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# Foreword to the Research Front on 'Tellurium in Biological and Environmental Systems: After Fukushima'

*Montserrat Filella*

Department F.-A. Forel, University of Geneva, Boulevard Carl-Vogt 66, CH-1205 Geneva, Switzerland. Email: montserrat.filella@unige.ch

Tellurium is of increasing technological importance and is a critical element for the development of green energy technologies. Tellurium, with its interplay of four oxidation states, has an exciting – albeit difficult – chemistry which led its discoverer, von Reichenstein, to qualify it as a 'problematic mineral'. Some bacteria are known to remove toxic tellurium from their immediate environment either by methylation to form volatile species or by reduction to give insoluble $Te^0$. Thus, microorganisms must be included to provide a comprehensive picture of tellurium in the environment. The Fukushima accident in 2011, where radioactive tellurium isotopes were released, alerted the scientific community to the many gaps in our knowledge of the environmental behaviour of the element, and boosted research on it. Therefore, it is now timely to review the situation by discussing all these subjects and bringing together the best interdisciplinary research on tellurium.

This Research Front opens with a comprehensive evaluation of the current situation concerning our understanding of tellurium's presence in the various environmental compartments (Filella et al. 2019). The study concludes that our current knowledge about the presence and behaviour of tellurium in the environment is rather limited, and any advances in our understanding urgently requires improvements in analytical procedures, including preconcentration and digestion methods.

Knowing the flows and stock dynamics of chemical elements in the anthroposphere is necessary to fully understand their global biogeochemical cycle, and lays the groundwork for a better management of the elements. Nuss (2019) presents an opportune life cycle-wide examination of the anthropogenic tellurium cycle. The author identifies the main tellurium inputs to the environment linked to tellurium production and uses, and signals the need for proper end-of-life management approaches when photovoltaic modules currently in use reach the end of their operational life.

Understanding the chemical behaviour of aqueous solutions is an important aspect in many fields, ranging from the environment to toxicology to regulations. Calculations for equilibrium modelling require thermodynamic equilibrium constants, and for the first time, the relevant equilibrium data for tellurium have been critically evaluated and entered into a thermodynamic database by Filella and May (2019). Main gaps have been identified and 'best' constant values proposed.

Tellurium interaction with prokaryotes is reviewed by Presentato et al. (2019). Although, as pointed out by the authors, 'Te biology may still be lagging behind other chemical elements' and 'the biomolecular mechanisms of the tellurite resistance determinants are far from established', tellurium interaction with prokaryotes is the domain where tellurium has been most studied, covering a range of aspects, including the current interest in bionanotechnologies.

Even if its radionuclides are scarcely monitored, tellurium is a non-negligible fission product in nuclear facilities. Through the evaluation of environmental releases of tellurium radionuclides registered after two major accidental events (Chernobyl and Fukushima Daiichi nuclear power plants), Gil-Díaz (2019) points to the probable underestimation of the importance of tellurium radionuclides during and after accidents, and recommends its inclusion in dispersion scenarios.

Little is known about the potential environmental and human and health impacts of the presence of tellurium in the surficial environment. The study by Hayes and Ramos (2019) combines the physico-chemical characterisation of tellurium present in two distinct tellurium-enriched mine tailings deposited by historic gold mining with physiologically-based extraction tests (synthetic stomach and lung fluids). The results obtained point to low to medium bioaccessibility of the element, which is expected for elements associated with iron (oxy)hydroxides.

The comprehensive study of the environmental behaviour of tellurium in surface waters (i.e. seasonal variations, solid/liquid partitioning, etc.) is also combined with biota uptake considerations by Gil-Díaz et al. (2019) in their work on the Lot–Garonne–Gironde fluvial-estuarine system. Interestingly, even if no direct anthropogenic sources were identified in the studied system, a non-negligible bioaccumulation in wild oysters at the estuary mouth was observed.

I am pleased to present this collection of papers at the forefront of current environmental research on tellurium. I am convinced that these studies will provide a valuable base for further research on this intriguing element. I thank the authors and referees for their contributions to this Research Front.

Montserrat Filella
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