Senior Research Proposal
Jacob Hall
Intro to Geologic Research
Professor Rowan Lockwood
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Introduction

Radon is a naturally-occurring gas that is a part of the uranium decay chain. It is a common hazard in residential basements, where radon seeping out the ground can enter into houses and eventually cause lung cancer. In the 70s, uranium decay products were identified in the Yorktown Formation, and since then numerous students and faculty in the William & Mary geology department have studied radon's presence in Williamsburg.

Online videos are an increasingly common medium for information and entertainment consumption, and have potential for effective science communication. (Finkler and Leon, 2019) One of the ways to make science communication engaging is to tell a story. Storytelling allows people to connect to a concept, and informs their own decisions. (Joubert et al., 2019)

For this project, I will produce a video that tells the story of radon in Williamsburg to the community. The project will include the development of storytelling methods and accessibility standards that the video will strive to meet.

Research Goal

The purpose of this video will be to communicate current radon research with the Williamsburg public. To do so, it will establish what radon is and how it is naturally formed, as well as how it is a health risk. The video will then summarize previous research on Radon in the Williamsburg area, including student research projects at William & Mary. The video will conclude with encouragement for viewers to learn more about radon, and to get their homes tested. To do all of this effectively, a literature review will be conducted to determine the best practices in video communication of science, as well as what accessibility guidelines should be followed. The video will be an approachable introduction to why radon is an important topic for everyone in Williamsburg to be aware of.

Geologic Background

Radon is a chemical element with the atomic number 86. It occurs naturally as a short, intermediate step in the uranium decay chain (less than four days). It takes the form of a colorless and odorless gas, so it is hard

to detect without the use of a specialized detector. Radon's half-life is 3.82 days, meaning that after that amount of time half of a given quantity of radon will have decayed into the next decay product. The products directly following radon are solids, and also short-lived. Two of them, polonium-218 and polonium-214, emit alpha particles. When radon is inhaled into the lungs, this process can take place within the lungs. Alpha particles can damage the cells lining airways within the lungs, eventually leading to cancer. This is how exposure to radon increases one's risk of lung cancer. (National Research Council (US) Committee on the Biological Effects of Ionizing Radiations, 1988)

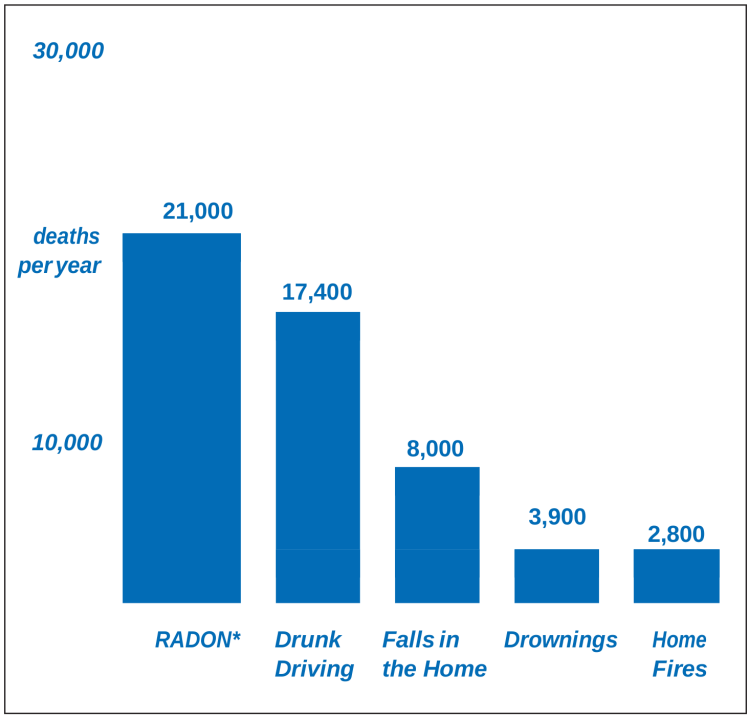

Figure 1: Graph from EPA report comparing yearly radon-related deaths compared to other common causes in the US

> Cooper's paper had the following quote and citation: "Naturally occuring uranium exists in many soil and rock types…one place [it] can become concentrated is in decayed organic material…(2)" (Swanson, 1961) I should add this to my paper

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+ "Yorktown formation is characterized by a high fossil content" [@cooper89]
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The coastal plain of Virginia is usually described as low-risk for radon. The Environmental Protection Agency's published radon risk map shows Virginia's coastal plain as the lowest-risk region in the state, labeled as "Low Potential (less than 2pCi/L)." ("Virginia - Radon Zones") The Virginia Department of Health has published the same map on their website ("Indoor Radon Program – Radiological Health") Someone living in the Williamsburg area who reads this map would likely conclude that their home is at negligible risk of

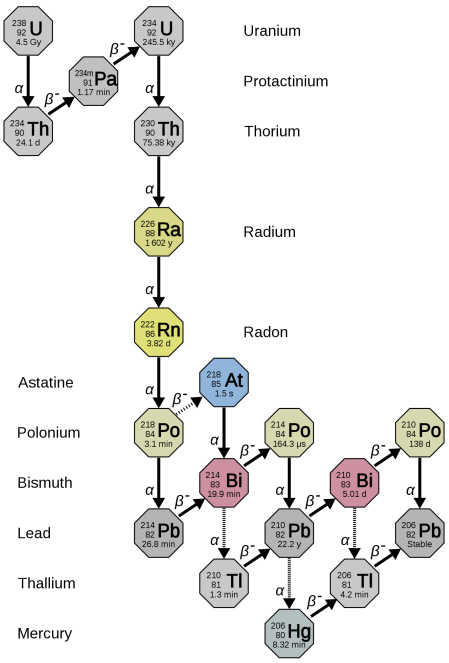


Figure 2: Decay chain of uranium (User:Tosaka, 2014)

radon exposure. While this might be true for much of the coastal plain region, research at William & Mary has shown there to be areas of higher risk that would be colored in red on the aforementioned map.

In 1978, Khandelwal and Singh published a short article in Health Physics sharing that they had discovered radioactivity in whale bone vertebra in the Chesapeake Bay, including in the Yorktown Formation. (1978)

Research on radon at William and Mary started around 1989 when Jennifer M. Cooper wrote her thesis investigating the Yorktown Formation as a potential source of radon in the Williamsburg area. Her big discovery was that a house had 30 picocuries per Liter, and even more underneath!

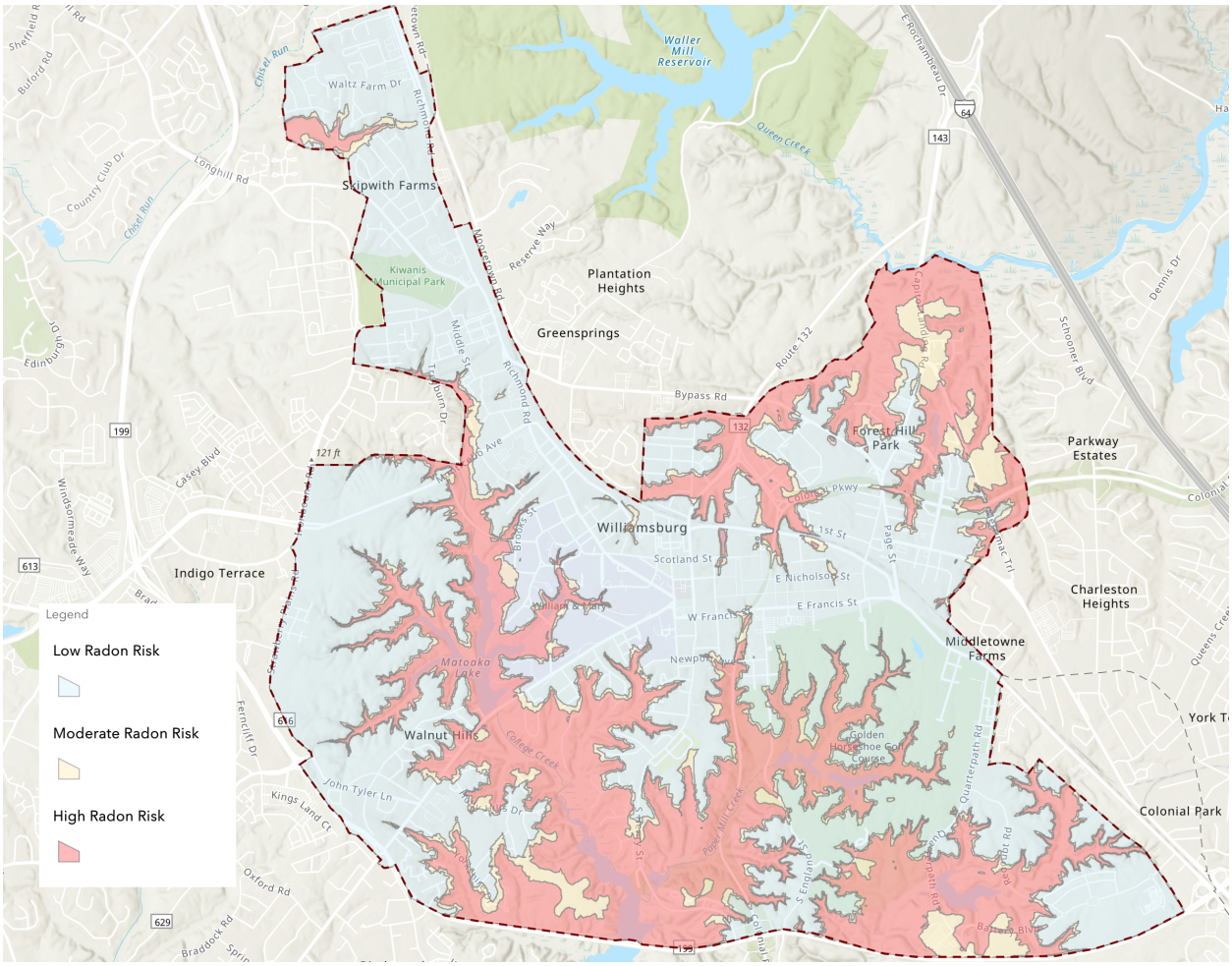
"In order for radon gas to be emitted from the ground, a fairly high level of soil permeability must exist (1)" Lasch, David K, 1988, "On Radon": Virginia Minerals, vol.34, no.1 published by Division of Mineral Resources.

Cooper's results suggested that there is radon emission from the Yorktown formation. (Cooper, 1989)

The second person to work on this was Tracy Whitesell. Her project involved testing different locations for radon, and she determined (Whitesell, 1990)

In 2020, Dorian Miller created a "risk map" of radon near William & Mary's campus. This map was created by mapping elevation data at certain thresholds, because the Yorktown Formation is a horizontal layer that

becomes closer to the surface as the elevation decreases. (Miller et al., 2020)



(Miller et al., 2020)

In 2021, Zoey Mondshine worked to confirm the risk map, by testing individual homes and comparing their relative test results to the regions on Dorian Miller's map. Among other observations, she identified homes in the "Low Radon Risk" region with radon levels above the EPA's recommended limit of 4pC/L.

Materials and Methods

This video will be produced in three major stages. The first will be a literature review investigating what makes videos for science communication effective, and how to make them as accessible as possible using captions and colors friendly to the color blind.

The second stage of this project will be script development. I will write a script based on the research goals described above and the guidelines established in my literature review. This stage will include meetings with

stakeholders including W&M faculty and students, and community members who have previously volunteered to participate in radon-related research.

The third stage of this project will be the development of the video. This will include filming any interviews or other footage that I might need, and editing them together to realize the script. I will review the video with the same stakeholders before finalizing it to make sure it represents their work as well as possible.

References

Cooper, J., 1989, A Study of the Relationships Between Radon Gas and the Geology of the Coastal Plain of Virginia: William & Mary, 31 p.

Finkler, W., and Leon, B., 2019, The power of storytelling and video: a visual rhetoric for science communication: Journal of Science Communication, v. 18, p. A02, doi:10.22323/2.18050202.

Indoor Radon Program – Radiological Health Virginia Department of Health, https://www.vdh.virginia.gov/radiological-health/indoor-radon-program/,%20https://www.vdh.virginia.gov/radiological-health/indoor-radon-program/ (accessed May 2021).

Joubert, M., Davis, L., and Metcalfe, J., 2019, Storytelling: the soul of science communication: Journal of Science Communication, v. 18, p. E, doi:10.22323/2.18050501.

Khandelwal, G.S., and Singh, J.J., 1978, Radioactivity of whale vertebra fossils in the Chesapeake Bay area: Health Physics, v. 35, p. 411–413.

Miller, D., Berquist, R., and Kaste, J., 2020, Radon in Williamsburg Area Homes (DRAFT): https://storymaps.arcgis.com/stories/10f6d3d7c0014a1087fe3ef14f306520 (accessed April 2021).

National Research Council (US) Committee on the Biological Effects of Ionizing Radiations, 1988, Health Risks of Radon and Other Internally Deposited Alpha-Emitters: Beir IV: Washington (DC), National Academies Press (US), http://www.ncbi.nlm.nih.gov/books/NBK218125/ (accessed May 2021).

Swanson, V.E., 1961, Geology and geochemistry of uranium in marine black shales–A review: Professional Paper, doi:10.3133/pp356C.

User:Tosaka, 2014, Uranium-238 decay chain diagram: https://commons.wikimedia.org/wiki/File:Decay_chain(4n%2B2,_Uranium_series).svg (accessed May 2021).

Virginia - Radon Zones Environmental Protection Agency, https://www.epa.gov/sites/production/files/2015-02/documents/r3-va-riskmap-largefont.pdf.

Whitesell, T.E., 1990, The Correlation Between Geologic Formations and Radon Emission in Surry and Williamsburg, Virginia: William & Mary, 63 p.

Budget

I do not anticipate any costs for this project. If I do need to meet with anyone outside of Williamsburg, it would probably be more appropriate to do so virtually anyways because of the ongoing COVID-19 pandemic.

Timeline

Summer 2021

By the start of the 2021-2022 school year, I will have completed the literature review drafted the script for the video, and reviewed the script with various stakeholders for their feedback.

Fall 2021

By 2022, I will have filmed all interviews, produced a draft video, and reviewed it with various stakeholders.

Spring 2022

By the W&M Geolgy Department's Senior Research Saturday, I will have adjusted the video based on feedback I received in the fall, and added any remaining captions.