South Carolina Environmental Public Health Tracking Program "Putting Tracking to Work for You"

Track it. Map it. Use it.
SC Environmental Public Health Tracking

Radium in Drinking Water, 2005-2016

Water is essential to life. However, elevated levels of radium in drinking water can pose serious health risks. The objective of this report was to examine if detectable levels of radium were higher for certain geological regions in South Carolina (SC).

Introduction

Radium is a naturally occurring radioactive element and is released into the environment by the radioactive decay of uranium and thorium (US EPA). Although the benefits of using radium in the treatment of cancer and scientific research are proven, exposure to radium in the environment may cause health concerns. Everyone is exposed to low concentrations of radium in the air, water and food; it is not known whether long-term exposure to these low levels is likely to result in harmful health effects. However, chronic exposure to elevated radium concentrations may result in harmful effects such as anemia, cataracts, cancer and death. Therefore, to protect public health, the US Environmental Protection Agency (US EPA) has established a maximum contaminant level (MCL) of 5 picoCuries per liter (pCi/L).

Recognizing the health risks associated with radium exposure, the South Carolina Environmental Public Health Tracking (SC EPHT) Program, in collaboration with the South Carolina Department of Health and Environmental Control (DHEC) Drinking Water Program, tracks radium (radioisotopes 226 & 228, combined) concentrations in the state's public water systems (PWS). SC EPHT investigated if mean concentrations of radium in PWS wells varied by geological region (Figure 1).

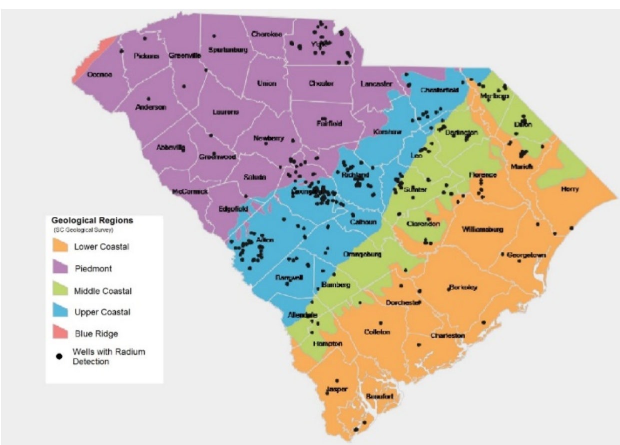

Figure 1. SC geological regions and well locations with at least one radium detection (2005-2016).

Methods

Radium concentrations measured in PWS (≥0 pCi/L) for the years 2005 through 2016 were examined in this analysis (n=2,213). The geocoded locations for the wells were used to identify the geological region in SC where each well was located. Figure 1 depicts location of wells which had at least one measurable detection during the study period. Mean concentrations of radium were compared by geological region using analysis of variance then pairwise comparisons with a Tukey adjustment. Concentrations were compared for all years combined, as well as annually. A p-value of <0.05 was used to determine statistical significance.

Results

The Upper Coastal Region had the highest mean radium concentration as compared to the other geological regions (Figure 2). Even though the means for all regions were below the MCL, 173 samples were identified state-wide that were greater than or equal to the MCL, with 94% of these exceedances found in wells from the Upper Coastal region.

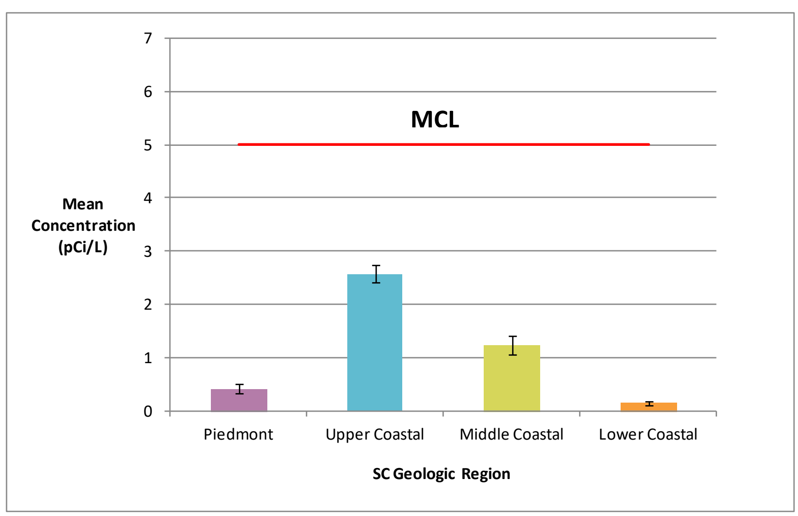

Figure 2. Mean radium concentration with 95% confidence interval by geological region, 2005-2016.

Table 1. Significant differences in mean radium concentration for pair-wise comparisons between geological region, 2005-2016.

Geological Region Comparisons	p-value
Piedmont vs. Upper Coastal	p<0.0001
Piedmont vs. Middle Coastal	p<0.0001
Piedmont vs. Lower Coastal	0.1708
Upper Coastal vs. Middle Coastal	p<0.0001
Upper Coastal vs. Lower Coastal	p<0.0001
Middle Coastal vs. Lower Coastal	p<0.0001

Pairwise comparisons were examined between geological region. Significant differences were noted across all geological region comparisons with the exception of Piedmont vs. Lower Coastal region (Table 1).

The mean radium concentration was consistently higher in the Upper Coastal region for all years examined while the mean concentrations for all geological regions stayed consistently similar (Figure 3).

Overall, the mean radium concentration for PWS wells located in the Upper Coastal region was significantly higher when compared to the other regions. The mean radium concentration for the Middle Coastal region was higher than both the Lower Coastal and Piedmont regions. There was no significant difference between the Piedmont and Lower Coastal region.

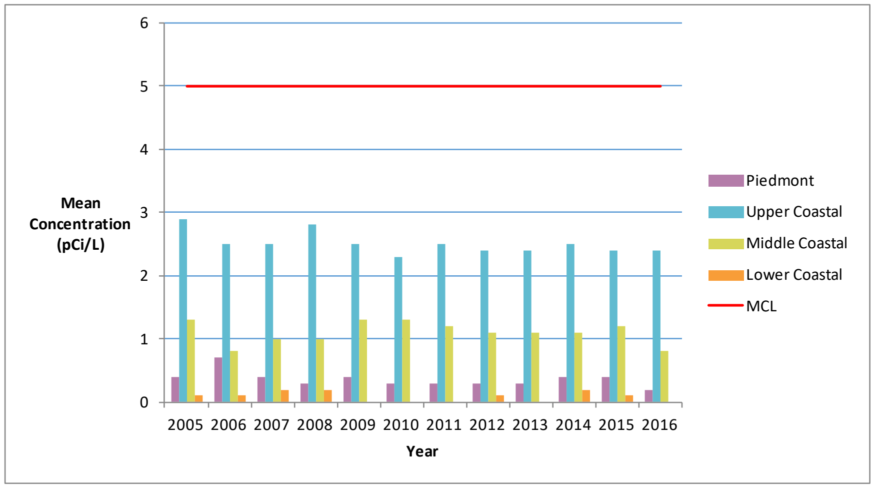

Figure 3. Mean annual radium concentration at test date by geological region, 2005-2016.

Conclusions

Potable drinking water is an expectation, especially among those who are served by a PWS. While PWS conduct periodic testing of radium and incorporate filtration methods (if necessary) to keep drinking water supplies below the established MCL, the presence of radium may persist due to the continuous decay of uranium-238 coupled with radium's prolonged half-life (1,600 years for radium 226, US EPA).

Studies have shown the geologic and geochemical makeup of the state's subsurface reasonably dictates the presence of persistent and intermittent radium in ground water in close proximity to the well (Denham, Millings, and Noonkester, 2005). Per the current study, drinking water sources from the Upper Coastal region had the highest mean radium concentrations, and the majority of radium concentrations that were ≥ MCL. These findings corroborate a previous study in SC, which indicated radium exceedances were more common and clustered toward the southwest portion of the Upper Coastal region (Stone, Devlin, Crawford, and Baize, 2005). However, it should be noted that radium has been detected in all geological regions (Figure 1), with exceedances detected in all but the Lower Coastal region.

There were some limitations to this study. First, over time, PWS wells may temporarily go off-line or be decommissioned and new ones installed. Consequently, the same wells may not have been consistently sampled at the same PWS during the time period examined. Additionally, the geology and geochemistry of the subsurface can vary with depth and lateral distance, so the placement of new wells, even within the same region and at the same PWS, may have measured radium concentrations that differ by one or more orders of magnitude. By monitoring patterns in radium concentrations across SC, targeted measures for protecting human health can be implemented. This could include outreach efforts, especially in the Upper Coastal region, to educate well owners on the health risks associated with radium exposure and actions that can be taken (e.g., in-home filtration) to reduce exposure.

For additional information about this fact sheet, please contact H. Reed Corley of the SC EPHT Program at corleyhr@dhec.sc.gov or (803) 898-1422.

References

Denham, M., Millings, M., Noonkester J. Intermittent Elevated Radium Concentrations in Coastal Plain Groundwater of South Carolina, U.S.A. WSRC-MS-2005-00565. 2005. <http://sti.srs.gov/fulltext/2005/ms2005565.pdf>.

Stone, P. A., Devlin, R. J., Crawford, B., Baize, D. G. Uranium, Radium, and Radon in Well Water in South Carolina: Distribution and Problems. Columbia, SC. South Carolina Department of Health and Environmental Control. 2005. <https://smartech.gatech.edu/bitstream/handle/1853/47952/StonePA%201of2%20papers.pdf>.

United States Environmental Protection Agency (US EPA). "Radionuclide Basics: Radium." <https://www.epa.gov/radiation/radionuclide-basics-radium#tab-1>.

More Information

Problems with Drinking Water (SC DHEC)
Radium (CDC)

S.C. Department of Health and Environmental Control