CARBON ISOTOPES AS A BASIS FOR EVALUATING ALKALINITY GENERATION OVER TIME WITH A SULFATE-REDUCING BIOREACTOR IN SOUTH-CENTRAL INDIANA[1]

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Abstract: Bioreactors provide passive treatment of acid mine drainage (AMD), sequestering metals and sulfides and producing a net alkaline outflow. However, ongoing studies in Indiana indicate that bioreactors do not perform as optimally as expected. Carbon isotopes provide a means of evaluating how alkalinity is generated inside a bioreactor. We are currently monitoring a large (220m long x 90m wide x 2m deep) bioreactor and aim to identify how alkalinity is being generated over time. If the alkalinity is being produced solely by the dissolution of the limited supply of limestone in the substrate, then the life span of the bioreactor is severely limited. Samples collected from 32 ports inside the bioreactor and at the outflow are being analyzed for temperature, conductivity, pH, Eh, alkalinity, iron (II) concentration, sulfide concentration, and $\delta^{13}C$ of dissolved inorganic carbon (DIC). There are two end member competing mechanisms producing the alkalinity. These mechanisms are limestone dissolution,

$$H_2SO_4 + CaCO_3 \rightarrow HCO_3^- + Ca^{2+} + SO_4^{2-} + H^+ \qquad [1]$$

and microbially mediated sulfate reduction,

$$2CH_2O + SO_4^{2-} \rightarrow 2HCO_3^- + H_2S \qquad [2]$$

Because of the large difference between the ^{13}C content of limestone ($\delta^{13}C = 0‰$) and organic matter (–24‰), we propose that the $\delta^{13}C$ of DIC should reflect the relative importance of these two reaction pathways as the bioreactor evolves over time. Low DIC $\delta^{13}C$ values indicate a dominance of the microbially mediated sulfate reduction pathway [2] compared to the inorganic production of alkalinity [1]. Preliminary results indicate that $\delta^{13}C$ ranges from -2.1 to -9.6 within the bioreactor even though it has been operational for only 2 months. The temporal trends in the $\delta^{13}C$ signatures will facilitate determinations of the rate of consumption of the substrate, and provide reclamationists important information concerning the optimum ratio of the components that may yield improved bioreactor performance and lifespan.

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