A consideration on in-situ measurement method of matters at sea area

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ABSTRACT

Recently, measurement of certain environmental factors such as dissolved oxygen and chlorophyll using electric sensors has been realized. Such measurement is continuous and automatic, and is very important for monitoring the environment in sea areas. However, it is difficult to continuously measure nutrient, hydrosulfide and so on, because data must be obtained by chemical analysis. This paper introduces a simplified measurement method of dissolved matter using absorbance spectrum in UV wavelength range and eigenvector of spectrum. The effectiveness of the present method is demonstrated.

KEY WORDS: nitrate; nitrite; hydrosulfide, principle component regression (PCR), eigenvector, optimization, measurement method, UV spectrum.

INTRODUCTION

Recent interest in the absorption of CO$_2$ in ocean may have been generated by relating flux of CO$_2$ to global warming. Additionally, coastal eutrophication has caused many kinds of environmental problems including red tide and anoxic water among others. In order to deal with these problems appropriately and provide a good understanding of ocean and the coastal sea ecosystem, it is important to measure these factors by in-situ measurements with high resolution in time and space.

Seafloor massive sulfides sources are found in the Okinawa Trough and the Izu-Ogasawara Arc near Japan (Halbach et al. 1989), (Iizasa, K. et al. 1999), (Kato, Y. et al. 1989). Since these sources are relatively abundant in Au and Ag, there is a strong possibility for mining in the near future. It is natural that many studies of quantitative methods for estimating the environmental impact of mining operations have been reported by a number of researchers (Burns, R. E. et al. 1980), (Schriever, G.A. et al. 1997), (Trueblood, D. D. et al. 1997). However, the environmental impact on mining and the ecosystem of the seafloor around hydrothermal plumes has not yet been clarified. One of the main reasons for the small number of studies on ecosystems around hydrothermal plumes is the fact that the instruments for in-situ measurements and the data concerning the environmental factors are far from sufficient.

At present, electric or optical sensors can easily be put to practical use for in-situ measurement of some of the environmental factors associated with such events. These devices can measure salinity, temperature, chlorophyll concentration and so on. However, certain chemical parameters such as nitrate (NO$_3^-$), hydrosulfide (HS$^-$) ions and so on, must be analyzed in a laboratory due to the complexities of the chemical processes and the analytical time required, making on-site measurement difficult.

Ogura, N. and Hanya, T. (1966) have examined the absorption characteristics in the UV range of seawater sampled in the western Pacific Ocean and at Sagami Nada. They found remarkable results in that the absorption of seawater at wavelengths between 210nm and 230nm is almost equal to the sum of absorptions owing to bromide (Br$^-$), dissolved organic matter (DOM), and nitrate. In addition, Collos et al. (1999) have measured nitrate and nitrite of pseudo seawater and indicated that these ions can be determined at only one wavelength—220nm—in the case of artificial seawater without any DOM. However, there are many kinds of compounds with UV absorption characteristics in seawater. This means that the absorbance of seawater in the UV range is composed of ones of these compounds and it is fundamentally difficult to extract nitrate accurately by one wavelength. Finch et al. (1998) and Clayson (2000) have developed an instrument for measuring nutrients on site. It can determine the nitrate concentration by analyzing data at six wavelengths. Though its accuracy is not sufficient for practical use, these results show the possibility of measuring absorption at a number of wavelengths by so-called “multi-wavelength spectroscopy”.

Johnson, K. S. and Coletti, L. J. (2002) have recently tried to measure nitrate and hydrosulfide on site in Monterey Bay using multi-wavelength spectroscopy in the 210nm to 300nm band. They measured the molar absorbance of ocean surface water without the main effects of nitrate and DOM as aspects of the “salinity”, which is primarily owing to bromide. The particular features of the absorption spectrum excluding nitrate and DOM have been shown by the spectrum of “salinity”. In view of these results, nitrate can now be measured by determining nitrate, sulfide and the salinity by curve fitting to the measured absorption spectrum in the UV range. However, the composition of the salinity significantly depends on time and location of the field. In the coastal sea and/or deep seawater around hydrothermal plume, the composition of many kinds of chemical components with UV absorption characteristics such as SiO$_2$, DOM and so on, cannot be