# Radium isotopes in coal combustion residuals in the United States

N. E. LAUER[1], J. C. HOWER[2], H. HSU-KIM[3] AND A. VENGOSH[1*]

[1]Division of Earth and Ocean Sciences, Nicholas School of the Environment, Duke University, Durham, NC 27708, United States (nancy.lauer@duke.edu, *correspondence: vengosh@duke.edu)

[2]Earth and Environmental Sciences, University of Kentucky, Lexington, KY 40506, United States (jchowe3@uky.edu)

[3]Environmental Engineering, Duke University, Durham, NC 27708, United States (hsukim@duke.edu)

In 2014, 39% of electricity in the United States was generated from coal combustion [1], and the EIA projects that coal will continue as a major player in the US electricity sector for at least the next 25 years [2]. Uranium and thorium as well as their daughter products are present in coal and are typically enriched in corresponding coal combustion residuals (CCRs). Critically lacking from previous research is the characterization of radionuclides in coals and associated CCRs from specific coal producing regions. Increased knowledge of the occurrence and distribution of radionuclides in CCRs from known coal basins heightens our ability to evaluate the environemtal risks of CCRs upon their disposal to landfills and surface impoundments. The objective of this study is to characterize the activities and ratios of naturally occuring radioactive materials (NORM) in Illinois, Appalachian, and Powder River coals and associated CCRs. We used gamma spectrometry to measure $^{226}$Ra, $^{228}$Ra, and $^{210}$Pb and their ratios in coals and CCRs. Differences in mean $^{228}$Ra/$^{226}$Ra activity ratios in CCRs originated from the Illinois, Appachian, and Powder River coals were found to be statistically significant. Illinois basin coal produces CCRs with the highest total Ra activity (298±46 bq/kg) and the lowest $^{228}$Ra/$^{226}$Ra activity ratio (0.31±0.09), followed by Appalachian CCRs (283±34 Bq/kg; 0.67±0.09), and Powder River CCRs (213±20 Bq/kg; 0.78±0.09). $^{228}$Ra/$^{226}$Ra activity ratios in CCRs reflect the $^{228}$Ra/$^{226}$Ra activity ratios in the parent coal, suggesting that the original uranium and thorium of the parent coal, characteristic to the source basin, controls the $^{228}$Ra/$^{226}$Ra activity ratios in the produced CCRs.

[1] Electric Power Monthly with Data for December 2014: U.S. EIA, 2015. [2] AEO2014 Early Release Overview: U.S. EIA, 2013.