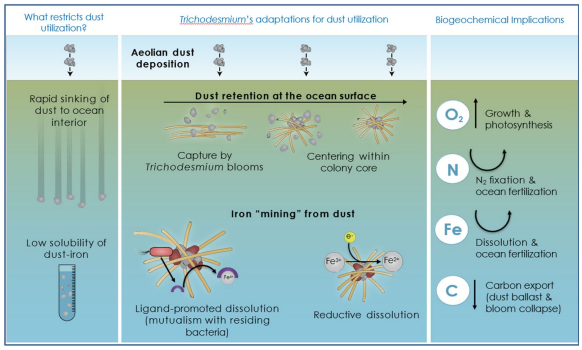
Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36284

Can Trichodesmium fertilize the ocean with iron?

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Our study revisits Rueter's long-standing hypothesis that the marine cyanobacterium *Trichodesmium* acts as a dual-nutrient fertilizer, providing ocean ecosystems with both fixed nitrogen and iron that it solubilizes from atmospheric dust. Combining advanced methodology with diverse experiments, we examine the capacity of natural Red Sea *Trichodesmium* to capture, transform, and reductively dissolve iron-bearing dust particles. By integrating literature data and field observations within a supply-versus-demand framework, we assess the environmental thresholds at which *Trichodesmium* blooms rely on active dust dissolution to meet their iron requirements and perform biofertilization.

Using XANES spectroscopy to analyze the Fe redox state of hundreds of dust particles entrained in individual natural colonies, we detected extensive biomediated Fe(II) production and mineral transformations. Turning to the aqueous phase, we measured contact-dependent reductive dissolution by *Trichodesmium* colonies and estimated that this pathway can satisfy their metabolic demands. The active role of *Trichodesmium* in "mining" dust for Fe was also confirmed in a recent XRF-based study revealing contact-dependent Fe uptake from dust [1]. While active dissolution and uptake of dust-Fe by natural Trichodesmium is evident, applying these findings to the broader ocean is constrained by a scarcity of data on colony-mineral interactions.

Such constraints are likely relaxed in *Trichodesmium's* surface blooms, which efficiently retain deposited dust, thereby facilitating active dissolution. Through incubations of a Red Sea coastal bloom, we quantified a significant release of dissolved metals, confirming their potential function as biofertilization hotspots. By integrating satellite-derived surface bloom datasets with dust deposition models, we identify regions characterized by high *Trichodesmium* biomass and low-to-moderate dust flux, such as the Southwest Pacific and offshore waters of Australia, as primary candidates for active biofertilization. Our findings extend the biogeochemical role of *Trichodesmium*, demonstrating its dual-nutrient fertilization potential and its contribution to regional ocean productivity (Fig. 1).

[1]. Shaked et al. 2025. Limnology and Oceanography 70 (11), 3155-3171