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Using Radon-222 to Locate and Quantify Groundwater Discharge in Farmington Bay, Great Salt Lake, Utah

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The groundwater component of the Great Salt Lake's water budget is poorly constrained. Previous studies shows that groundwater discharge in Great Salt Lake ranges from 3-14% [1, 2, 3]. To better constrain this groundwater contribution, we used radon-222 to locate and quantify groundwater discharge in the Great Salt Lake. We analyzed surface water samples using alpha spectrometry. Radon, produced naturally in the subsurface from the decay of radium-226, is dissolved into groundwater leading to a high natural concentration. Surface waters are depleted in radon due to radioactive decay and gas exchange with the atmosphere. Farmington Bay shows a heterogenous distribution of radon indicating it is useful tracer in identifying locations of groundwater discharge (Figure 1).

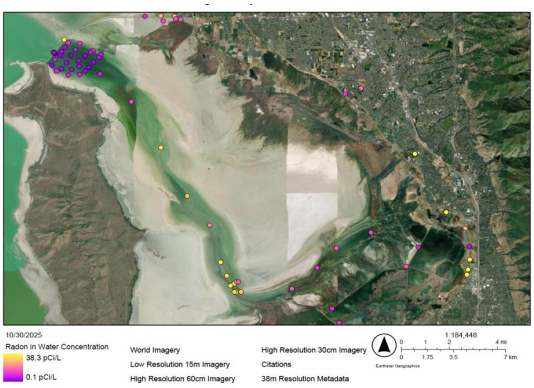

Figure 1: Spatial radon distribution throughout Farmington Bay, Great Salt Lake.

The amount of radon in surface water is a function of the production rate in the subsurface, the amount of overland transportation, and the exchange rate with the atmosphere. Using these parameters we calibrated a model to predict groundwater discharge based on radon concentration. We are developing a non-linear inversion model that can take our measured radon concentrations and predict a groundwater discharge pattern that best fits the observed data. This model works well for regions with high sample density.

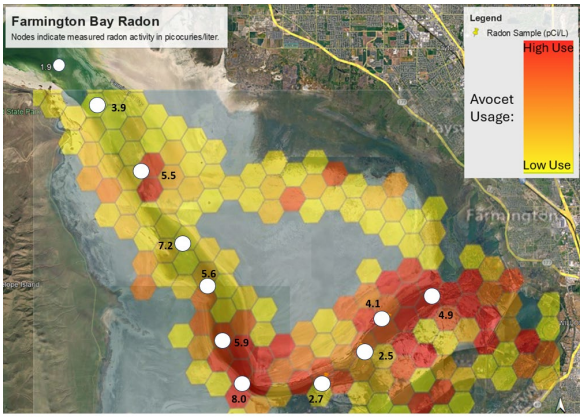

Figure 2: Surface water radon concentrations overlaid with Avocet usage.

We discovered a correlation between Avocet birds and locations that experience more groundwater discharge. These birds tend to spend time in places with higher discharge (Figure 2). This was used to guide our sampling and more easily discover locations with high radon concentrations.

We installed several seepage meters to directly quantify seepage at a given location, however, we found that discharge in the Great Salt Lake is very discrete. Direct seepage measurements have yielded rates close to the detection limit of the device. Modeling groundwater discharge using radon-222 concentrations could help constrain the groundwater budget for the Great Salt Lake. This will help refine water budgets and build understanding in available water resources for the Great Salt Lake area.

[1] Arnow and Stephens (1975), United States Geological Survey Water-Supply Paper 2332.

[2] Feth et al. (1966), United States Geological Survey Professional Paper 518.

[3] Waddell and Barton (1980), Utah Department of Natural Resources.