Tracking oil and gas isotopic signatures in freshwater bivalves

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Bivalves are found in all major waterways in North America and could be potential monitors of freshwater quality. Select constituents such as metals and organic compounds incorporated into both the soft tissue and the hard shell layers can reflect previous water conditions, allowing single specimens to possibly provide several years of geochemical data. Changes in water chemistry due to oil and gas management could be recorded in freshwater bivalves. For example, bivalves growing downstream of permitted releases of oil and gas wastewater could record changes in water quality and identify sources using chemical fingerprints of oil and gas wastewater.

Bivalves were grown for eight weeks in controlled laboratory environments and dosed with produced water from an unconventional shale play. Mortality of bivalves under dosed conditions were four times higher than the bivlaves in the control conditions. Soft tissue and shells were analyzed for major element chemistry (Ba, Sr, Ca), organics using GCxGC-TOFMS, and ^{226}Ra and ^{228}Ra activity to identify potential geochemical fingerprints that could be used as geochemcial tracers. Ra, Ba, Sr, and cyclic hydrocarbons showed potential to accumulate in the soft tissue of freshwater mussels and could potentially be used as forensic tools to record discharges of effluent over time, monitor and reconstruct changes in water quality due to anthropogenic activity, and fingerprint contamination sources. Surprisingly, radium activity did not increase in the soft tisue of the bivalves grown in tanks dosed with oil and gas wastewater relative to control conditions, but the ^{226}Ra/^{228}Ra activity appeared to reflect changes in the ratios of the dosed tanks. Hard shell material showed little growth during the 8-week study, and may not incorporate oil and gas signatures in large spill events. Further evaluation of the mechanisms of incorportion will determine if freshwater bivalves can quantify human and environmental health risks, which can then be used to guide future management strategies.