

# ***Interactive comment on “Bottom-water temperature controls on biogenic silica dissolution and recycling in surficial deep-sea sediments” by Shahab Varkouhi and Jonathan Wells***

## **Anonymous Referee #1**

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In this very long manuscript the authors attempt to show that oceanic bottom temperature controls biogenic dissolution in surficial deep-sea sediments. From the onset, it is important to note that the range of bottom water temperatures that are presented in this manuscript is less than 2.5 C (2.44 C to be precise), an extremely small span. This study does not present any experimental data, it is based on sourcing information from previous ODP reports and interpreting previous papers that have investigated biogenic/opal dissolution to make the case. However, because of the reasons explained below, I cannot recommend this paper for publication. Reasons

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Indeed, it has been known for a while, since the early work of Fournier et al. (1960, and later) that the concentration of dissolved silica in hydrothermal waters can be used as a geologic thermometer. It has also been well documented that in the case of biogenic silica/opal there is a temperature dependency in terms of dissolution kinetics – works cited by the authors. However, these dependencies were documented over far greater temperature ranges than the one this study is looking at. For example, the Van Cappellen and Qiu (1997a) study that the authors list – lines # 63 to 67– as a support for focusing solely on temperature reports how the solubility in silica rich sediments varies over temperatures ranging between 5 and 35 C. They also show very large uncertainties associated with these experiments. This study does not report anything about kinetics – as this is addressed in the second paper published in that DSR special issue; Van Cappellen and Qiu (1997b). Subsequent experiments were also performed either at room temperature ( 20 +/- 2 C) or T= 2, 19, and 60 C with fluctuations about +/- 1 C as stated by Rickert (2000) - Rickert in his thesis notes that small variations in temperature, i.e., +/- 1C produce negligible “uncertainties” – that is no changes in the reaction rate kinetics.

The authors used an estimate of the apparent energy of activation of 50 kJ/mol – lines #382-383; and further writing it as 5000 J/mol!, are all these digits significant digits? - when the papers that they list report large uncertainties related to this quantity. Indeed, since biogenic silica is not a pure mineral phase, that the dissolution kinetics of various diatoms species vary greatly, that sorption of aluminium plays an important role - to cite a few other factors that have been shown to control biogenic silica dissolution - there are large uncertainties/variability associated with these data.

The major issue that I have with this manuscript, is that the authors have completely neglected to perform any uncertainty analysis with the data that they have used. Given the very small temperature range addressed, the known variability/uncertainty in the data that they show are the trends presented in Figs. 4, 5, 6 and 7 indeed meaningful? It is also not clear how “average values” (e.g., Fig. 6) can improve trends in the depen-

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gency of the dissolution rate so well over such a small temperature range. What are the standard deviations about these averages. Since the authors have not provided the data for evaluating these average values it is difficult to figure out what has been done. Similarly, we have no idea of the uncertainties related to the coefficients in the equations used to calculate saturation concentrations – line # 402 & 403. How many significant digits can we expect? Looking at Fig. 3, one can assume large uncertainties for detrital-hosted sediments. As for carbonate hosted sediments the increase in the saturation concentration, i.e., the “asymptotic silica concentration” is so steep over  $\sim 1\text{C}$  that it leads to an expression that may be characterized with a great R value but leads to totally unreasonable concentrations for temperatures as low as  $5\text{C}$ .

In addition, and maybe more importantly, I cannot see how one can use ODP core data to get any flux calculation performed rather accurately given that pore water analyses are performed on 10 cm thick sediment slices. To obtain any reasonable estimate of the silica efflux from sediments the sediment water interface needs to be preserved as well as possible. Is this the case for long cores as explained in section 4.

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