Title: A Study of the Factors Affecting the Gross Alpha Measurement, and a Radiochemical Analysis of some Groundwater Samples from the State of Wisconsin Exhibiting an Elevated Gross Alpha Activity

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Investigators:

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Background/Need: Groundwater samples from many public water systems in the state of Wisconsin exhibit gross alpha activities in violation of the 15 pCi/L limit set by the United States Environmental Protection Agency. The interpretation of the gross alpha activity has long been a source of confusion among water utility operators and people working in public health fields. The gross alpha activity is quite variable. It depends on which method is used, on which calibration standard is used, on such factors as the times at which certain steps in the sample preparation process are performed, and for EPA method 900.0 on the uniformity of the film in the planchet (sample holder for counting radioactivity).

Objectives: The main objective of this study was to gain an understanding of the gross alpha measurement and to make a quantitative determination of how much each alpha-emitting radionuclide in a groundwater sample contributed to the gross alpha activity.

Methods: Ninety eight groundwater samples from water utilities from around the state of Wisconsin were analyzed for uranium activity (U-234, U-235, and U-238), thorium activity (Th-228, Th-230, Th-232), radium activity (Ra-226 and Ra-228), polonium-210 activity (Po-210), and gross alpha activity. The gross alpha activity was determined using EPA method 900.0. Many of these groundwater sources were known to have a combined Ra-226 and Ra-228 activity in excess of 5 pCi/L, which is a radium violation according to EPA regulations.

Results and Discussion: Most of these samples contained insignificant amounts of thorium or Po-210. The activity of thorium found in the all of the samples was on the order of 0.1 pCi/L or less. Only two samples contained Po-210 at a level of 1 pCi/L or more. A model was developed to determine the contribution of each radionuclide to the gross alpha activity. An analysis of the factors affecting the gross alpha measurement was conducted using this model. The gross alpha activity depends appreciably on the radionuclide used as the calibration standard, the time between sample collection and sample preparation, and the time between sample preparation and sample analysis. The adjusted gross alpha activity, the gross alpha activity minus the total uranium activity, can depend appreciably on whether a radiochemical or a gravimetric method is used to determine the total uranium activity. This is important since according to EPA regulations an adjusted gross alpha activity exceeding 15 pCi/L is considered to be a gross alpha violation. Using the model, it is shown that for some water samples the value obtained for the adjusted gross alpha activity can range from being well within compliance to being well out of compliance as the parameters affecting the gross alpha activity are varied within the limits set forth by Method 900.0. In cases where a water sample was analyzed within a few days of collection, it was found that if the sample contained a significant amount of Ra-228, the measured gross alpha activity was significantly greater than the calculated gross alpha activity unless it was assumed that the sample also contained Ra-224 at a level approximately equal to the Ra-228 activity. This result is not unexpected since Ra-224 is in secular

equilibrium with Ra-228. In many cases, the majority of the gross alpha activity of a sample was due to the alpha-emitting progeny of Ra-226 and to Ra-224 and its alpha-emitting progeny. This situation often leads to confusion about the gross alpha activity, since the activities of the progeny of Ra-226 and of Ra-224 and its progeny are never routinely measured in the laboratory.

Conclusions/Implications/ Recommendations: The use of the model developed in this work should be of assistance in helping a water utility with a gross alpha violation determine the reason for the violation, and, therefore, should be helpful in determining how to treat the gross alpha violation. Current EPA regulations do not provide much guidance on how to proceed when one encounters a gross alpha violation. If the gross alpha activity is to be retained as a regulatory device, some plan of action should be set forth in the EPA regulations to try to identify the source of a gross alpha violation. If a sample with a gross alpha violation was processed soon after collection, the planchet could be recounted or the sample could be reanalyzed at a later time, when the Ra-224 activity has decayed away, in order to determine whether the gross alpha violation is related to the amount of Ra-224 in the sample. If the adjusted gross alpha was computed using a uranium activity determined using a gravimetric method, it could be recalculated using a uranium activity determined by a radiochemical method. Another step may be to determine whether a calculation of the gross alpha activity, based on the known activities of the most commonly measured radionuclides (U-234, U-235, U-238, Ra-226, and Ra-228) is consistent with the experimental gross alpha activity. If not, then it may be necessary to test the water for other radionuclides. In this study and others, the levels of thorium isotopes found in all of the water samples were not significant. Two samples had significant levels of Po-210. Consequently, when an unexplained gross alpha violation persists, a Po-210 determination may be in order. If the gross alpha violation persists, it may be necessary to test for radionuclides whose origin is due to human activity.

Related Publications: none

Key Words: Groundwater, gross alpha activity, radium violation, radionuclide.

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Final Report: A final report containing more detailed information on this project is available for loan at the Water Resources Institute Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069.