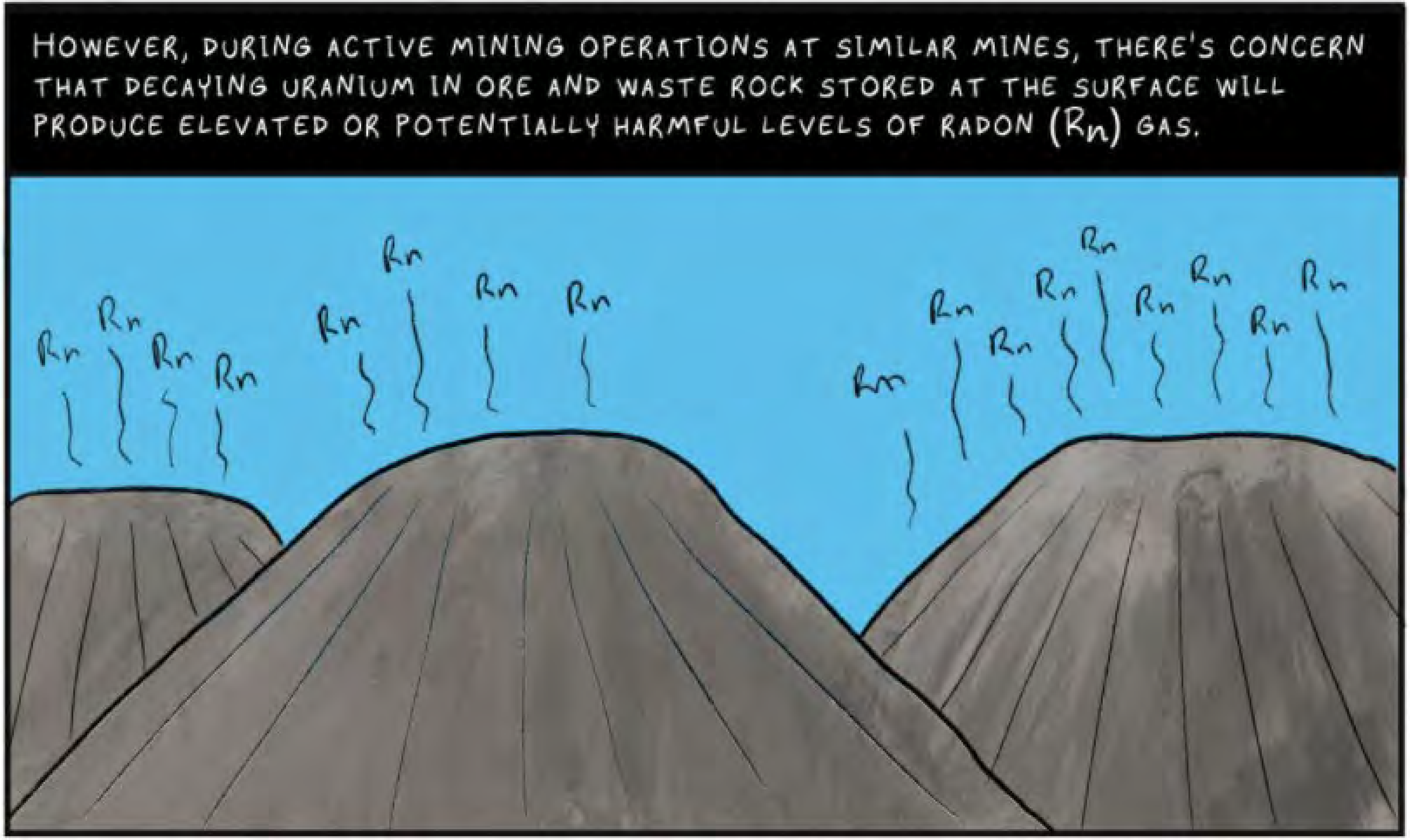
Invisible: Radon Gas at the Pinenut Uranium Mine

Arizona, USA, 2015-16

Katherine Walton-Day, JoAnna R. Wendel, Jo Ellen Hinck, David L. Naftz, and Sharon L. Qi

January 15, 2021


JUST NORTH OF THE GRAND CANYON LIES PINENUT MINE, A URANIUM MINE THAT PRODUCED MORE THAN 1.4 MILLION POUNDS OF URANIUM OXIDE ORE SINCE THE 1980S.
MINE VENT
CONTAINMENT POND
HEAD FRAME
ORE STORAGE
OPERATIONS AT THE MINE ENDED IN 2016, AND MOST RECLAMATION ACTIVITIES WERE COMPLETED BETWEEN 2018 AND 2019.


HOWEVER, DURING ACTIVE MINING OPERATIONS AT SIMILAR MINES, THERE'S CONCERN THAT DECAYING URANIUM IN ORE AND WASTE ROCK STORED AT THE SURFACE WILL PRODUCE ELEVATED OR POTENTIALLY HARMFUL LEVELS OF RADON (Rn) GAS.
Rn
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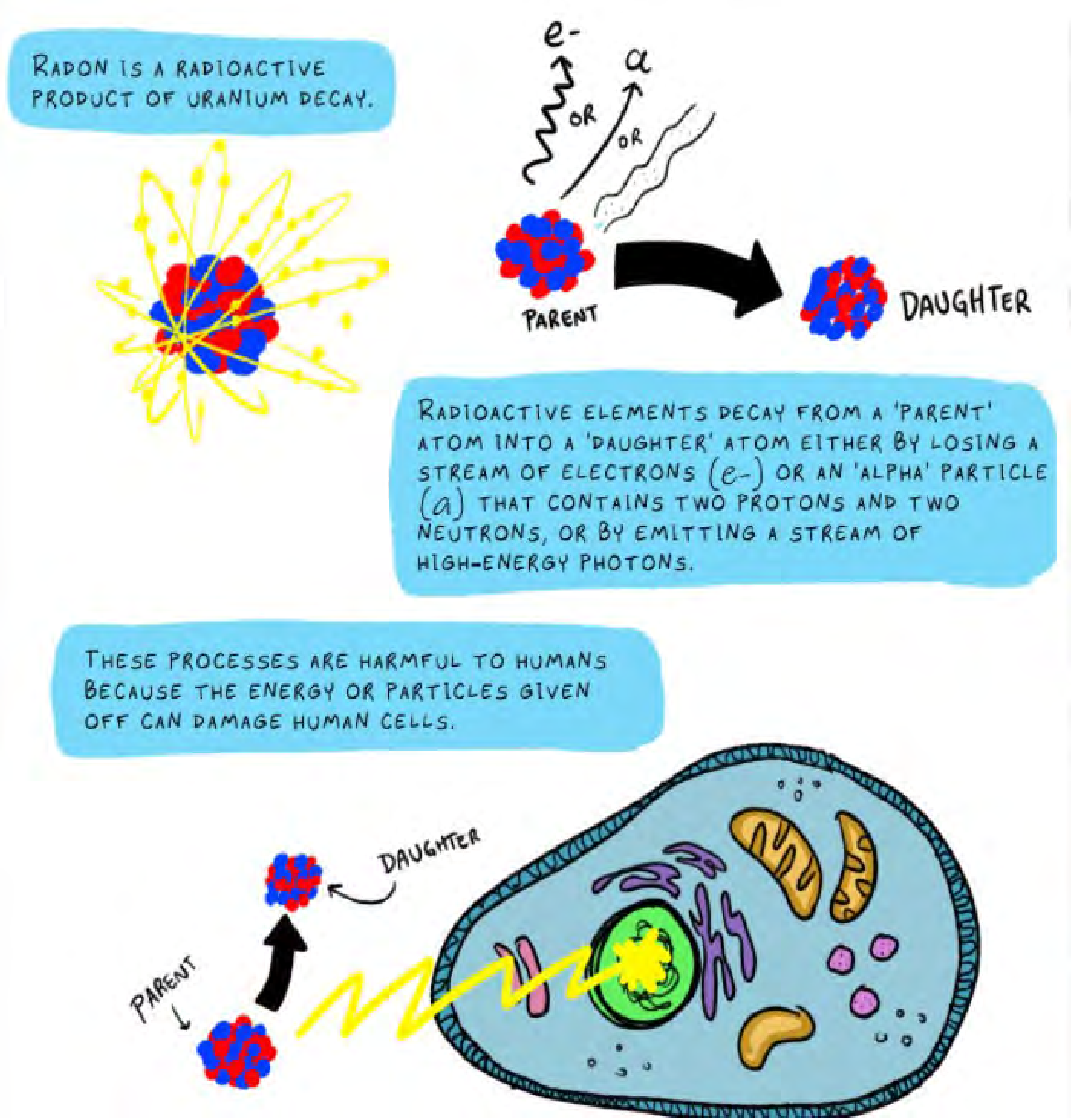
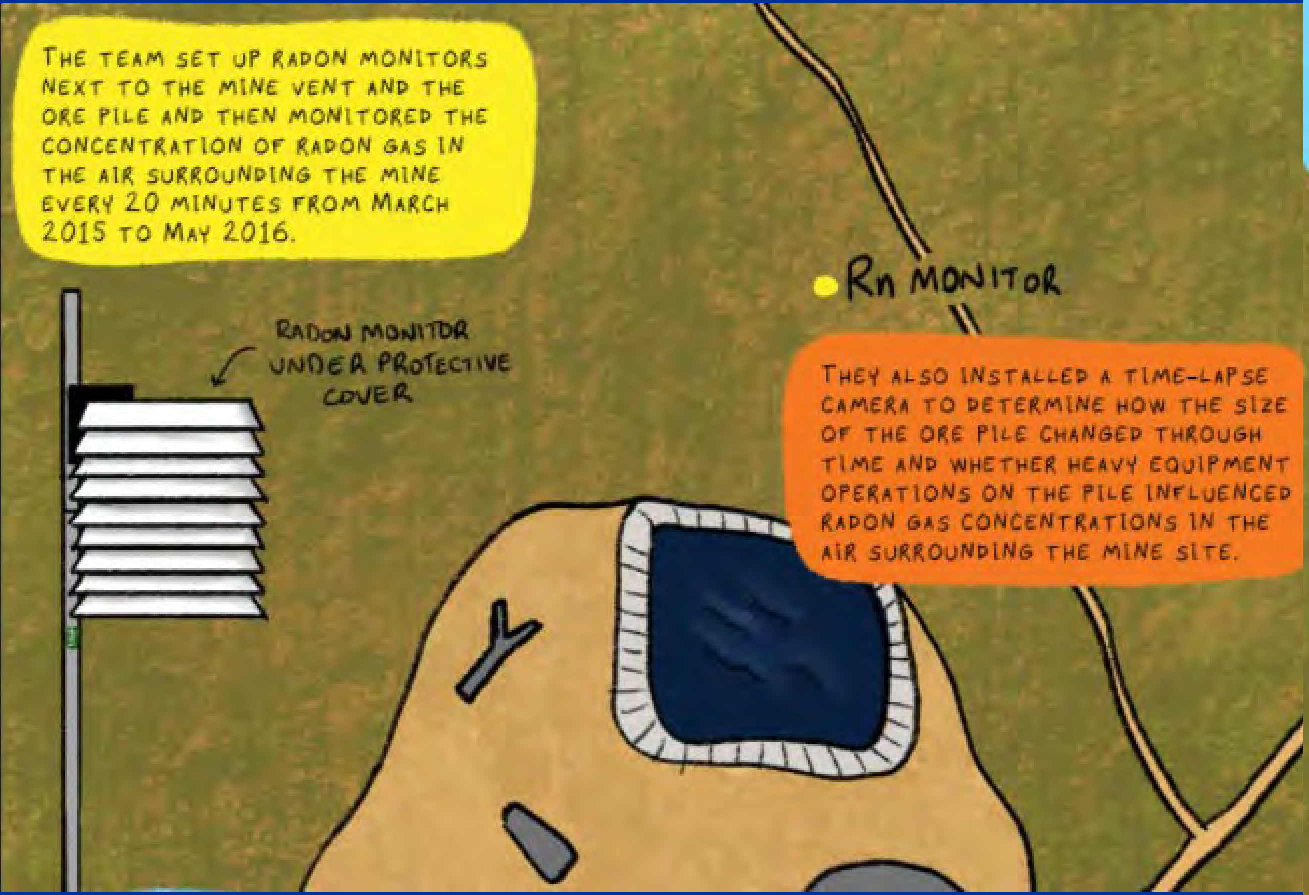
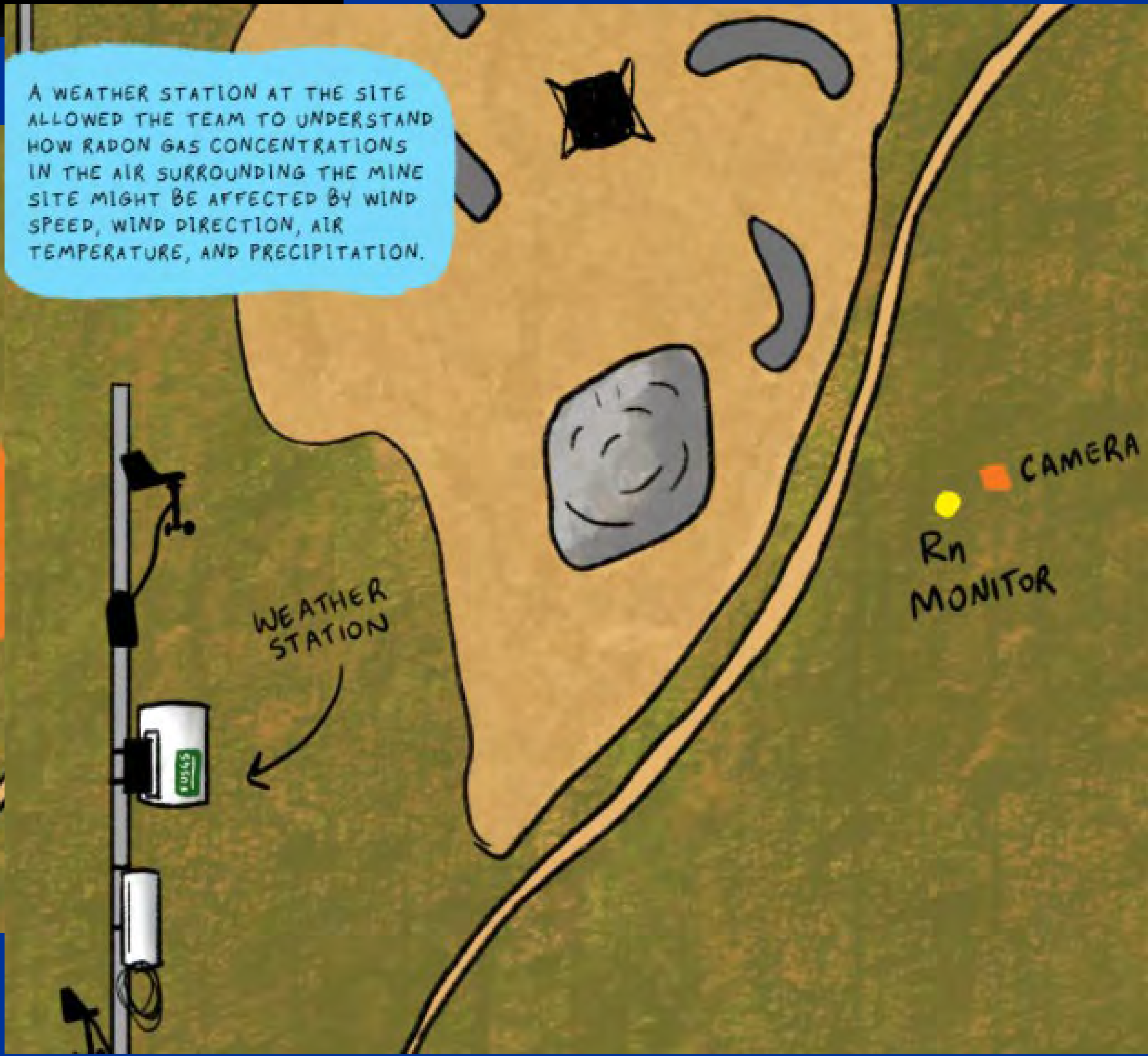
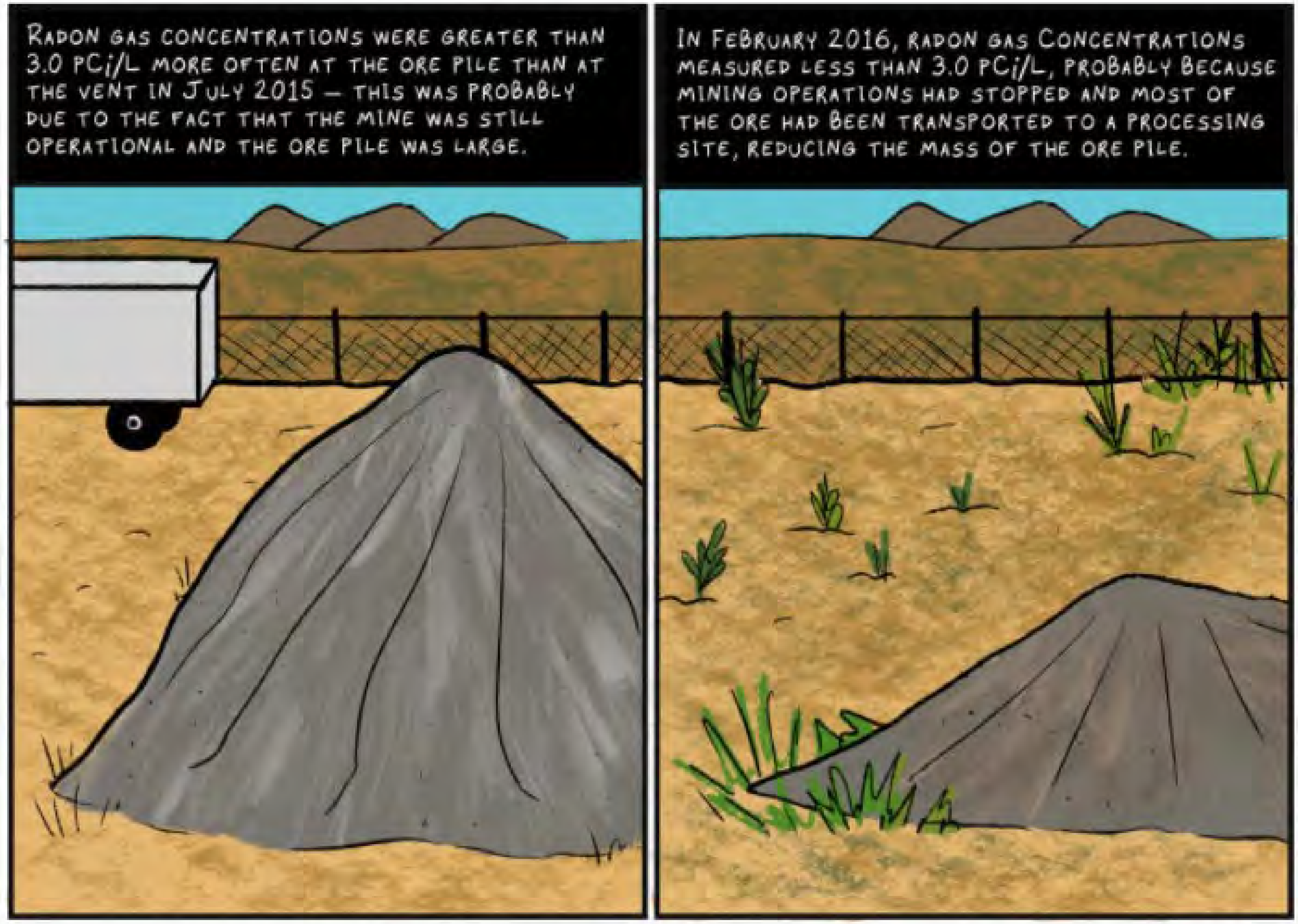

RADON IS A RADIOACTIVE PRODUCT OF URANIUM DECAY.
e-
OR
a
OR
PARENT
DAUGHTER
RADIOACTIVE ELEMENTS DECAY FROM A 'PARENT' ATOM INTO A 'DAUGHTER' ATOM EITHER BY LOSING A STREAM OF ELECTRONS (e-) OR AN 'ALPHA' PARTICLE (a) THAT CONTAINS TWO PROTONS AND TWO NEUTRONS, OR BY EMITTING A STREAM OF HIGH-ENERGY PHOTONS.
THESE PROCESSES ARE HARMFUL TO HUMANS BECAUSE THE ENERGY OR PARTICLES GIVEN OFF CAN DAMAGE HUMAN CELLS.
DAUGHTER
PARENT

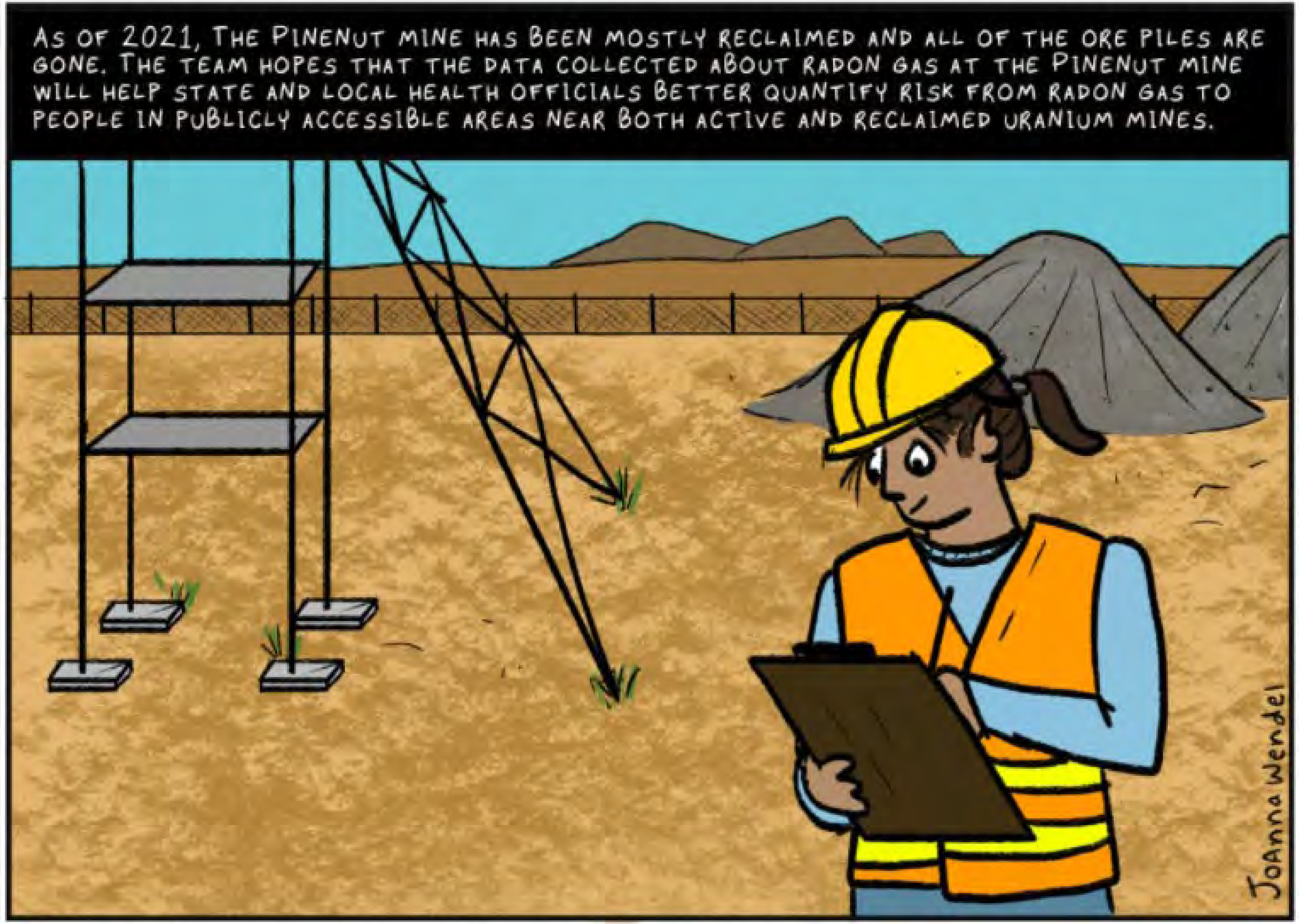
BACK TO THE PINENUT MINE. IN 2015, A TEAM OF U.S. GEOLOGICAL SURVEY SCIENTISTS SET OUT TO DETERMINE HOW MUCH RADON (Rn) GAS WAS BEING RELEASED DURING MINING, BOTH FROM THE VENTILATION FROM UNDERGROUND TUNNELS AND FROM THE ORE PILE BEING STOCKPILED AT THE SURFACE DURING MINING.





USGS


RADON GAS CONCENTRATIONS WERE GREATER THAN 3.0 PCi/L MORE OFTEN AT THE ORE PILE THAN AT THE VENT IN JULY 2015 — THIS WAS PROBABLY DUE TO THE FACT THAT THE MINE WAS STILL OPERATIONAL AND THE ORE PILE WAS LARGE.
IN FEBRUARY 2016, RADON GAS CONCENTRATIONS MEASURED LESS THAN 3.0 PCi/L, PROBABLY BECAUSE MINING OPERATIONS HAD STOPPED AND MOST OF THE ORE HAD BEEN TRANSPORTED TO A PROCESSING SITE, REDUCING THE MASS OF THE ORE PILE.


As of 2021, the Pinenut mine has been mostly reclaimed and all of the ore piles are gone. The team hopes that the data collected about radon gas at the Pinenut mine will help state and local health officials better quantify risk from radon gas to people in publicly accessible areas near both active and reclaimed uranium mines.
JoAnna Wendel

USGS Fact 4p. Fact Sheet

- Summarizes ~ 20 scientific studies
- Art "centerfold" depicts important aspects of the study area
  - Surrounded by one-two sentence science summaries
- Will be available in print and on-line
- Using the engaging visuals of this artist's work to draw in the audience

USGS

What have we learned about how mining affect resources - land, water, and biological - that humans use?

Uranium is important, but it's not only about uranium.

Mining increases uranium and chemical levels in soil. Reclamation procedures helps decrease soil levels, but they do not return back to pre-mining levels. 16, 17

Ore contains many elements besides uranium: arse nic, copper, silver, lead, zinc, cobalt, molybdenum, and nickel minerals. 19

Wind can move mining-related chemicals off-site of the mine. 5

Ore piles produce greater radon levels than the mine vent during active mining. Wind and rain reduce radon accumulation in air around the mine. Radon risk thresholds for outdoors are not available. 18

Studies at mine sites have shown uranium is not the driver of risk for animals[3]

We used traditional and new survey tools to understand how mining activities can affect local food webs. Chemicals can enter animals by ingestion, inhalation, absorption, and dietary transfer. 4-9

Risks from mining related-chemicals were low for terrestrial animals. Animals that eat invertebrates may have risk from arsenic, cadmium, copper, and zinc. Risk to aquatic animals is unknown. 3

Mines are not always the source of uranium in water[1]

Natural sources of uranium are in groundwater and spring water.

Uranium is associated with calcium and carbonates in some Grand Canyon spring water. These forms of uranium are not available to animals. 13

Uranium and other chemical levels in water in the Colorado River in GCNP are low, but sometimes higher in tributaries where mining has or will occur. On average, these tributaries contribute very small amounts of uranium and other chemicals to the Colorado River.1,20

Deep groundwater feeding some south rim springs contains some relatively young water. Thus, groundwater is potentially more vulnerable to contamination from activities at the surface than previously thought. Solder and Beisner 2020 a,b.

Aquatic insects are unlikely to transport uranium from aquatic to terrestrial environments[14]

Aquatic invertebrates, including wild populations of mayfly larvae, take up little uranium because uranium in the water they live in is in forms that are not biologically available. Ingestion and retention of uranium associated with food are also modest 13-14. In mayflies, uranium accumulated in tissues is rapidly eliminated, which further reduces the quantity of uranium in their bodies.

Studies at mine sites have shown adverse effects to plants and terrestrial animals from U mining-related chemicals are unlikely even with long-term (30 year) exposure[11]

Radiation levels in plants and animals were low. Radiation enters rodents through soil interactions (burrowing, incidental ingestion, bathing, etc.) or their diet. Radium-226 was below protective levels. It is of most concern for rodent health. 5,10,11

Plants and animals take up mining-related radionuclides, uranium, other elements but direct effects were not found. Arsenic and selenium may be harmful to aquatic animals like tadpoles. 5,11,12

New Effort

- Working in collaboration with Eric Welch and Lesley Michalegko (Arizona State University)
- Use social science to match message format to intended audiences and examine challenges of communicating science about this topic
- Develop engagement strategy for interested parties
- Review and synthesize existing products
- Use findings to develop at least one new communication product.

Summary

- Working within our institutional guidelines (peer-reviewed publications) to develop products that communicate our results in a different way
- Important to reach a broad audience and accurately communicate our results.
- The greater the understanding of the results, the greater the amount of informed discussion about underlying issues.

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journal homepage: www.elsevier.com/locate/chemosphere

Elemental and radionuclide exposures and uptakes by small rodents, invertebrates, and vegetation at active and post-production uranium mines in the Grand Canyon watershed

Danielle Cleveland [a,*], Jo Ellen Hinck [a], Julia S. Lankton [b]

Journal of Environmental Radioactivity 220-221 (2020) 106286
Contents lists available at ScienceDirect
Journal of Environmental Radioactivity
journal homepage: http://www.elsevier.com/locate/jenvrad

Natural and anthropogenic processes affecting radon releases during mining and early stage reclamation activities, Pinenut uranium mine, Arizona, USA

David L. Naftz [a,*], Katie Walton-Day [b], W. Payton Gardner [c], Michael C. Duniway [d], Donald Bills [e]

Hydrogeology Journal (2020) 28:1615–1633
https://doi.org/10.1007/s10040-020-02192-0

REPORT

Geochemical characterization of groundwater evolution south of Grand Canyon, Arizona (USA)

Kimberly R. Beisner [1] · John E. Solder [2] · Fred D. Tillman [3] · Jessica R. Anderson [4] · Ronald C. Antweiler [5]

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Terrestrial ecological risk analysis via dietary exposure at uranium mine sites in the Grand Canyon watershed (Arizona, USA)

Jo Ellen Hinck [a,*], Danielle Cleveland [a], Bradley E. Sample [b]

Environmental Science & Technology
pubs.acs.org/est

Uranium Bioaccumulation Dynamics in the Mayfly *Neocloeon triangulifer* and Application to Site-Specific Prediction

Brianna L. Henry, Marie-Noële Croteau,* David M. Walters, Janet L. Miller, Daniel J. Cain, and Christopher C. Fuller

Cite This: Environ. Sci. Technol. 2020, 54, 11313–11321

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Environmental Pollution
journal homepage: www.elsevier.com/locate/envpol

Improved enrichment factor calculations through principal component analysis: Examples from soils near breccia pipe uranium mines, Arizona, USA

Carleton R. Bern [a,*], Katie Walton-Day [a], David L. Naftz [b]

diversity
MDPI
Article

Metabarcoding of Environmental DNA Samples to Explore the Use of Uranium Mine Containment Ponds as a Water Source for Wildlife

Katy E. Klymus *, Catherine A. Richter, Nathan Thompson and Jo Ellen Hinck
Columbia Environmental Research Center, U.S. Geological Survey, Columbia, MO 65201, USA

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Diversity 2017, 9, 54; doi:10.3390/d9040054

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- Web Page: https://webapps.usgs.gov/uraniummine/
- Geonarrative on radon at Pinenut mine: Walton-Day, K., Wendel, J.R., Hinck, J.E., Naftz, D.L., and Qi, S.L., 2021, Invisible: Radon gas at the Pinenut uranium mine, Arizona, USA, 2015-2016: Geonarrative webpage: https://apps.usgs.gov/colorado-water/radon-pinenut-mine.html.

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- Environmental Health Program (USGS)