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Origin and dissolution of barite in the oceans: Insights from a global ocean dissolved Ba model

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Oceanic barium (Ba) has a distribution similar to that of a nutrient, yet its distribution is thought to be regulated in large part by the precipitation and dissolution of inorganic barite ($BaSO_4$). We have developed a global ocean model of Ba biogeochemical cycling in order to discern which processes are most important in controlling global Ba. Our approach first utilizes a combination of observations and machine learning algorithms to obtain a global Ba climatology, so that we can calculate the saturation states of barite in global oceans. We find that barite is only supersaturated in certain regions, including the surface Southern Ocean, surface Arctic Ocean, intermediate North Pacific Ocean, and intermediate Indian Ocean. Next, a mechanistic model is developed which includes both biological uptake and release of Ba, along with the precipitation and dissolution of pelagic barite, within an OCIM circulation. We find that ambient seawater is the primary source of Ba in barite, and the amount of Ba sourced from organic matter is negligible. We also tested various models for the dissolution of barite when sinking in the water column, finding that barite dissolution rates are relatively independent of the degree of barite undersaturation. Overall, this study provides new insights into the global Ba cycle, highlighting the importance of pelagic barite formation and dissolution, and providing a better mechanistic framework for the application of Ba as a paleoproductivity tracer.