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A first look into the gallium-aluminium systematics of Early Earth's seawater: Evidence from banded iron formations

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We present our results of a first study on Ga-Al systematics in Early Precambrian banded iron formations (BIFs) from which individual adjacent Fe oxide, metachert and mixed-type bands were investigated. Gallium mass fractions in BIFs are low (< 10 ppm) and analyses typically suffer from multiple mass interferences on the two stable isotopes ^{69}Ga and ^{71}Ga. Therefore, we did comparative analyses with SF-ICP-MS and ICP-MS/MS of dissolved samples and LA-SF-ICP-MS on nano-particulate pressed powder tablets and polished sections. We also conducted a two-component mixing experiment with the BIF reference material IF-G and pure synthetic quartz sand. The results corroborate the high analytical quality of our Ga-Al data even for the very trace metal-poor metachert bands. Furthermore, the results from natural BIFs and the mixing experiment strongly suggest that the Ga-Al distribution in BIF (meta)chert bands is dominated by finely dispersed Fe oxide particles. The measured Ga/Al ratios cover a range between 2×10^{-4} and 1×10^{-3} [mg/mg] in all BIF bands. The compilation of our data reveals constant Ga/Al ratios in the investigated BIFs and suggests rather stable seawater Ga/Al ratios throughout the Archaean and Early Paleoproterozoic. These Ga/Al ratios are above those of potential detritus, but below those of modern seawater. Two conclusions are conceivable: (i) Seawater had significantly lower Ga/Al ratios in the Precambrian than today, possibly due to the reduced importance of organisms and organic compounds during weathering, riverine and estuarine processes; (ii) Ga and Al were fractionated during BIF formation.