

A fresh look at metal residence times in the Arctic Ocean

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The concept of salinity -i.e., the constant proportion of many ions in seawater- has proven to be very useful since its development by Forchhammer (1865)[1]. It is an integral part of how we describe water masses, how we model thermohaline circulation, and how we understand chemical speciation in the ocean. The underlying concept of largely invariant proportions of elements in seawater is closely related to their residence times, which depend on supply/removal terms, and the size of their oceanic reservoir. More supply/removal and smaller basins lead to shorter residence times, which means more variable behavior. The GEOTRACES programme has revealed a number of previously unknown or underestimated sources and sinks of metals for the ocean, which in turn requires a re-evaluation of many residence times, typically making them shorter.

The Arctic Ocean and the Nordic Seas, which form together the so-called “Arctic Mediterranean”, form a basin that is fully enclosed below 1000 meters, and that has limited exchange above. At the same time, it receives a much larger than average proportion of freshwater by rivers, it is subject to sea-ice transport and brine formation, hosts seawater-precipitated minerals like gypsum or ikaite, and sampling campaigns during the last International Polar Year and as part of GEOTRACES have revealed active hydrothermalism at the seafloor as well as submarine groundwater discharge at its margins. In this light, and seen together with the fact that the Arctic Ocean was an even more enclosed, at least partly fresh and de-oxygenated basin in past periods, salinity in the Arctic Ocean may not be the invariable concept known from other parts of the ocean. This has implications for understanding its trace metal cycles, but also for the understanding of its circulation, sedimentary proxies and water mass signals.

References

[1] Forchhammer, G. (1865). On the Composition of Sea-Water in the Different Parts of the Ocean. *Philosophical Transactions of the Royal Society of London*, 155, 203-262.
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