Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12311

Integrating geochemical analyses and global-scale modeling to better understand the biogeochemical selenium cycle. 2022 Science Innovation Award

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Trace elements (metals, metalloids, non-metals) play a major role in human and animal health. Certain trace elements are toxic, even at very low concentrations while others, referred to as micronutrients, are essential to humans and other organisms, however only in specific concentration ranges. Too high intakes of micronutrients can lead to toxicity while too low intakes can lead to deficiency. To prevent over- or underexposure of trace elements, it is essential to better understand the factors determining their distributions and chemical speciation and to know how they are cycled within and between the various environmental compartments. Selenium (Se) is one of the essential trace elements that has a narrow safe intake level. It is important as an antioxidant and for the regulation of various immune functions. However, Se is characterized by heterogenous environmental distributions and generally low Se levels in soils and food crops, leading to low dietary intakes in many regions. Studying Se cycling remains challenging due to generally low environmental concentrations and the redox-active nature of Se, causing it to exist in various chemical forms in different compartments. Still, since the environmental distribution and chemical speciation of selenium is closely related to environmental health issues, it is of major importance to better understand the factors that control its biogeochemical cycling, from the molecular to global scale.

In this talk, I will show how molecular-scale experimental lab and fieldwork can be combined with global-scale modeling approaches to learn more about the biogeochemical cycle of Se, thereby linking terrestrial, marine and atmospheric processes. I will show that the atmosphere is an important and dynamic reservoir of selenium (Se), supplying marine and terrestrial ecosystems with this essential trace element. I will discuss how sources of atmospheric Se can be quantified and how existing atmospheric emission estimates can be constrained. Furthermore, I will show how analyses of chemical speciation of Se can help elucidate major processes controlling the cycling of Se between soils, biota and the atmosphere. Finally, quantitative and qualitative implications of climate and policy changes on atmospheric Se cycling and inputs to ecosystems and food chains will be addressed.