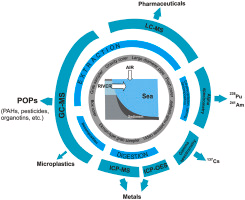
Marine sediment analysis – A review of advanced approaches and practices focused on contaminants

Abstract

This review is aimed at critical analysis of current and emerging capabilities of analytical methods as employed for marine sediment analysis. An emphasis is given to the most reliable experimental strategies used to quantifying the various classes of contaminants and thus to acquiring analytical information that is relevant to assess the quality of sediments with regard to possible pollution of marine ecosystems. Advanced analytical methodology in use basically relies on the application of mass spectrometry to enable identification and quantification of hazardous chemical species, directly or after separation using the principles of gas and liquid chromatography. Also addressed are sample preparation techniques which – given the complexity of sediment matrices and the diverse and multiple nature of contaminants – are often a key for successful analysis. Among the trends in marine sediment analysis is an inclination to chemicals that are only recently recognized as emerging pollutants of very high concern, such as microplastics, pharmaceuticals and their metabolites.

Graphical abstract

Image 1



Introduction

Analysis of marine sediments is the field of analytical chemistry that is closely associated with the impact of anthropogenic factors on the environment. Sediments are a large storage of various pollutants, especially in regions with intense industrial activities, oil exploration, shipping, etc. When released into the overlying water through physical (erosion, resuspension, deposition), biological (bioturbation) and chemical (desorption and benthic diffusion) processes , the accumulated toxicants exert a strong influence on the ecological health of marine ecosystems . Therefore, sediment surveying in terms of the level of potential contaminants is a major concern to assess the state of the marine environment and to provide baseline guidance for relevant control authorities.

Section snippets

Organic contaminants

Of an array of sediment pollutants of organic nature, POPs represent the widest class of chemicals. They are mostly lipophilic, highly toxic and rugged in the environment synthetic compounds, being hence transported over long distances and leading to global pollution. Particularly significant and most commonly identified POPs are organochlorines, such as PCBs, PAHs and pesticides, for which marine sediments act as a bioaccumulation pool. The pollution of marine sediments by various organic

Pharmaceuticals

Pharmaceuticals and their metabolites have been increasingly detected in different environmental compartments, including marine sediments [7,55]. This is due to a growing medical and veterinary employment of pharmaceuticals world-wide. Their inherent biological activity poses high risks to the ecosystem and to human health via contact with contaminated sediments. Although the latter are only the last, end-up receiver of the marine contamination, an increasing number of reports focused on

Heavy metals

Owing to extreme toxicity, non-biodegradability and high accumulation potential of heavy metals, their presence in aquatic ecosystems is a matter of serious anxiety. The metal content in marine sediments fluctuates being impacted by various anthropogenic factors, such as industrial waste, transportation, agriculture, etc. [61], or naturally but differently enriched from the rocks outcropping in the source area. Importantly, the sediment is not only an important reservoir but also a source of…..

Radionuclides

There are two major routes how radionuclides find their way into the environment and may then cause harmful effects on living organisms including humans. One is radiation accidents unavoidably occurring in nuclear facilities, i.e. nuclear power and research reactors or involved in nuclear-weapons programs. The second is due to still no safe means for final geological disposal of radioactive waste produced by nuclear reactors. As a result of such anthropogenic activities, substantial amours of

Microplastics

Of other classes of relevant contaminants, plastic materials with micro- or nano-sizes have become of increasing apprehension [11], even though the associated dangers after final disposal at the deep sea-floor and mobilization by natural processes need to be unambiguously confirmed. Such small sizes can be a result of degradation or fragmentation of larger plastic materials upon their waste into the environment or intentional production (and disposal) of manufactured microplastics.

Conclusions and perspectives

The literature regarding the analysis of marine sediments continues to expand, numbering over 10000 documents in press over the past decade (as provided by Sci finder database). A great proportion of these contributions are devoted to assessment of the ecological state of various marine environments as based on identification and determination of primary or emerging sedimentary contaminants. The present review is the first to address all the major classes of contaminants, requiring not discrete