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Combined 226Ra + 228Ra analysis in groundwater by MC-ICPMS

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Radium (Ra) is a naturally occurring contaminant that can be found at relatively high levels in groundwater sources used for drinking water. In the United States, the Environmental Protection Agency requires that the combined activities of ^{226}Ra + ^{228}Ra are less than 0.185 Bq/L in water distributed for public consumption. For water utilities to remain in compliance, analyses of ^{226}Ra + ^{228}Ra can only be reported using approved methods such as gas proportional counting, radon emanation, and gamma spectrometry. Although these methods are accurate, they are precision-limited due to relatively low count rates. Precision is not typically considered when evaluating exceedances of the regulatory limits, making it difficult to make water quality decisions for waters containing ^{226}Ra + ^{228}Ra near the limit. Mass spectrometry analysis of ^{226}Ra and ^{228}Ra has been used in the research community for over 40 years, but has not been used for compliance monitoring. The Midwestern Cambrian-Ordovician Aquifer system, located in the north central United States, contains elevated levels of radium that often exceed the regulatory limits. This aquifer system provides a natural setting where new methodology can be tested and compared to existing regulatory datasets. Over several years, we have used multi-collector inductively coupled plasma mass spectrometry to measure the combined activities of ^{226}Ra + ^{228}Ra in specific well waters, among other types of water samples. Two aliquots of a water sample are used for the measurement of both isotopes. One aliquot is spiked with ^{228}Ra tracer solution, purified, and $^{226}Ra/^{228}Ra$ is measured to obtain concentrations by isotope dilution. A second aliquot, also purified, is used to measure the natural $^{226}Ra/^{228}Ra$. The count rates associated with mass spectrometry are higher than radiochemical methods, resulting in better precision. Additionally, comparisons of mass spectrometry data to radiochemical analytical data show that both the ^{226}Ra and ^{228}Ra activities can be measured accurately by mass spectrometry. Water utilities could use the mass spectrometry method to help evaluate water quality needs near the regulation limit, and the method can be used more generally for research aimed at understanding Ra geochemistry in groundwater systems.