SOIL SCIENCE COLLOQUIUM

Special session: Arsenic, from the atmosphere to the gut.

Tuesday 16th of Nov 2021, 4.15 pm – 6.00 pm

You are welcome to attend in person in Hallerstrasse 12, seminar room 002 or virtually in the Zoom seminar room.

Arsenic inputs to terrestrial ecosystems through precipitation

Guest speaker
Dr Laurie Savage
University of Glasgow

ABSTRACT. There is a paucity of data relating to the atmospheric cycling of arsenic, particularly regarding its natural fluxes, sources, and fate. A two-year study, which included diurnal collection of atmospheric deposition, was carried out in a semi-rural region of Northern Ireland. Inorganic arsenic (As_i) was found to be the dominant species present, with trimethylarsine oxide (TMAO) also present in a significant number of samples. TMAO was found to have an annual deposition of 50 nM per m^2, with As_i deposition about five times this amount.

Weather trajectory modelling was incorporated into the data set, including trace element analysis. Spearman's correlation suggested that TMAO has a predominant marine source, while As_i was found to originate from both anthropogenic and marine sources. Further studies of wet deposition in SE Asia and a remote site in SW Ireland also indicated predominantly marine sources of TMAO.

A laboratory experiment was carried out to investigate the marine origin of organic arsenic (As_o) in the atmosphere. Reaction chambers were set up with seawater from the Northern Ireland coast with silver nitrate impregnated silica gel devices to trap arsine emissions from phytoplankton. Seawater with a 1 nM dimethylarsinic acid (DMAA) spike generated significantly higher amounts of TMAO, providing evidence that arsenic is biovolatilised from seawater and may be a source of organic arsenic to terrestrial ecosystems.

BIO. Dr Laurie Sauvage is a Research Associate at the University of Glasgow. He obtained his PhD in Biological Sciences from Queen's University Belfast in 2018. Prior to working at the University of Glasgow he held post-doctoral research positions at Queen's University Belfast and the University of Aberdeen. Laurie is an environmental and analytical chemist with a focus on mass spectrometry techniques including GC-MS, ICP-MS and the coupling of liquid chromatography to ICP-MS. Laurie is currently working on a UKRI funded project focused on optimising decentralised wastewater infrastructure. Current research includes using non-targeted mass spectrometry techniques to aid the development of nano-sensors.

Of mice and rice: The denouement

Dr Teresa Chavez-Capilla
Soil Science Group, University of Bern

ABSTRACT. According to the World Health Organization, arsenic is one of the ten pollutants of major health concern, with more than 200 million people worldwide being at risk of arsenic exposure from their diet. In particular, rice accumulates up to 0.4 µg g−1 of arsenic, of which 85 – 90 % corresponds to arsenous acid (AsIII) and arsenic acid (AsV); and the remaining to methylarsonic acid (MMAsV) and dimethylarsinic acid (DMAsV). Although all four arsenic species are classified as carcinogens by the IARC, their specific modes of toxic action are strongly related to their metabolites once in the human body. In addition, interpopulation variability can influence arsenic metabolic products and excretion rates, which depend on human genetics and gut microbiome. Understanding the effect of gut microbial communities on arsenic biotransformations can help to prevent the adverse effects of chronic arsenic exposure in humans. This study aims to unveil the microbial-mediated transformations of AsIII, AsV, MMAsV, DMAsV from rice in the mammalian gut. Specific pathogen free (SPF) and germ free (GF) mice were fed rice-containing chow diets at varying concentrations of inorganic and organic arsenic species. After seven weeks of chronic arsenic exposure, mice were euthanized, and all gut contents and key organs involved in arsenic metabolism were analysed for arsenic speciation. Our findings show how the gut microbiome plays an important role in the methylation of arsenic from diet but also promotes the transformation of arsenic into the more toxic thiolated arsenic species. In addition, we identified differences on the specific arsenic excretion pathways in the absence and presence of gut microbiota. The results from this study provide valuable insights to effectively understand how the mammalian gut can help in mitigating the pernicious effects of dietary exposure to arsenic.

BIO. Dr Chavez-Capilla is a multidisciplinary chemist interested in solving environmental problems that primarily affect food safety and human health. She holds a Licentiate degree (BSc + MSc) in Chemistry by the Autonomous University of Madrid (2009) and a MSc in Inorganic Chemistry and Chemical Engineering by the Spanish Distance University (2011). Her research trajectory started in material science and electrochemistry at IMDEA Energy (Spain) through the synthesis and investigation of new material for energy storage. In 2013 she moved to Australia with a PhD scholarship to investigate the metabolism of arsenic in humans. Ever since, Dr Chavez-Capilla has specialised in applying bioanalytical techniques to understand the biotransformations of arsenic from food in biological systems. In 2019, she joined the Soil Science Unit at the University of Bern as a postdoctoral researcher. In addition to her research activities, Dr Chavez-Capilla is engaged in science communication and making science accessible to the public by organizing outreach events for 500 Women Scientists Bern.