Salinization of the Rio Grande, North America: Origins and implications for mitigation

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The Rio Grande flows approximately 1,000 km south from its headwaters in Colorado to the national border of the U.S. with Mexico. Over this distance the total dissolved solids increase from about 40 mg/L to over 1,000 mg/L. The cause of this increase has long been a matter of dispute. We have employed δ^2H, $\delta^{18}O$, Cl/Br, ^{87}Sr, ^{36}Cl, solute mass balances, geochemical modelling and other methods to understand the sources and dynamics of this salinization. Our results show that it can be attributed to a combination of natural mineral weathering, discharge of deep sedimentary brines, and reactions with soil minerals that are enhanced under irrigated fields. These processes produce an evolution from a Ca-Na HCO_3 water to a Na-Mg SO_4-Cl water, accompanied by large increases in TDS. Some degree of mitigation of the TDS may be achieved by intercepting sedimentary brines at their discharge points, but the long residence time of water in the system and repeated application of the water to agricultural soils produces a baseline salinity due to mineral equilibrium beyond which TDS probably cannot be reduced.

Imaging biogeochemical processes with MRI: Application of paramagetic tracers

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Introduction

While most reknown for its use in medicine, magnetic resonance imaging (MRI) has tremendous potential in the study of biogeochemical processes [1-3]. Here we report on our manipulation of MRI's sensitivity to paramagnetic metals to image the transport and fate of (a) heavy metals [4,5] and (b) parmagnetically tagged organic molecules, inside individual biofilms.

Methods and Results

The presence of paramagnetic ions causes a reduction in the transverse (T_2) or longitudinal (T_1) relaxation times of ^1H nuclei at that location. This relationship enables us to quantify the concentration of paramagnetic metals at any point inside the biofilm. This method was used to image the transport and fate of the paramagnetic heavy metal Cu^{2+} through a natural phototrophic biofilm. Critically, this temporally and spatially resovled data enabled us to unravel the transport and immobilization mechanisms for Cu^{2+} in this system. Furthermore, to demonstrate this method can be used to track the transport of organic macromolecules, we used Gd[DTPA], an organic molecule tagged with the paramagnetic ion Gd^{3+} (Fig. 1). We propose this method can be utilized to track the transport and fate of high molecular weight organics and nanoparticulates in biofilm systems.

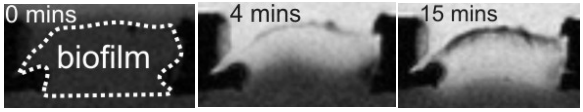

Figure 1: diffusion of Gd[DTPA] into biofilm: brighter regions indicate regions of higher Gd[DTPA] concentration.

[1] Manz *et al*. (2003) *Biotech. Bioeng.* **84**, 424-432. [2] McLean *et al*. (2008) *ISME* **2,** 121-131 [3] von der Schulenburg *et al*. (2008). *Biotec. Bioen.* **99**, 821-829. [4] Phoenix *et al*. (2008) *Appl. Environ. Microbiol*. **74**, 4934–4943. [5] Phoenix *et al*. (2008) *Min. Mag.* **72**, 483-486.