Radium isotopes in Cayuga Lake, New York: Indicators of inflow and mixing processes

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Limnol. Oceanogr., 50(1), 2005, 158-168 | DOI: 10.4319/lo.2005.50.1.0158

ABSTRACT: Naturally occurring radium isotopes (^{223}Ra, ^{224}Ra, ^{226}Ra, and ^{228}Ra) were measured in lake and tributary water of Cayuga Lake, New York, during the course of a vernal inflow event in the spring of 2001. A large influx of groundwater, probably from a carbonate aquifer, entered the lake at its extreme southern end early in the vernal inflow event and spread northward, covering an extensive part of the southern end of the lake. The low ^{228}Ra/^{226}Ra activity ratio of this water mass, compared with bulk lake water, allowed its identification through time. Estimates of mixing with bulk lake water were calculated from changes in the 226Ra content. Groundwater inflow to the lake around the delta of a major tributary was detected on the basis of ^{223}Ra and ^{224}Ra activity of lake and tributary water. Inflow of a water mass to the surface of the lake was also detected using ^{223}Ra and ^{224}Ra activity. The integrity of this water mass was monitored using short-lived radium isotopes. Suspended sediment in the lake water is a source of the short-lived radium isotopes ^{223}Ra (~2 x 10^{-4} dpm L^{-1}) and ^{224}Ra (~3 x x 10^{-3} dpm L^{-1}), but bottom sediments are a more significant source of ^{228}Ra. Radium isotopes can be valuable new tools in limnological investigations, allowing detection and monitoring of events and processes such as water inflow and mixing, determining sources of inflowing water, and monitoring introduced water masses as they move within the lake.

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