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Diatom growth is enhanced by phycosphere bacteria exometabolite-mediated mobilization of Fe from mineral dust

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The availability of iron limits primary production over 30-40% of the surface ocean due to iron's poor solubility and low concentration in seawater. The physiological and molecular response of individual microorganisms to nutrient limitation has been extensively characterized, however interactions with the surrounding community which may facilitate iron solubilization have received less attention. It is still poorly understood how marine organisms access iron from poorly soluble phases such as dust, which is a dominant iron source to the open ocean. Here, we examine how the diatom *Phaeodactylum tricornutum*'s growth is impacted by a phycosphere-associated bacterium, *Marinobacter* 3-2, under iron-limited conditions. In experiments using Arizona Test Dust (2-5% Fe_2O_3 by weight) as the sole iron source, *Marinobacter* significantly improved diatom growth under iron-limited conditions, with the diatom reaching a final cell density over three times higher than that of the axenic culture. Bacterial abundance remained relatively low (less than 40,000 cells/mL) throughout the experiment, suggesting that low abundance taxa can have a disproportionate effect on iron uptake by primary producers. When iron-limited cultures (10 nM iron complexed with EDTA) received a pulse of Arizona Test Dust during logarithmic growth, the axenic diatom did not show a growth response while diatoms in co-culture with *Marinobacter* significantly increased in density post-dust addition. This increase in growth was accompanied by a modest (7-31%) increase in dissolved iron(II) within minutes of dust addition that was not replicated by the axenic diatoms. When this dust pulse was added to media filtered from cultures at the same growth stage, iron(II) increased by 15-140%, suggesting that exuded reductants contribute to the observed iron mobilization. Exometabolomic profiling comparing the axenic diatom and the *Marinobacter* co-cultures revealed a suite of aromatic organosulfur and nitrogen-containing compounds associated with bacterial presence that may be involved. These results shed light on the mechanistic basis of microbial interactions that promote iron reduction and dissolution from dust in a model marine system and provide insight into natural community responses to dust deposition events.