Mutiple isotopic tracers to monitor remediation of uranium solution mining

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Roll front uranium deposits form by interaction of U-bearing groundwater with reduction-oxidation gradients in the host sediments. This redox gradient in many roll-front deposits can be visually identified by hematite staining on the oxic side and green-gray sediment color on the anoxic side. A dark boundary between these two zones is concentrated in U(IV) minerals and other reduced metals such as Se and Mo. Solution mining of roll-front deposits perturbs natural redox conditions by oxidizing U (and other metals) in the main ore body for economic recovery. This perturbation coupled with an extensive monitoring well network provides a unique opportunity to assess the natural recovery of reducing conditions after the cessation of mining as a remediation strategy.

We have conducted a characterization survey of groundwater, mining fluids and complimentary ore body sediment core from the Smith Ranch mine in eastern Wyoming, USA for $^{87}Sr/^{86}Sr$, $\delta^{34}S$ sulfate, $\delta^{238/235}U$ and the $^{234/238}U$ activity ratio. Sampling locations include both active and inactive mining sites. Monitoring wells surrounding the ore body have 4-22 ppb U, 68-413 ppm SO_4, $^{234}U/^{238}U$ activity ratio 2.9-5.5, $\delta^{34}S$ -16.6-10.8‰, $\delta^{238/235}U$ is between 0-2‰ for most samples.

Acid leachates of sediment core from a previously mined unit have low $^{234}U/^{238}U$ activity (0.6-1.6) compared to groundwater outside the ore zone. $\delta^{34}S$ spans nearly 52‰ (-48-+3.8‰) and most samples have $\delta^{238/235}U$ between -2 and 0‰. The depletion of ^{238}U in dissolved U(VI) as indicated by negative $\delta^{238/235}U$ suggests U(VI) reduction in the groundwater. There are no observed correlations between $^{234}U/^{238}U$ activity and $\delta^{238/235}U$. However the U activity ratio does correlate with depth. The low ($^{234}U/^{238}U$) in the ore zone will be a sensitive tracer for quantifying the migration of ore zone U to uncontaminated groundwater.

Iron availability controls phytoplankton ecophysiology in the South Atlantic Subtropical Convergence Zone

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Measurements of phytoplankton photophysiology using Fast Repetition Rate fluorometry (FRRf) from the UK-GEOTRACES 40°S Atlantic cruise (GA10; JC068) have characterized two dominant ecophysiological regimes which are interpreted on the basis of nutrient limitation. South of the South Subtropical Convergence (SSTC) in the Antarctic Circumpolar Current (ACC) of the Eastern Atlantic Basin, waters are characterized by elevated chlorophyll concentrations, dominance by larger phytoplankton cells, and low F_v/F_m values. The reason for the low F_v/F_m values was iron (Fe) limitation, which was confirmed via 24 hour on-board Fe addition incubation experiments. Fe supply to these waters, either through artificial bottle additions or natural downstream enrichment from Gough Island in the Central Atlantic, resulted in significantly increased F_v/F_m. Satellite images suggest a broader region of enhanced chlorophyll concentrations around the SSTC of the Western Atlantic relative to the Eastern Atlantic, which is hypothesised to be a result of higher iron supply from the South American continent. To the north of the SSTC at the southern boundary of the South Atlantic Gyre, phytoplankton are characterized by high values of F_v/F_m, which coupled with the low macronutrient concentrations and increased presence of picocyanobacteria, are interpreted as conditions of Fe replete, balanced macronutrient-limited growth.

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