



Editorial

Arsenic in marine hydrothermal systems: Source, fate and environmental implications

Despite its notoriety as an environmental toxin, its abundance in hydrothermal ore deposits and its close relationship with gold, arsenic (As) is one of the few elements, rarely investigated in marine hydrothermal systems. In contrast, in non-marine systems, such as meteoric water, the source, transport, fate and effect of arsenic are well studied. This is, at least, partly due to the widespread arsenic poisoning in south-east Asia and the recent lowering of the maximum contaminant level (MCL) for arsenic in drinking water in the United States from 50 to 10 µg/L. Arsenic is also a well-known contaminant in on-land geothermal systems, which are used for energy generation. The deep reservoir hydrothermal fluids, which are tapped and brought to the surface, can contain more than 50 mg/L of arsenic, 5000-times the recommended drinking water standard. Despite such high concentrations little is known about the processes, which lead to the observed enrichment. This is even more so for marine hydrothermal systems, which recently have obtained interest for their vast geothermal potential to produce electricity and desalinate seawater.

We can distinguish two types of marine hydrothermal systems, deep and shallow. The deep systems, which are generally in water depths greater than 2000 m are related to plate tectonic features, such as divergent and convergent margins. There, the circulating hydrothermal fluid is more or less exclusively comprised of seawater, which ultimately sets them apart from their counterparts in shallower, near-shore environments, where the hydrothermal fluid can be seawater, meteoric groundwater or a mixture of the two. Higher hydrostatic pressure in deeper water also allows for higher discharge temperatures, generally in the range of 300 °C, compared to 100 °C in shallow systems. Little is known about the chemistry and biology of arsenic in both systems, although there have been some arsenic studies for shallow-water systems. The controls of arsenic occurrence, toxicity and fate, nevertheless, remain largely unknown.

The compilation of papers in this special issue provides a state-of-the-art account of arsenic research in marine hydrothermal systems, showing recent advancements and challenging issues, innovative developments and the necessity and opportunity for future research.

It has become clear that the study of arsenic in hydrothermal systems is a multidisciplinary scientific endeavor that is problem-driven with the aim to provide knowledge and understanding about the behavior of arsenic and its impact on the marine environment. Individual studies tend to take a holistic approach to the interpretation of the role of arsenic, applying geochemical, biological and thermodynamic methods.

In the first of the six papers included in this special issue, Breuer et al. give a global overview of the present-day knowledge about arsenic in hydrothermal fluids emerging at the seafloor along mid-ocean ridges or in back arc basins and island arcs. The following two papers by Price et al. and Villanueva Estrada et al. address geochemical processes showcasing research results from the shallow-water hydrothermal systems near Milos Island (Greece) and Bahía Concepción (Mexico). The next paper by Meyer-Dombard et al. illustrates the microbial diversity and potential for arsenic and iron biogeochemical cycling in the arsenic-rich shallow-water hydrothermal system in Tutum Bay (Papua New Guinea). The last two papers by Price et al. and Ruiz-Chancho et al. address the bioaccumulation and biotransformation of arsenic in several coral reef organisms in Tutum Bay (Papua New Guinea) and in the gastropod, *Cyclope nerita*, in Paleochori Bay, Milos Island (Greece).

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