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The role of pretreatments on the efficiency of metallic nanoparticle extraction from marine sediments using sp-ICP-MS

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We compared the efficiency of two treatments for extracting metallic nanoparticles (Cu, Zn, Al, Fe and Mn) — tetrasodium pyrophosphate (TSPP) and Milli-Q water (MQ) — from marine sediment samples. The sediments differed in mineral composition (authigenic aragonite and calcite vs. detrital aluminosilicates), elemental composition (Sr vs. Al and Mn), depositional settings (shallow marine lake vs. deep-sea environment), and sediment characteristics (organic matter type and content). The treatments were tested on native bulk sediments, bulk sediments after organic matter removal, and sediment fractions before and after OM removal to determine whether these pretreatments (OM removal and sediment fractionation) improve nanoparticle extraction efficiency.

The results showed that the two treatments had different effects depending on the selected metal and sediment type, but in general, the TSPP treatment resulted in a greater number of extracted nanoparticles.

The efficiency of OM removal on nanoparticle release from sediment depended mainly on sediment type − in carbonate settings, it resulted in an increase in nanoparticles in all samples and for all metals, while in deep-sea aluminosilicate sediment, the effect depended on the metal in question and sample type (bulk or fractions).

The efficiency of sediment fractionation on particle number concentration depended mainly on the metal in question and sediment type; however, Al and Fe were unequivocally higher in the size fractions.

This study provides valuable insights into optimizing extraction protocols for metallic nanoparticles from compositionally diverse marine sediments, emphasizing the importance of adjusting pretreatment strategies to sediment type and target element when conducting nanoparticle analysis using sp-ICP-MS.