Groundwater-surface water interaction in Martis Valley

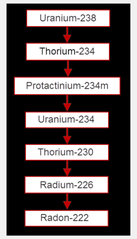
Elizabeth DeRubeis [1,3], Richard Bibby[2], Bradley Esser[2], and Jean Moran[1]

[1]California State University East Bay, [2]Lawrence Livermore National Laboratory,
[3]Lawrence Livermore National Laboratory Glenn T Seaborg Institute

Abstract: The goal of this project is to find areas of groundwater influx to Martis Creek, located near Lake Tahoe, California, in order to determine baseflow of the stream. Using ^{222}Rn, a naturally produced tracer, and Xe, an introduced tracer, it is possible to determine the degassing constant (*k*) and quantify groundwater influx to the stream.

Introduction:

- Martis Valley is a recharge area due to snowfall/snowmelt and the mountains surrounding the valley.
- The geology of the area includes igneous and metamorphic rocks, alluvium and glacial deposits.
- ^{222}Rn is volatile, has a half life of 3.82 days, and can be used as a ground water tracer since it has higher activity levels in groundwater than in surface water.
- Hyporheic zone sediments may also release ^{222}Rn into the surface water.
- With climate change, an increase in temperatures would lead to earlier snow melt which could affect the baseflow of the creek. This would have an effect on human population in the area, fish populations in the stream, and the ecosystem of Martis Creek.



Portion of the ^{238}U decay sequence illustrates decay path from ^{238}U to ^{222}Rn

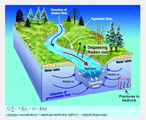


Illustration of the different ^{222}Rn inputs and outputs in a stream

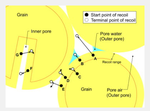
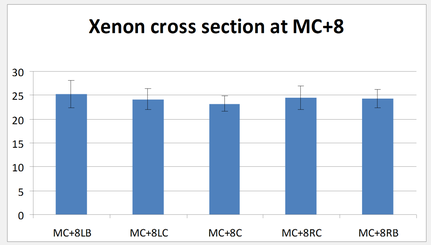


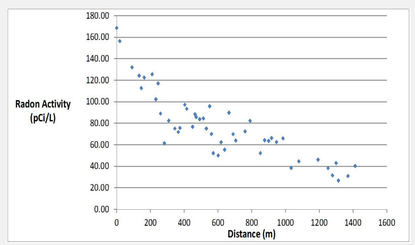
Illustration of ^{222}Rn to pore water in the hyporheic zone

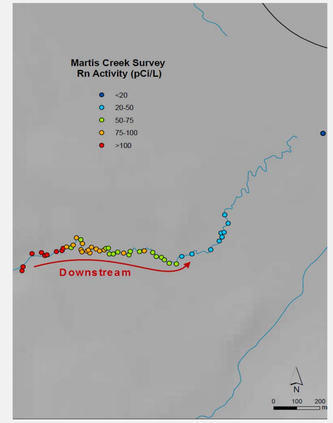
Results:

The wells and springs closest to Martis Creek have ^{222}Rn activities of approximately 500 pCi/L. In surface water we found ^{222}Rn activities of up to 168 pCi/L. In general, ^{222}Rn activities decrease with distance downstream. We also found negligible contribution of ^{222}Rn from the hyporheic zone.



Graph that shows the Xe tracer was well mixed across the stream profile soon after introduction.





Graph and map illustrating the general decrease in Rn activity with distance downstream.

Methods:

Surface water samples were injected with a syringe beneath 10mL of scintillation cocktail. Sediment samples were sieved into four size categories and three grams of each size were placed in scintillation vials with 10mL of DI water and 10mL of scintillation cocktail. Samples were measured on a liquid scintillation counter.

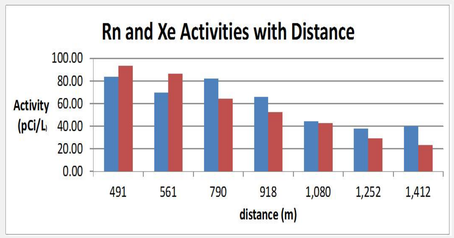
$$Q\frac{dc}{dx} = I(c_i - c) - kwc \quad (1)$$

Equation used to quantify groundwater influx to the stream

Where
Q = stream discharge (m^3/day),
C = stream Rn activity (pCi/L),
Ci = groundwater Rn activity (pCi/L),
I = groundwater discharge (m^3/m/day),
w = stream width (m), and
k = gas transfer velocity (m/day).

Discussion:

The increase in ^{222}Rn in two places in Martis Creek indicates potential areas of groundwater influx. The general decrease of ^{222}Rn activity with distance downstream indicates that groundwater influx is occurring in reaches upstream. The introduced Xe tracer shows an exponential decrease with distance downstream and allows us to quantify the degassing rate.



Rn activity shown in blue, Xe concentration shown in red. Xe concentration decreases with distance in a smooth curve, while the naturally occurring Rn tracer generally decreases with distance, but shows a slight increase in two places. This may indicate regions of groundwater influx.

Future Work: Quantify groundwater influx using equation 1. This value can be used when creating water budgets for the region.

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