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Existence of dissolved Fe^{2+} in a spring bloom at Funka Bay*

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Summary

All metals in seawater with the exception of mercury are very important for the growth of phytoplankton. Among the metals, only iron is in particulate form in coastal seawater. Thus, it is necessary to know how particulate iron is assimilated by phytoplankton, which can increase to 10^3–10^5 cells/ml in a spring bloom or red tide. There are two methods to change particulate iron to dissolved iron: one is chelation with a chelating organic substance, the other is reduction to Fe^{2+}. A spring bloom in Funka Bay occurred during March and the dissolved Fe^{2+} in oxic surface layers was found during the bloom.

1. Introduction

Certain trace metals, especially iron and manganese, play an important role in the growth of phytoplankton. These metals exist in particulate forms in the ocean. In coastal seawater, however, manganese exists only in a dissolved form since its oxidation rate is very slow; of these metals, only iron is found in particulate form in coastal seawater. Since iron is reported to be a limiting factor for the growth of phytoplankton, especially for flagellata (LEWIN and CHEN, 1971; GLOVER, 1978; FINDEN *et al.*, 1984), it is important to know how particulate iron is assimilated by phytoplankton, even when the chemical and physical conditions, e.g. the nutrient and vitamin content, salinity and water temperature for the growth of phytoplankton are satisfied.

In the culture of flagellates, for instance, Fe-EDTA must be added to the medium to induce the phytoplankton to grow (IWASAKI and IWASA, 1982; YAMOCHI, 1983). To change particulate iron to a dissolved form, there are two methods: one is chelation with a chelating substance, the other is reduction to Fe^{2+}.

MATSUNAGA *et al.* (1982 and 1984) reported the existence of a fulvic acid-Fe complex in river, lake and coastal waters, and the assimilation of this complex by phytoplankton in lake water.

HONG and KESTER (1986) have reported that Fe^{2+}, which was reduced in the deeper anoxic layer, was carried to a surface layer by upwelling off Peru. High primary production off Peru may be due to the presence of this Fe^{2+}. The relationship between iron and red tide outbreak was reviewed by OKAICHI and MONTANI (1987).

In this paper, we describe the existence of Fe^{2+} in seawater during a spring bloom.

2. Experimental

Water samples were collected with Go-Flo sampling bottles at the station shown in Fig. 1 during the period February–April 1987. The sampler was hung on a nylon rope attached to a steel wire to avoid sample contamination from the wire. After collection, bathophenanthroline was immediately added to the samples for ferrous ion determination.

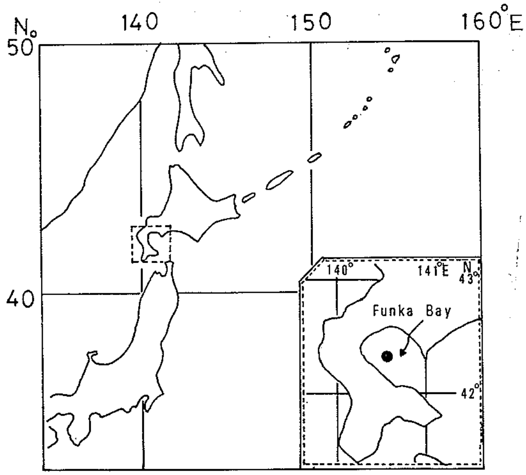

Fig. 1. Sampling area showing the location of the sampling station.

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Ferrous-bathophenanthroline complex was extracted to *n*-hexanol and the absorbance of the complex in the organic phase was determined with a 5 cm cell by a spectrophotometer. For particulate iron, 11 of each sample was passed through a filter (0.45 μm pore size) in a clean bench and the filter was soaked in 2M HCl for 2hr. Dissolved iron in the acid would be of a type which can be reduced to Fe^{2+}. In the particulate iron, Fe^{2+} is included because it is oxidized to Fe^{3+} until filtration.

Chlorophyll-*a* was determined by the method of PARSONS *et al.* (1983).

3. Results and discussion

In the bay, vertical water mixing continues until late February and the bay sediment is transported to the surface layer. Fig. 2 shows the seasonal variation in the vertical distribution of chlorophill-a. Its concentration is below 0.5 μg/*l* during the water mixing and increases from the middle of March. The maximum concentration is found from the middle of March to early April. This is the period of the spring bloom in the bay.

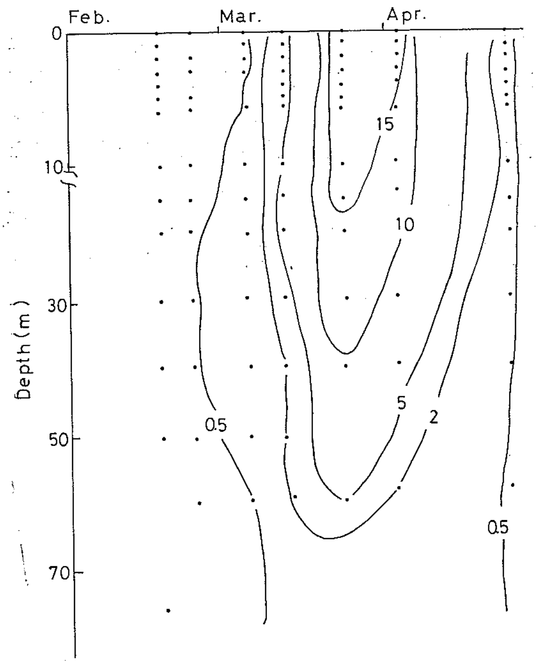

Fig. 2. Seasonal vertical distribution of chlorophyll-*a* (μg/*l*).

Fig. 3 shows the seasonal variation in the vertical distribution of dissolved Fe^{2+}. The Fe^{2+} concentration is below the detection limit (0.014 μM) during the water mixing. However, 0.02–0.04 μM of Fe^{2+} appears from the middle of March to early April, that is, during the spring bloom. The Fe^{2+} concentration had again fallen below the detection limit at the middle of April. Its vertical distribution is the same as that of chlorophyll-*a*.

For particulate iron, the vertical section of dissolved iron in the acid is also shown in Fig. 3. Its concentration in February is high because of the water mixing and its origin is in the bay sediment, and decreases with time due to deposition.

In this paper, the existence of the dissolved Fe^{2+} in oxic seawater during the bloom was described. The mechanism of existence of the dissolved Fe^{2+} in oxic surface layer will be reported elsewhere.

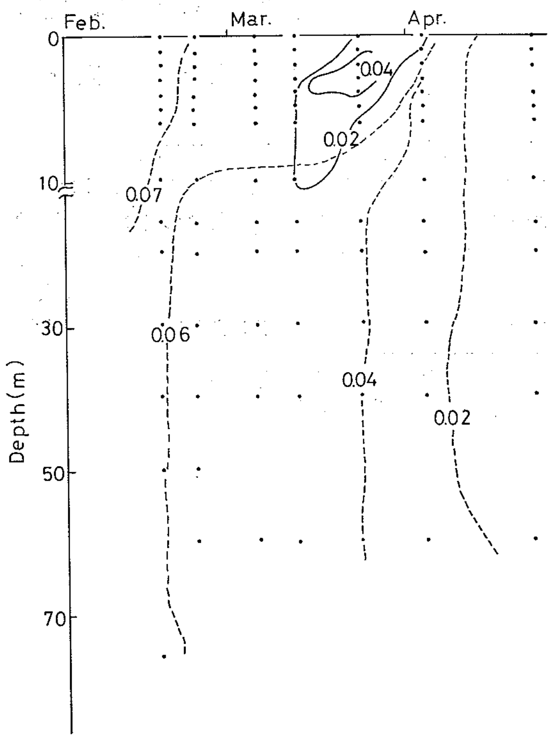

Fig. 3. Seasonal vertical distributions of Fe^{2+} and particulate iron. solid line: Fe^{2+} (μM); dotted line: particulate iron (μM).

Acknowledgment

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噴火湾における spring bloom と溶存２価鉄

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生物は水銀以外の金属を必要とするが，沿岸海域においては鉄のみが粒子として存在している。スプリングブルーム，または，赤潮時には植物プランクトンは 10^3-10^5 cells/ml はまで増殖する。従って海水で存在する鉄をどのような機構で，あるいはどのような形態の鉄を摂取しているかを知ることは植物プランクトンの増殖機構を知る上に極めて重要である。粒状鉄を溶存鉄に変えるには，有機物質とのキレート化あるいは粒状鉄を還元して Fe^{2+} にするかのいずれかである。ある種の植物プランクトンはキレート物質を排泄し，鉄をキレート化するとの報告もあるが，種類が限られているために Fe^{2+} を摂取していると考えた方が普遍的である。噴火湾で1987年２月－４月にかけて観測を行い，ブルーム時に Fe^{2+}の存在が確認された。

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