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Understanding the mineral life of germanium in the aquatic continuum

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Traditionally, most data on the concentration of chemical elements in natural systems refer to the 'dissolved fraction,' based on water filtration through specific pore-size filters. The 'particulate fraction' has received less attention, possibly due to its perceived lesser relevance to ecotoxicity and bioavailability or to the complexity of its analysis.

Curiously, in river systems and depending on the amount of suspended solids, many elements are more abundant in the particulate phase than in the dissolved phase [1,2]. However, their exact forms remain largely unknown because available operational techniques, such as sequential extractions, often classify them largely in a 'residual fraction,' which is rarely characterized mineralogically.

Germanium is an interesting candidate for improving our understanding of the particulate/residual fraction. Its chemical similarity to silicon has made it a key tool for monitoring weathering processes through Ge/Si ratios, a concept dating back to Goldschmidt's time. As a result, a significant amount of data is available on germanium, which in principle can help address current gaps in knowledge about the composition of the particulate fraction. Unfortunately, detailed analysis of the published data [3] reveals significant analytical challenges. Issues include flawed digestion methods, limitations in analytical techniques, a lack of certified reference materials, and careless blank corrections. Additionally, conventional interpretation of Ge/Si ratios in rivers overlooks factors such as physical erosion, colloidal particles containing germanium, phytolith formation, and germanium methylation. Despite these challenges, the extensive data available on germanium offer valuable insights. In particular, they enhance our understanding of the implications of analytical data quality and help integrate detrital fractions and biomineralization processes into the broader framework of the biogeochemical cycle of germanium.

[1] Gaillardet et al. (2014), Trace elements in river waters. In: K.K. Turekian (Ed.), *Treatise in Geochemistry, 2nd edn*. Elsevier, Oxford, pp. 195-235

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