Examination of radiation levels in Rowan County using dosimeters

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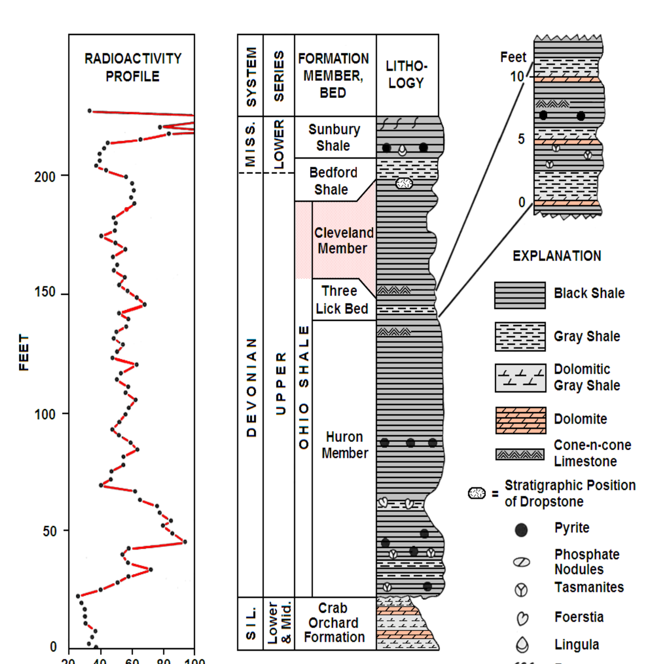
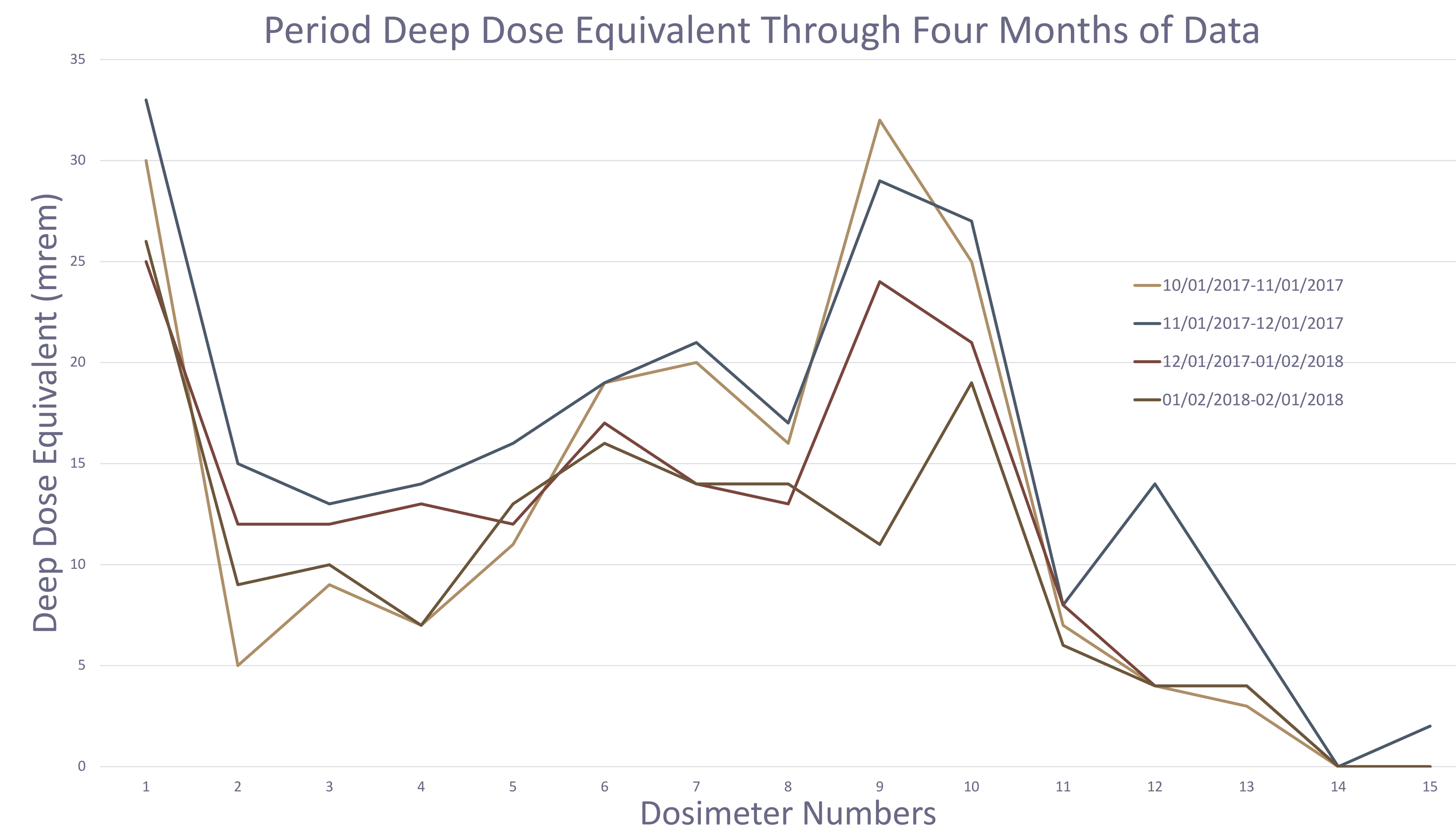
ABSTRACT

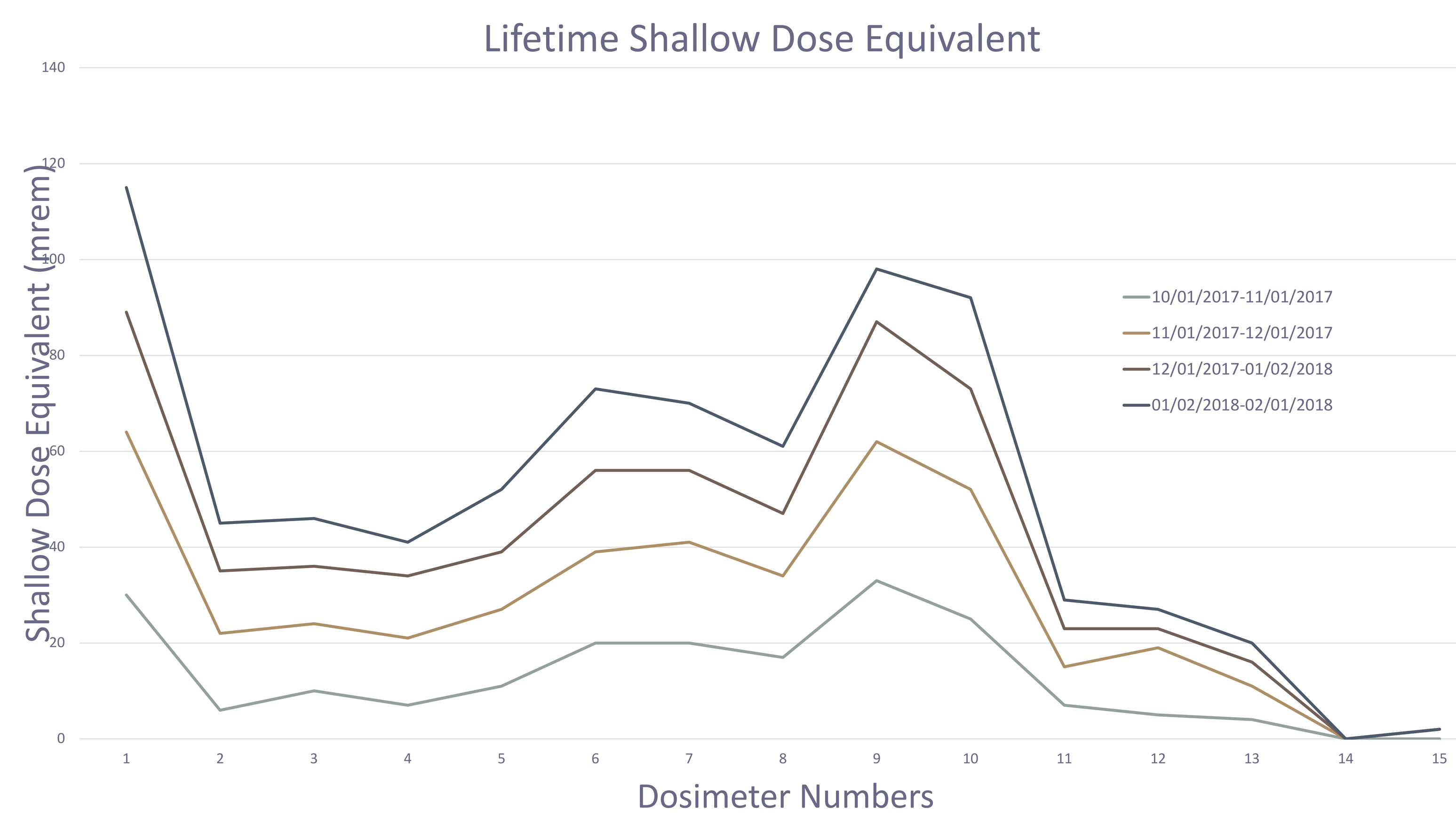
This study's goal is to determine if there is a connection between radiation originating from black shale formations and the high cancer rates observed in Eastern Kentucky. We placed fifteen small devices for measuring radiation dosage (dosimeter) in different locations in Rowan county. The dosimeters are collected and replaced monthly. Each dosimeter is labeled with a number, one-fifteen, to ensure the proper data for each formation is collected each month. Preliminary findings show that the dosimeters placed in the lower Huron member of black shale formations along with the upper Cleveland member have the highest monthly radiation average, followed by sunburry shale. All of the shales are found to have higher averages than the controls, following the pattern of higher cancer rates, according to https://www.cancer-rates.info/ky/, occurring in areas containing higher shale deposits.

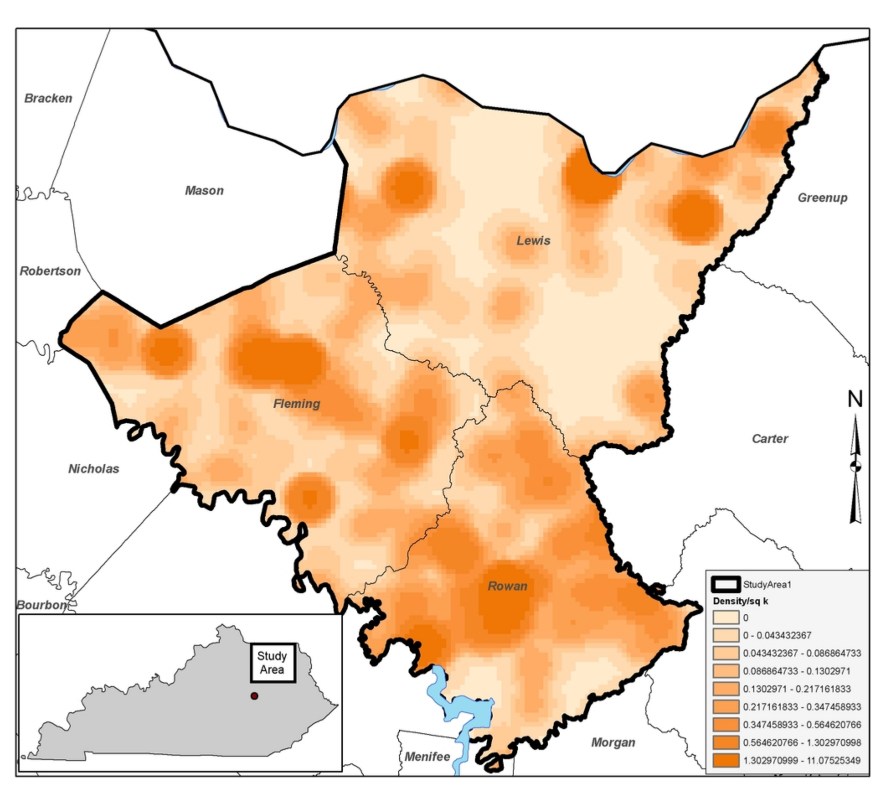
BACKGROUND

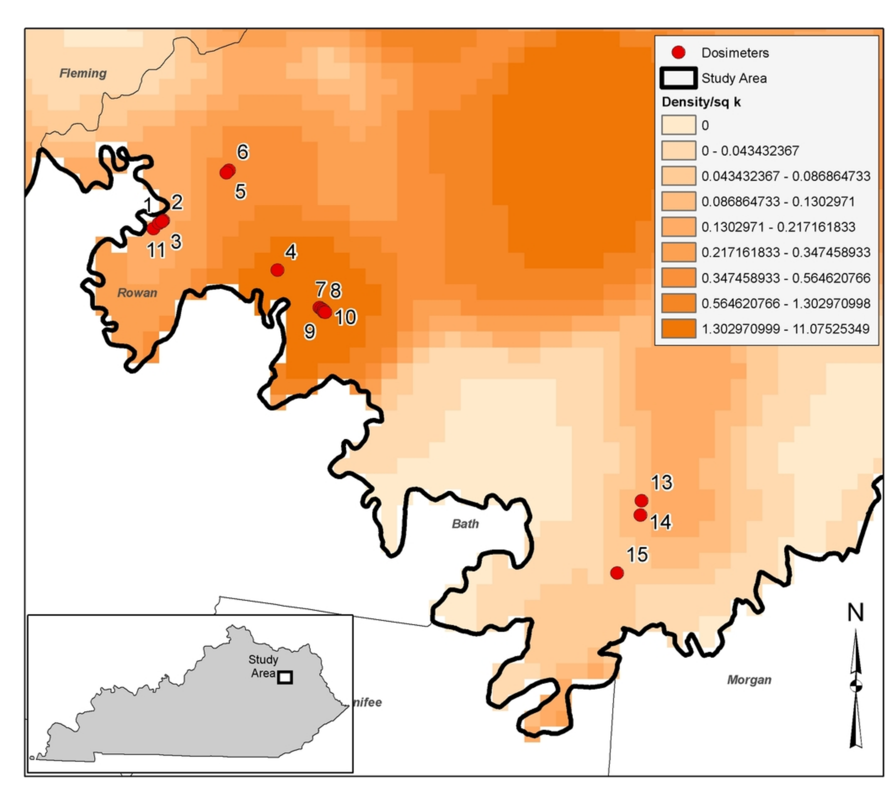
- Previous research shows a complex interplay of social, economic, behavioral, and healthcare factors affecting cancer incidence and mortality. Recent evidence suggests that specific geological formations, such as eastern Kentucky's black shales, may account for some of the observed geographical variation in cancer rates.
- Radiation, specifically gamma and x ionizing rays, are linked to several variations of cancers including leukemia, organ cancers including thyroid, lung, and skin cancers.
- Landauer Luxel+ dosimeters, used in this study, measure x, gamma, and beta radiation. Landauer's reports include the levels of radiation millirems, which are defined as the same amount of biological injury observed with one rad of X rays or gamma rays. Higher rems means more damage has occurred. 100rems=1Sv, which is the standard unit of radiation measurements. Previous studies show that one Sievert carries a 5.5% chance of developing cancer.
- The reports given show different depths of ionizing radiation, including Deep dose equivalent which applies to external whole body exposure at a tissue depth of 1 cm, Eye lens dose equivalent which applies to external exposure of the lens at a depth of 0.3 cm, and finally shallow dose equivalent which applies to skin or extremity exposure at a tissue depth of 0.007 cm. These equivalents are given in a period dose, which is the time the dosimeter was in the field, and a lifetime dose which is the amount of radiation an individual would experience in this environment over the course of a lifetime. Deep dose equivalents and lifetime shallow dose equivalents for all fifteen badges are shown in the following graphs.

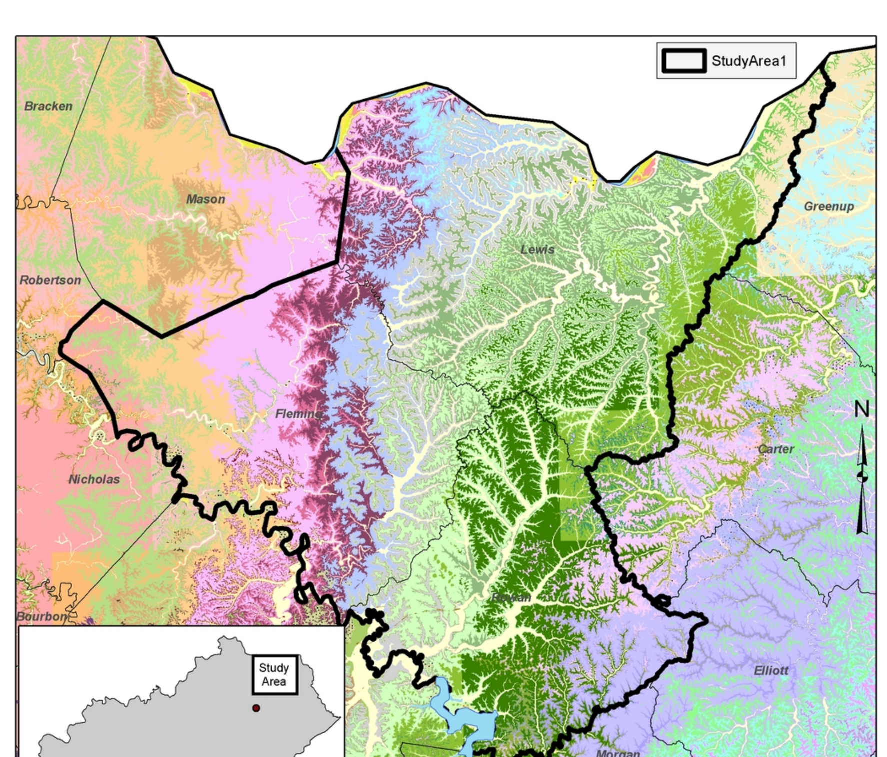


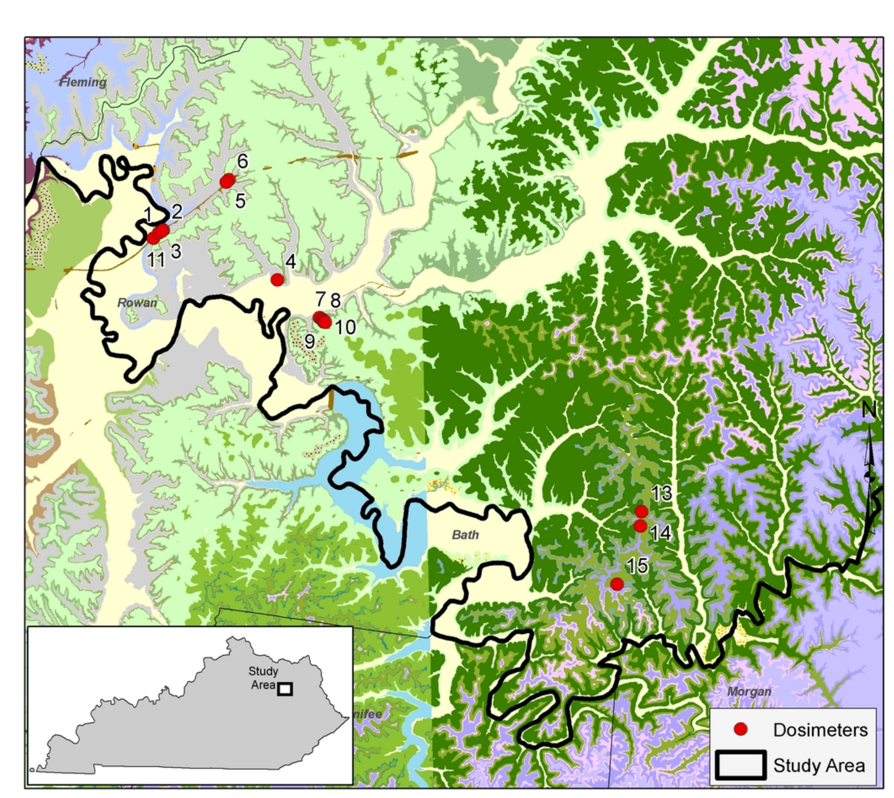












METHODS

- Each dosimeter is numbered one through fifteen. Each is placed in a certain location (see map) and replaced monthly. The locations of each dosimeter are:
  - Numbers one and two are placed in the lower Huron member of black shale formations.
  - Three and four are placed in the middle portion of the Huron member.
  - Five is located in the upper section of the Huron member.
  - Six through eight are placed in the Cleveland member of black shale formations.
  - Nine and ten are located in Sandburry Shale formations.
  - Eleven is placed in the crab orchard formation of gray shale.
  - Twelve is in Bedford Shale formations.
  - Thirteen is Borden siltstone, fourteen is in Slade shale, and fifteen is in sandstone to serve as controls.
- Lead shields were constructed to cover the badges and protect from external cosmic radiation and ensure all of the data are collected from the rock formations themselves. The badges are stored in a large lead pipe before being placed in the field to ensure they are not contaminated before placed in the desired locations.
- The top figure displays cancer densities and the corresponding geological formations in the study area.
- The study is being expanded to Lewis, Bath, and Fleming counties and will be continued for several years. Environmental dosimeters, which are much larger and stay in the field for a year rather then just a month, are being placed in all areas.
- The study also includes microbiology water testing to discover additional effects of this radiation on the environment. In the future more testing, including radon testing in wells and basements built in shale formations, will expand this study.

CONCLUSION

Preliminary results indicate dosimeters one, eight, and nine have the highest rems of radiation across all three depth equivalents with as much as four times the radiation of the other badges. This shows that the lower Huron member gives off the highest amounts of damaging ionizing radiation, followed by higher elevations of the Cleveland member and Bedford shale. The three controls, fifteen in sandstone, fourteen in limestone, and thirteen in Borden siltstone have the lowest amounts of radiation across all three equivalents among all of the badges. These findings correspond with the figures showing that badges placed in locations with a density of cancer incidents are also locations with large amounts of black shale deposits, while other formations, such as limestone, are found to produce lower levels of radiation and correlate with areas of low cancer. Our findings further the validity of the theory of geological formations impacting cancer occurrence in certain geographical locations. A definite cause and effect relationship between the two is impossible to state due to the exponential amount of other factors that can influence the prevalence of cancer, including life styles. Further data will continue to be collected to observe how other factors, such as weather and temperature, affect these amounts of radiation.

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