Silicic acid uptake by marine phytoplankton blooming near a marine sewage outfall located in the Gulf of Saronikos

by

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Introduction

The strong probability that silicon at times limits growth of diatoms has caused continuous interest in the marine silicon cycle. Other marine algae also contain silica in their structural components (e.g., silicoflagellates), but diatoms are the only algae which have been shown to have an absolute requirement for silicon.

Diatoms are often the dominant group of phytoplankton in nutrient rich regions (e.g., upwelling regions, sewage polluted regions). Silicon therefore plays a very important role in the production of organic matter in these ecosystems.

Because silicon has no commercially available radioisotopes, we have developed a stable isotope tracer technique which employs ^{29} Si to study cycling of silicon in marine ecosystems [GOERING, NELSON & CARTER, 1973]. The ^{29} Si tracer technique is similar to the ^{15}N technique which has proved very successful in nitrogen cycling studies [DUGDALE & GOERING, 1967].

In this communication we discuss soluble silica uptake by algal populations growing in nutrient rich waters located in the vicinity of the Keratsini sewage outfall in the Gulf of Saronikos near Piraeus, Greece. The ^{29} Si tracer technique was used to measure the presented uptake rates.

Results

The results presented here are from Cruise 47 of the University of Washington's R/V *Thomas G. Thompson* which took place in the Mediterranean, in March 1970, for the most part in waters near the Attic Peninsula of Greece.

The growth of phytoplankton near the Keratsini outfall as evidenced by marked increases in chlorophyll *a* is visibly enhanced by nutrients added to the ambient seawater by the outfall.

Near the outfall, the uptake of ^{29}Si-labeled $Si(OH)_4$ was measured at 5 different $Si(OH)_4$ concentrations (2.7, 3.0, 4.2, 5.9, and 9.4 µg atoms Si liter^{-1}). The uptake was linear over this concentration range. This is in disagreement with experiments we have conducted in upwelling regions where Michaelis-Menten saturation kinetics were observed within this concentration range. Different species of phytoplankton may explain these differences.

The concentration of nutrients, chlorophyll *a* and the uptake of ^{15}N-and ^{29}Si-labeled compounds at 5 stations located in the bloom of phytoplankton near the outfall are given in Figure 1. The water for these experiments was obtained from 5 m and incubations were conducted for 24 hr in 50 % ambient light. The station locations increase in distance as they increase in number. In general, the uptake velocities of silicon (V_{si}) and ammonium (V_{NH_3}) exhibit the same trend with maximum values occurring when ambient levels of these nutrients are greatest. Nitrate uptake velocities were maximum near mid-plume (station 49) a region of low nitrate content. This probably results from the inducible nature of the nitrate reductase enzyme which is responsible for catalyzing the uptake of nitrate.

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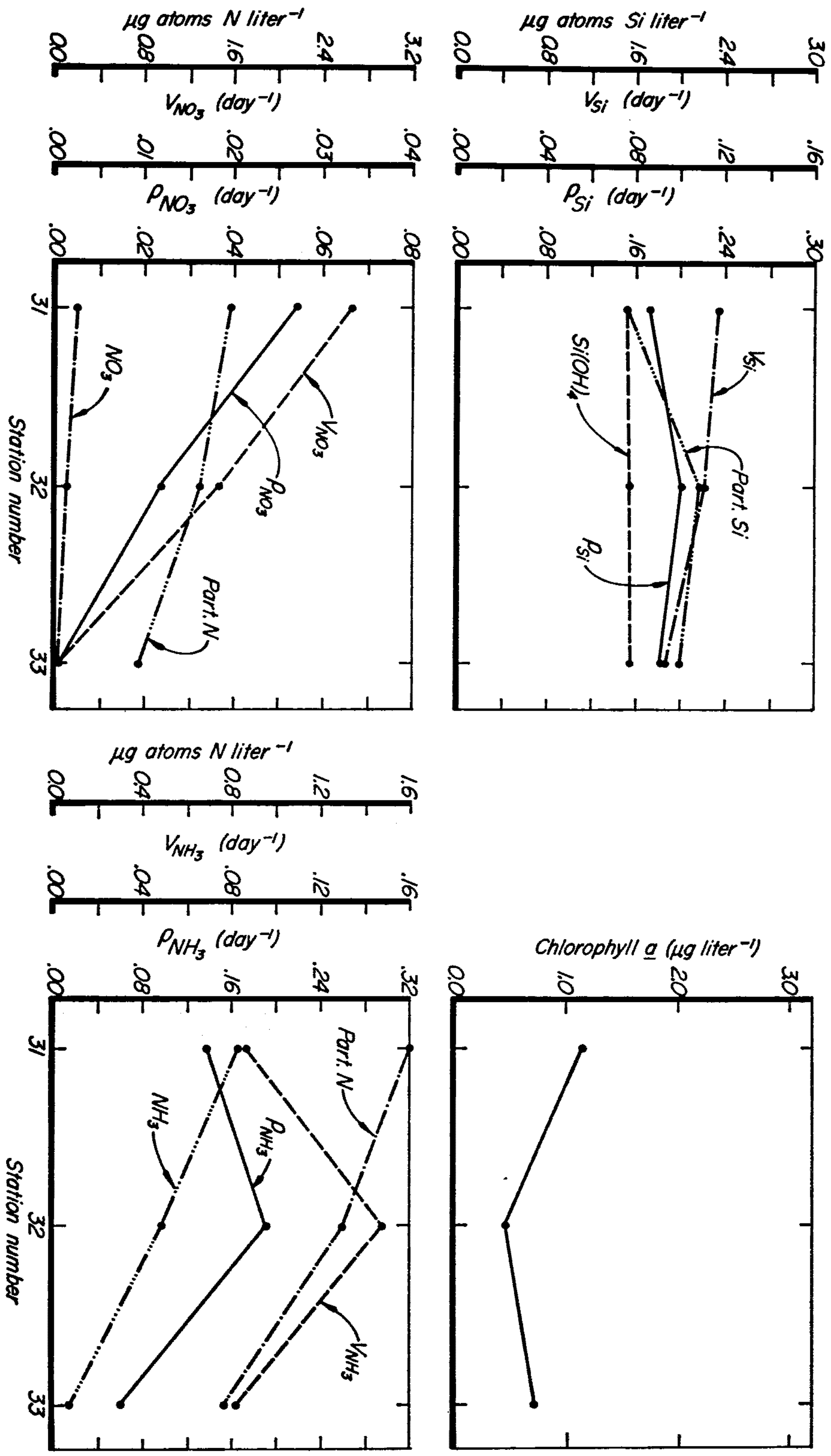

FIGURE 1. — The Uptake of Silicon and Nitrogen and Other Selected Parameters at 5 Stations in the Saronikos Gulf Near the Keratsini Outfall.

The concentrations of particulate nitrogen and chlorophyll *a* were greatest near the outfall and then declined with an increase in distance. Particulate silicon, however, increases with distance and reaches maximum levels near the edge of the phytoplankton bloom. This distribution suggests that silicon is not regenerated as rapidly as nitrogen. We have also shown that Si(OH) behaves virtually as a non-regenerated nutrient in the euphotic zone of nutrient-rich upwelled water near Peru, thereby, limiting diatom growth [Dugdale & Goering, 1970].

The rates of $^{29}Si(OH)_4$ uptake at stations located in the offshore Mediterranean were significantly lower than those recorded near the outfall. However, the concentrations of ambient $Si(OH)_4$ in the two waters are similar suggesting that sewage addition of nutrients other than silicon (e.g., nitrogen and phosphorus) are probably responsible for the accelerated growth of phytoplankton near the outfall.

References

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