A modern analogue for Superheavy pyrites?

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Although the main trend in the secular variations of $\delta^{34}S_{pyrite}$ can be explained by changes in the global sulfur cycle, many large and short-term $\delta^{34}S_{pyrite}$ variations seem to be related to poorly understood local or regional controls.

It's especially true for the sedimentary successions presenting heavy $\delta^{34}S_{pyrite}$ combined with higher $\delta^{34}S_{pyrite}$ than coeval $\delta^{34}S_{CAS}$, so-called superheavy pyrites To date, it remains unclear if they result from post depositional processes, or from a combination of water column redox stratification, low sulfate concentrations and sulfide oxidative processes. This later assumption would benefit from being validated by a modern analog but none of the anoxic systems identified so far display theses atypical signatures.

Here, we report the first observation of superheavy pyrites from both the water column and surface sediments of the modern thalassohaline Dziani Dzaha lake, located in the Petite Terre Island of Mayotte Archipelago (Indian Ocean). A combination of low sulfate content (< 3 mM), ^{34}S enriched isotopic compositions of both sulfate and sulfide (average value of $\delta^{34}S_{sulfate}$ ~ 34 ‰ and $\delta^{34}S_{sulfide}$ ~ 36.7 ‰), and a negative apparent fractionation between sulfate and sulfides ($\Delta^{34}S_{sulfate\text{-}sulfide}$ ~ -2.7 ‰) is observed in its water column. These features were probably established by a Rayleigh distillation of the sulfate reservoir resulting in the heavy isotope signature and the low sulfate content, thus setting the stage for quantitative sulfate reduction coupled to sulfides reoxydation periodically near the halocline.

Our results demonstrate for the first time in a modern system that these atypical isotope signatures do not require post-depositional or secondary oxidative processes, and validate the idea that they may instead provide key information on the paleoenvironmental conditions prevailing at the time of the superheavy pyrites occurrences observed in the geological record.