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Editorial: Understanding heavy metal pollution and control in the environment around metal tailings

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Editorial on the Research Topic
Understanding heavy metal pollution and control in the environment around metal tailings

Heavy metal pollution is a serious problem faced by global industrial development, which mainly comes from industrial pollution, traffic pollution and household garbage pollution. Due to the biological toxicity and radioactivity of heavy metals, once discharged into the atmosphere, water and soil, they will cause serious environmental pollution. In addition, if they enter the human body, they can cause multiple diseases, including cancers, neurological damage, and adverse reproductive outcomes. Therefore, it is of great significance to study the characteristics and source analysis of heavy metal pollution around metal mining and smelting enterprises for understanding the enrichment law of heavy metals and preventing heavy metal pollution. In this Research Topic, heavy metal pollution is studied from the aspects of harmfulness, migration characteristics and control measures. Here, we briefly review and summarize these articles.

Zhang et al. studied the relationship between exposure to the heavy metal lead and liver fibrosis, using data obtained from the National Health and Nutrition Examination Survey (NHANES) 2017–2020. Their study is the first to use liver elasticity to explore the relationship between liver fibrosis and blood lead level. The diagnostic accuracy for fibrosis has been greatly improved by using this new method. They demonstrated an association between blood lead level and liver fibrosis in individuals without known chronic liver disease. However, the causal relationship and underlying mechanism between lead and fibrosis requires further investigation.

Xue et al. reported the release behavior of uranium in soil of uranium tailings dam through simulation experiment. They systematically explored the physical and chemical properties, distribution characteristics, state of occurrence, and law of migration and transformation of uranium in tailing ponds, which can predict the dynamic migration trend of uranium in tailing reservoir in the natural environment, and provide a theoretical basis for establishing an effective uranium tailing pollution prevention and control system. They selected nine soils at different depths in a decommissioned uranium tailing pond in Jiangxi Province to study their mineralogical properties and revealed the leaching law of uranium under natural rainfall conditions. They found the distribution characteristics of uranium are affected by the mineral composition, microscopic morphology and physical and chemical properties of uranium tailings. In static leaching experiments, acidic solutions, small particles, and high solid-to-liquid ratios all promote the release of uranium. In the

dynamic leaching experiment, the lower the pH of simulated rainfall, the more uranium is released. According to Fick theory, the migration mechanism of uranium is mainly surface dissolution, and the release of uranium is related to the content of migratory uranium.

Yu et al. and Shi et al. studied and reviewed the treatment methods of heavy metal pollution. Yu et al. simulated the reducing reaction between pyrite, magnetite, and redox-sensitive radionuclides (U, Se, Tc, and Np) in the Gansu proposed-treatment plant area by PHREEQC. They concluded that pyrite can effectively reduce the high-valence state of U, Se, Tc, and Np and easily migrate to the low-valence oxide species, which are difficult to migrate and easy to precipitate. In contrast, magnetite has a certain reduction effect on Se and Np but a poor effect on U and Tc. The simulation results not only theoretically illustrate the feasibility of the reduction of radionuclides by pyrite and magnetite, but also quantify their reaction depth. However, the kinetic effects and the influence of the partial pressure of oxygen in the atmosphere on the process were not considered in this work, hence there will be some deviations in the actual process. These conclusions have an important guiding significance for the prevention and retention of radioactive pollution released into the biological environment.

Phytoremediation is treated as environmentally friendly, long-term effective and low-cost restoration method. However, tailing soil acidification, low organic matter content, poor water holding capacity and compaction make plant struggle to survive. Biochar, a soil conditioner can promote plant growth by improving the physical, chemical and biological properties of soil, thus strengthening the ability of phytoremediation in the contaminated tailings. Shi et al. reviewed how the physicochemical properties of biochar affect phytoremediation and how the raw materials of biochar affect the physicochemical characteristics, and prospected the future research directions. They summarized the addition of biochar will simultaneously affect physical, chemical and biological properties, and these properties will also interact with each other to jointly strengthen the effect of phytoremediation. The application of biochar is beneficial to reduce the mobility and bioavailability of heavy metals in tailings, improve soil structure, enhance soil fertility, promote plant growth, and promote soil microbial activity. Therefore, in order to improve soil properties before large-scale biochar utilization, more extensive studies on biochar-soil-plant systems are needed to promote the effect of phytoremediation of heavy metal-contaminated soil, so as to enhance phytoremediation. They suggested future research should focus on the following Research Topic that need attention: First, at present, many studies are limited to laboratory scale and conducted under greenhouse conditions, so there is a lack of field studies to evaluate the ability of biochar to enhance. Second, microorganisms play an important role on phytoremediation, so more research should be emphasized on the biochar-soil-microbe-plant interaction. Third, whether the pollutants (PAHs and HMs) may carried by biochar, especially modified biochar, will cause secondary pollution to the environment is a problem worthy of attention.

The purpose of this Research Topic is to deepen our understanding of heavy metal pollution and treatment measures in the environment surrounding metal tailings. As a research community, we have made significant progress in understanding of heavy metal pollution processes and hazards over the past few decades. Despite this progress, heavy metal pollution remains a national, regional and international problem. Future research will continue using a variety of methods-including physical methods (soil exchange, isolation, etc.), chemical methods (chemical fixation, soil leaching, etc.), biological methods (phytoremediation, microbial remediation, etc.) and modelling to mitigate the effects of heavy metal pollution.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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