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Monitoring Thoron in the Presence of Radon to Locate Terrestrial Sources of Pollution in Thailand Waterways

Restoring depleted underground freshwater tables can inadvertently release accumulated pollutants into adjacent waterways via submarine groundwater discharge (SGD). The abundance of ^{222}Rn (Radon) in rocks and soil makes it a useful groundwater tracer for these pollutants. While the presence of elevated Radon in waterways may indicate the presence of SGD, Radon detection alone cannot accurately locate the SGD source if the waterway's volume is exchanged on a timescale longer than Radon's 3.82-day half-life, because Radon will be distributed over a large area.

"The Durridge RAD7's unique ability to rapidly and accurately discriminate Thoron in the presence of Radon was the key to pinpointing exact sites of groundwater entry to the studied waterways."
- Bill Burnett, Professor Emeritus and SGD Pioneer

With a half-life of less than 1-minute, ^{220}Rn (Thoron) will only occur in proximity to the groundwater source. According to the project's leader, FSU Professor Emeritus Dr. Bill Burnett, "The Durridge RAD7's unique ability to rapidly and accurately discriminate Thoron in the presence of Radon was the key to pinpointing exact sites of groundwater entry to the studied waterways."

The measured energy distributions of radioactive decay events include natural variations due to the incident angles of detected alpha particles. As shown in figure 1, such natural variations can cause RAD7 counts to "spill over" from an energy window corresponding to a particular decay species into an adjacent window. When prospecting for Thoron in the presence of Radon, some 1% of "old Radon" counts in the "C" energy window can spill over into the Thoron "B" energy window, artificially inflating the Thoron counts. This effect is more pronounced when the Thoron concentration is relatively low. Said Burnett, "We worked with Durridge to improve the accuracy of Thoron counts by establishing a Meaningful Thoron Threshold (MTT)," a calculation of channel "C" counts to be subtracted from the Thoron counts based on the old Radon concentration and calibration of the RAD7. The MTT has been added to Durridge's CAPTURE companion software for the RAD7.

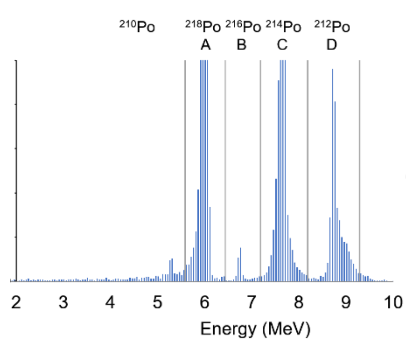

Figure 1 Energy spectrum of Thoron (B window) in presence of higher concentration of Radon (C window) showing C→B spillover

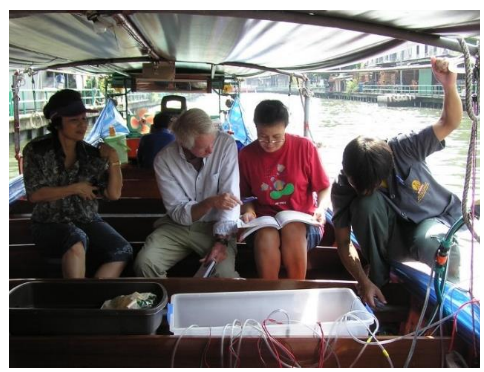

Figure 2 Professor Burnett and Professor Chanyotha monitor Thoron and Radon with a set of three RAD7s.

Figure 3 shows the Thoron distribution measured using RAD7 and RAD AQUA along a 25-km stretch of Klong Bangkok Noi from surveys in 2009 (a) and 2013 (b) together with the MTT. Peaks labeled 1-4 from both surveys occur at the same points along the Klong and are all well above the MTT. Being collocated with observations of concentrated human activity, the peaks indicate likely sources of groundwater ingress which may deliver pollutants to the waterway.

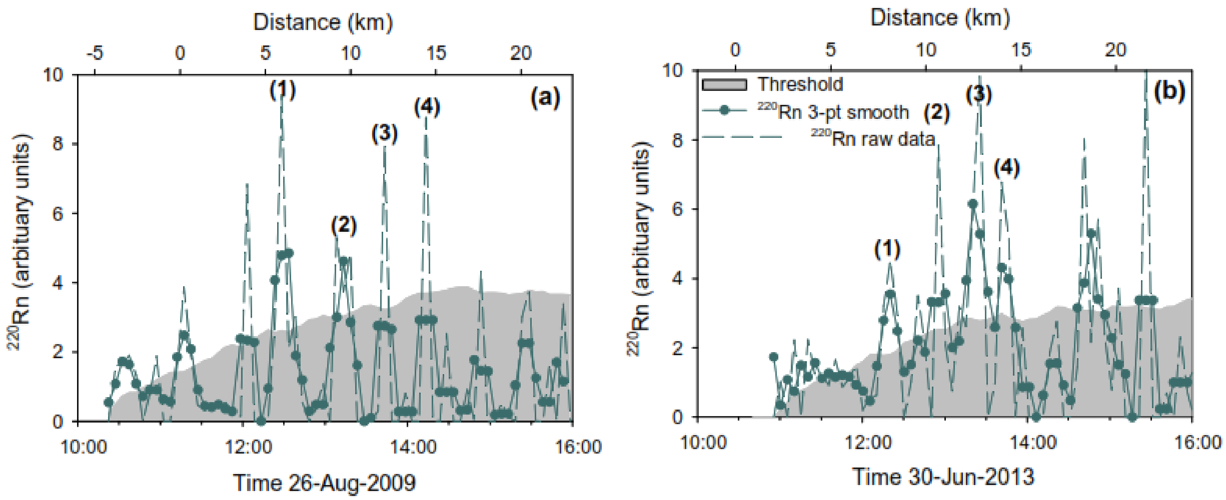

Figure 3 Thoron measurements along Thailand's Klong Bangkok Noi

Nutrient analyses at a site of suspected high discharge showed that dissolved inorganic nitrogen and phosphate correlated significantly to Radon concentration. Rough estimates of the nutrient fluxes that are orders of magnitude higher than coastal settings make it appear likely that seepage of shallow groundwater is an important pathway for nutrient contamination of the klongs, and thus to the river, and ultimately to the Gulf of Thailand.

References

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