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Inorganic Particles and Fibres: Integrating Minero-Chemistry and Hazard Assessment for Eco-Exposome Development

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Description

Exposure to mineral particles and fibres causes respiratory diseases and malignancies, mainly in occupational settings. Though the incidence of occupational lung disease has decreased in many countries, exposure to asbestos, silica, and other mineral dusts is responsible for 25% of all occupational lung diseases. Furthermore, new environmental hazard may arise from emerging pollutants (EP) such waterborne asbestos and asbestos-like minerals [1]. Diseases associated with unexpected sources, and non-conventional exposure scenarios require new strategies for risk assessment, monitoring, and mitigation. The development of eco-exposome(s), the new frontier for assessing the effects of multiple exposures to chemicals, requires, for inorganic particles and fibres, an integrated strategy for bridging minero-chemical properties to hazard assessment [2].

To design an integrated occupational and environmental strategy for health hazard assessment and control, the toxicity paradigms for airborne toxic particles have to be extended to the whole realm of inorganic dusts also in non-conventional exposure scenarios. To tackle this challenge, we must advance our knowledge on the complex interplay established by inorganic particles and biological environments. In parallel, new exposure scenarios of well-known or poorly described inorganic dusts, e.g., asbestos or celestial dusts, should be investigated in terms of adequate risk assessment, monitoring, and mitigation strategies [3].

The aim of the current Research Topic is to cover promising, recent, and novel research trends in all aspects of toxic or potentially toxic inorganic particles and fibres from an interdisciplinary point-of-view, welcoming contributions from chemistry, geology, medicine, and industrial hygiene fields. Areas to be covered in this Research Topic may include, but are not limited to

- Studies focusing on chemical and physical properties of inorganic particles and fibres and their influence on the bio-interactions and toxicity mechanisms;
- Novel chemistry approaches for inorganic dust monitoring and mitigation;
- Inorganic particle and fibre mineralogical definition, including regulatory aspects;
- Inorganic particle and fibre risk assessment, migration, transport, and fate in natural and occupational environments
- Mechanistic studies on non-conventional scenarios, including volcanic ashes, celestial dusts, dusts from large construction sites, and general composite dust [4].

Although the human exposome and eco-exposome are defined in similar terms, there are differences in the application of these concepts. Measurements of the human exposome are typically limited to nondestructive assessment of blood, urine, or feces. In contrast, measurements made in the context of the eco-exposome can use whole organisms or portions thereof, including known or suspected target tissues. In practice, individual susceptibility represents an important factor for translation of the internal exposure to effects in humans, whereas in ecotoxicology the assessment is most often focused on maintenance of self-sustaining populations rather than the health of individuals [5]. With respect to application of the eco-exposome concept, many species (or model representatives of their taxa/trophic level) are available for small-scale and/or high-throughput screening studies, which enables experimental examination of mechanisms and perturbed pathways through which a given internal exposure leads to adverse outcomes. This direct verification of hypothesized adverse effects is only possible to a limited extent in humans. By comparison with the human exposome, integration of the eco-exposome over time can be more easily established by trans-sectional analysis; that is, by subsampling different life stages from an entire population. Furthermore, for some ecologically relevant organisms, the life span is short enough that the eco-exposome can be observed during their entire lifetime. One major challenge of the eco-exposome concept involves the numerous taxonomic groups and species in an ecosystem; however, one could envisage using selected species as sentinels for a specific trophic level or environmental compartment, as is often done for ecological risk assessment.

Principles of the eco-exposome assessment

Chemical versus bioanalytical assessment of the exposome

While initial assessments of the human exposome focused largely on chemical measurements, simultaneous consideration of the biological attributes of the internal environment may provide additional means to better characterize complex exposures. Accordingly, some authors have proposed that assessment of the exposome should be complemented by the use of biochemical receptor-binding assays in vitro cellular bioassays, and targeted omics techniques. Bioassays can be used to measure effects caused by extracted internal chemicals, thereby improving assessment of the eco-exposome. While chemical analytics can provide internal exposure information for thousands of exogenous compounds, current methods cannot detect all chemicals of potential toxicological concern, so concurrent measures of biological effects may help account for undetected yet toxicologically important chemicals and provide insight on potential mixture effects such as synergism or antagonism.

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Bioanalytical assessment would also allow for improved consideration of the role of endogenous chemicals synthesized by the body in response to exogenous chemicals and relevant for signaling processes that trigger diverse toxicity pathways. For instance, exposure to exogenous chemicals can result in elevated levels of reactive oxygen species (ROS) normally produced by the body.

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Conflict of Interest

None

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