Diatoms as a potential paleoproxy

Reconstructing sea-surface conditions using the Nano-SIMS

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Introduction

Diatoms are responsible for over 40% of the total primary production in modern oceans[1] and yet their skeletons have not been developed into a leading paleo-proxy. Instead, over the past few decades, foraminiferal-based proxies have dominated paleoclimate research. However, recent developments in analytical techniques have made it possible to look at the chemical characteristics of geological materials such as diatoms on the submicron scale with a Nano-SIMS (Secondary Ion Mass Spectrometer), opening up exciting new directions of research that may improve our understanding of the factoc governing their shell chemistry and its relevance for paleoreconstructions. In this study we aim to identify changes in the elemental composition of diatoms in relation to environmental changes in sea surface waters, in both the diatom frustule itself and the occluded organic matter. Here we present the first results from Nano-SIMS analyses of Mediterranean water-column diatoms. With these results, we can discuss the implications for the potential application of diatom element ratios as a new paleo-proxy for sea surface conditions.

Materials & Methods

The materials were gathered during a Netherlands Earth System Science Center (NESSC) expedition to the Mediterranean where an East - West transect was made. Diatoms were filtered from the seawater at 3 different depths. Carbon tape was used to release the tests and enter them into the Nano-SIMS. In the Nano-SIMS seven different ions were measured:

^{12}C, ^{13}C, $^{12}C^{14}N$, ^{16}O, ^{28}Si, ^{31}P, ^{32}S

The data was then studied using the Look@NanoSIMS[2] software.

Results & Discussion

During the first trial runs, entire diatoms were measured in an attempt to reveal the varying relative abundances within the diatom. Silicon is present throughout the test, confirming the nature of the frustule. The organics ($^{12}C^{14}N$, ^{31}P & ^{32}S) are only abundant on the inside of the frustule possibly suggesting a protected setting with paleo-proxy potential.

Figures 1 - 5 show the different relative chemical signals of the test. The test is a broken fragment of the Odontella species. Region of interest outlines are also visible.

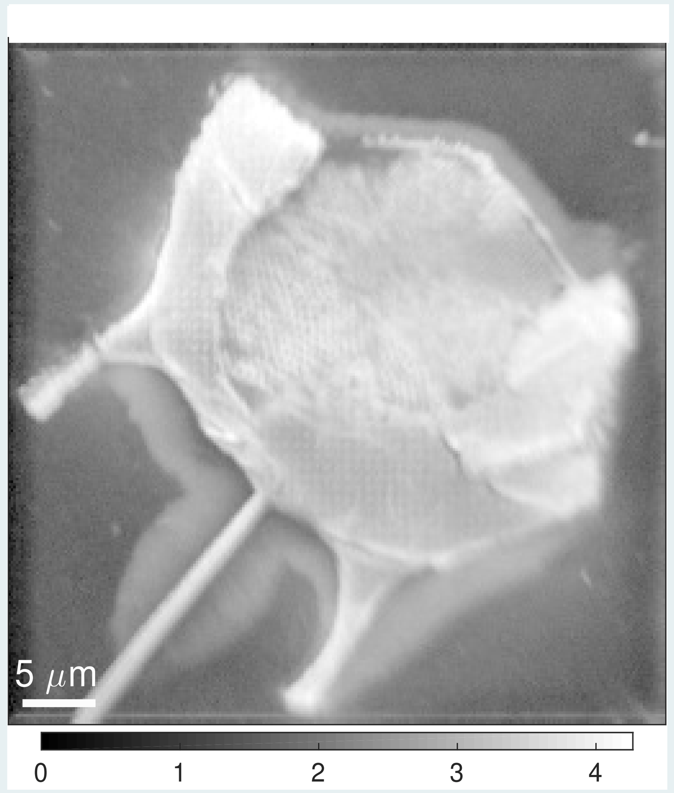

Figure 1 - log(^{16}O)

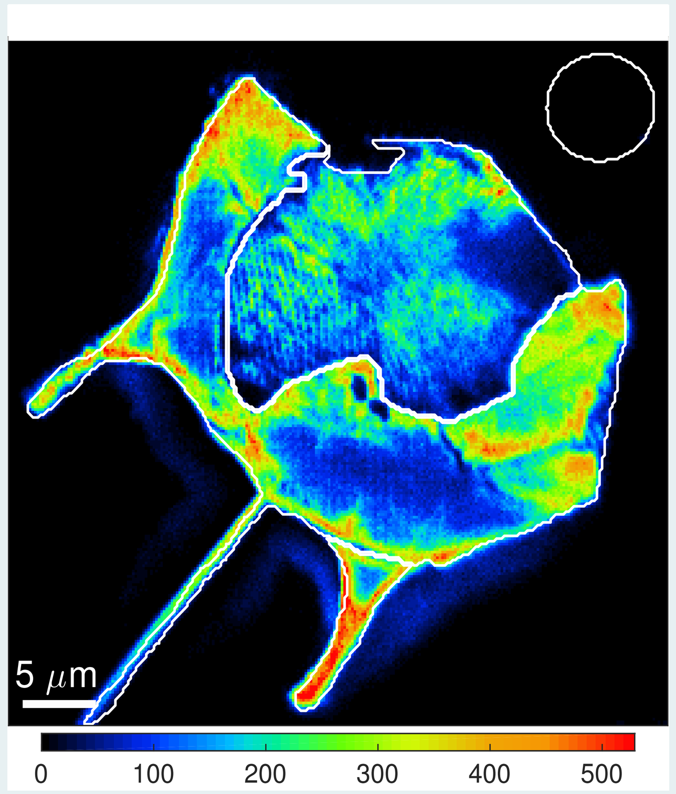

Figure 2 - ^{28}Si

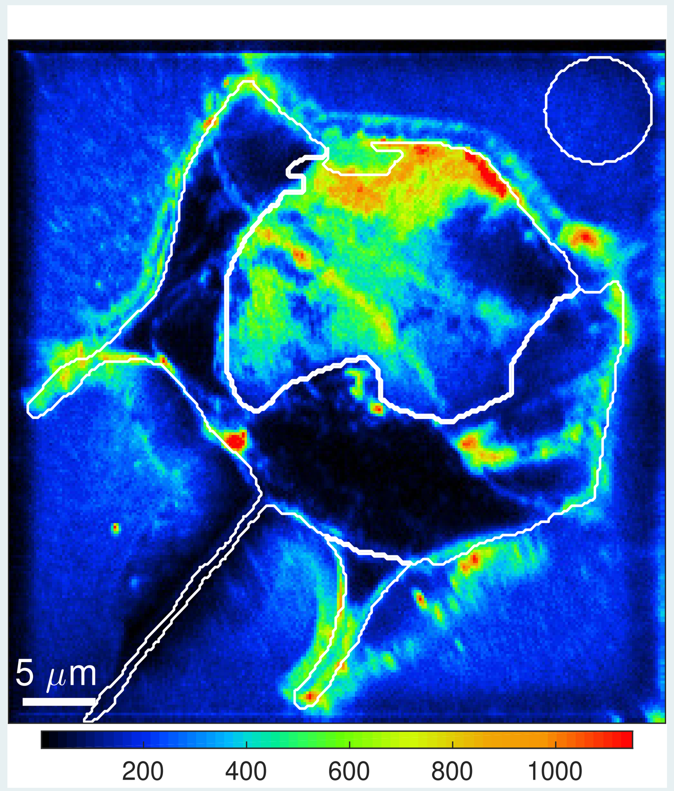

Figure 3 - $^{12}C^{14}N$

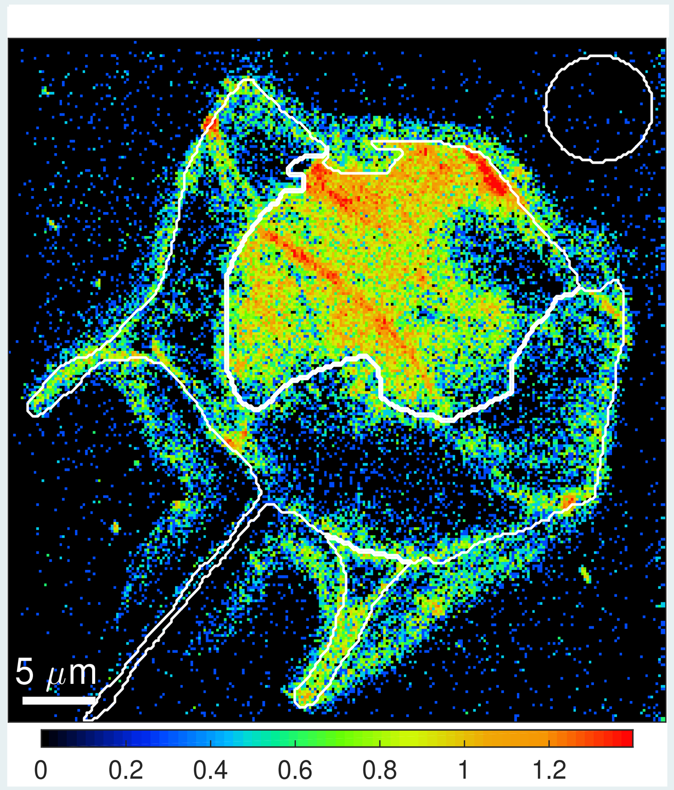

Figure 4 - log(^{31}P)

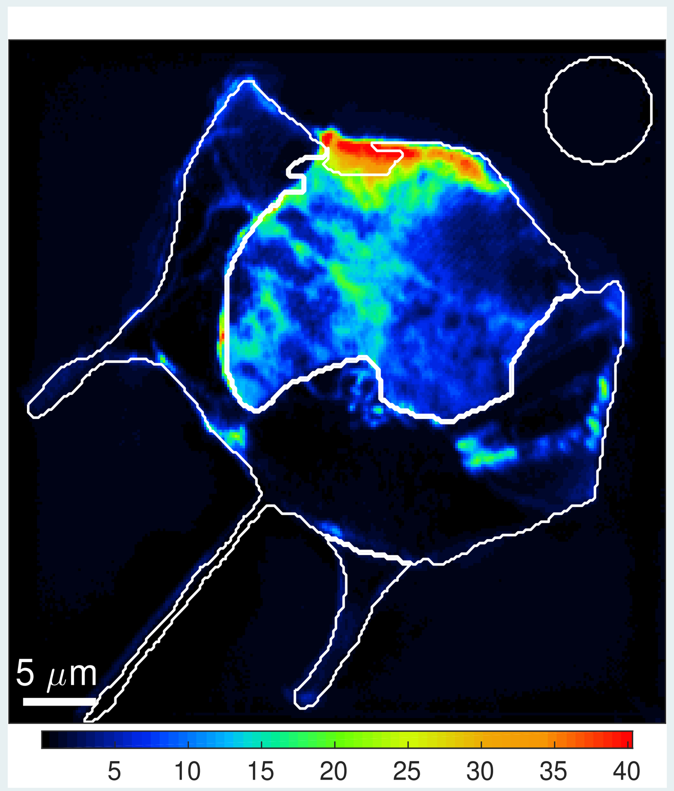

Figure 5 - ^{32}S

Conclusion

The first results show that there may be some potential for a chemical paleo-proxy contained within the inside of the diatom frustule. There is a clear organic signal preserved internally that is absent on the outside of the frustule.
Future steps will include identifying further broken diatoms obtained under differing environmental conditions. In these diatoms we will measure on an even smaller scale (5µm) in an attempt to amplify the signal situated on the inside of the frustule. If this is successful it may be possible to study less abundant elements in the search of potential novel proxies.

Literature

(1) Nelson, D.M., Treguer, P., Brzezinski, M.A., Leynaert, A., Que - guiner, B., 1995. Production and dissolution of biogenic silica in the ocean. Revised global estimates, comparison with region- al data and relationship to biogenic sedimentation. Global Bio- geochem. Cycles 9, 359–372.
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