Constraining the modern riverine sulfur isotopic budget

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The sulfur cycle has an important influence on global climate, for instance through weathering and aerosols, and is intricately linked to both the carbon and oxygen cycles. However, many aspects of the modern sulfur budget are not well understood. We present new $\delta^{34}S$ and $\delta^{33}S$ measurements on aqueous sulfate from more than 50 rivers from different geographical and climatic regions. These data were measured by a new MC-ICP-MS method that requires only 5 nmol of sulfate [1], with typical isotopic uncertainties of only 0.1‰. Combined with previously published sulfur isotope data, more than 44% of the world's freshwater flux to the ocean is involved in this estimate of the global riverine sulfur isotopic budget. We find a large range in the $\delta^{34}S$ of rivers, both temporally and spatially. Riverine $\delta^{34}S$ values range from -2‰ to 14‰, and some smaller tributaries lie outside of this range. Time series data from the Fraser River show a seasonal cycle in the $\delta^{34}S$ of more than 3‰.

Combined with major anion and cation data, the sulfur isotope data allows us to tease apart the relative contributions of different processes to the modern sulfur budget, including the oxidative weathering of pyrites, the weathering of sedimentary sulfates, and anthropogenic influences. These data yield important insights into the modern sulfur cycle and the weathering of sulfur bearing minerals, and are first order terms in balancing the modern sulfur isotopic budget. The large range of sulfur isotopic ratios in modern rivers also has implications for our intepretation of the past changes in the sulfur isotopic composition of seawater. Secular changes in the lithologies exposed to weathering through time could play a major role in driving the variations in $\delta^{34}S$ in seawater over the Phanerozoic.

[1] Paris *et al.* (2013), *Chemical Geology* **345**, 50-61.

Aerosols and plant leaf surfaces

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Aerosols are ubiquitous and have always been part of the atmospheric environment of plants, while plant surfaces are probably the major terrestrial sink of fine aerosols. The deposition of fine aerosols is strongly influenced by leaf surface micro-roughness. Given constant aerosol concentrations over evolutionary timescales, plants have possibly developed leaf surface adaptations to control particle accumulation. Depending on the respective environment, plants may benefit from the nutrient content of aerosols or use them as a humidity sensor, but deposited particles may also promote leaf pathogen growth or act as desiccants [1].

The impact of aerosol exclusion on plant water relations was investigated in greenhouses, using pine seedlings, sunflower, and bean plants. Transpiration rates were lower for plants grown in filtered air (FA) than for plants grown in ambient air (AA) [2], and further effects were observed under increased CO_2 concentrations. Humidity fluctuations within an environmental scanning electron microscope (ESEM) caused a differentiated expansion of salt particles on leaf surfaces. This was related to the position of the ions within the Hofmeister series and reflected their impact on water surface tension [3]. A similar order applied when the drought tolerance of plants was measured after spraying leaves with different types of salt solutions.

Our results show that aerosol deposition strongly contributes to the ecophysiological reactions of plants, both in natural and in polluted conditions. Strong global increases of fine dust concentrations due to anthropogenic pollution or land use change may thus have world-wide impacts on plant communities.

[1] Burkhardt (2010) *Ecol. Monographs* . **80**, 369-391. [2] Pariyar *et al.* (2013) *Env. Exp. Bot* . **88**, 43-52. [3] Burkhardt *et al.* (2012) *New Phyt.* **196**, 774-787.

DOI:10.1180/minmag.2013.077.5.2
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