Influence of UV-B on the photoreduction of Fe(III) to Fe(II)

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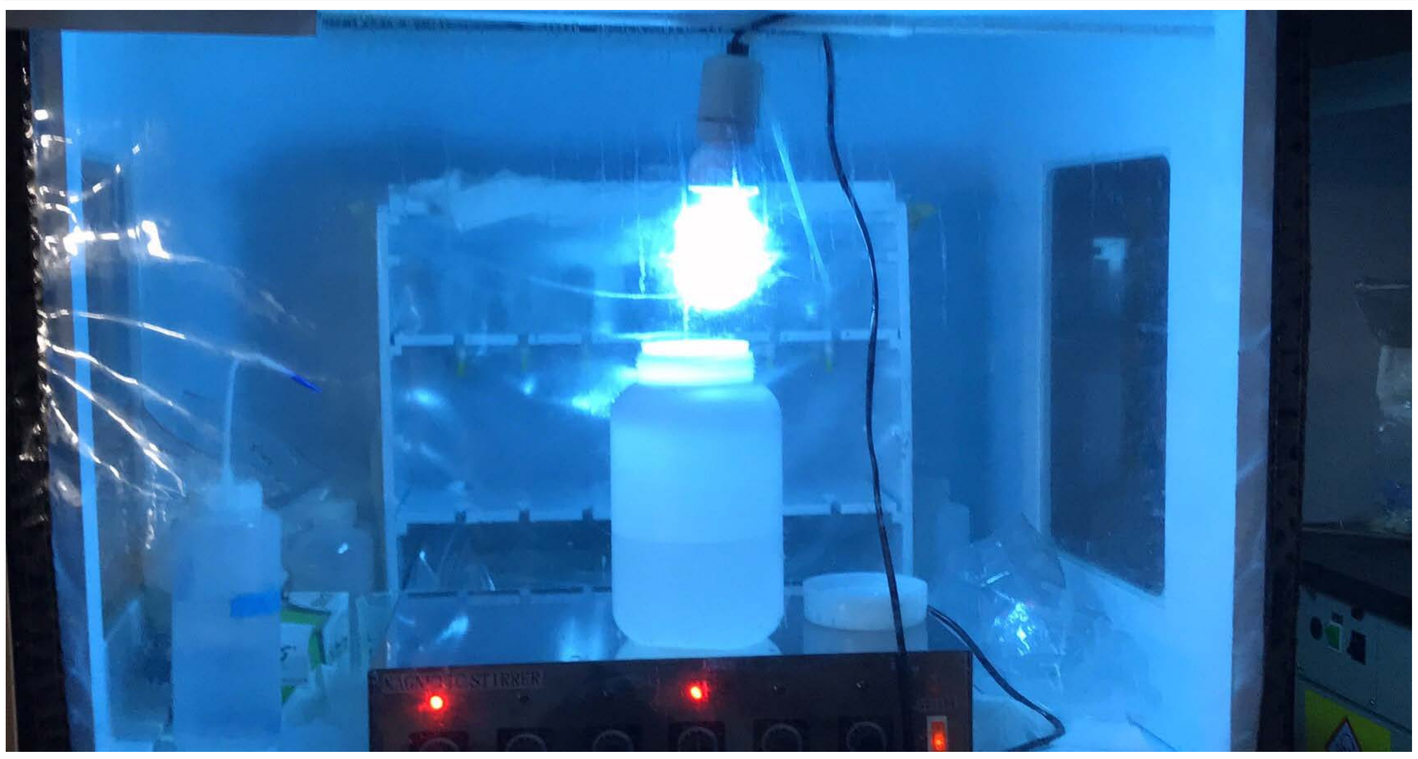
Introduction

Iron is a limiting factor for phytoplankton growth in the ocean. Studies show that the transformation between Fe(III) & Fe(II) would affect Fe bioavailability[1]. Ultraviolet-B radiation (UV-B, 280-320 nm) is known to be an important environmental factor deciding the reduction rates[2,3,4].

$$Fe(III)L_n + UV\text{-}B \rightarrow Fe(II)$$

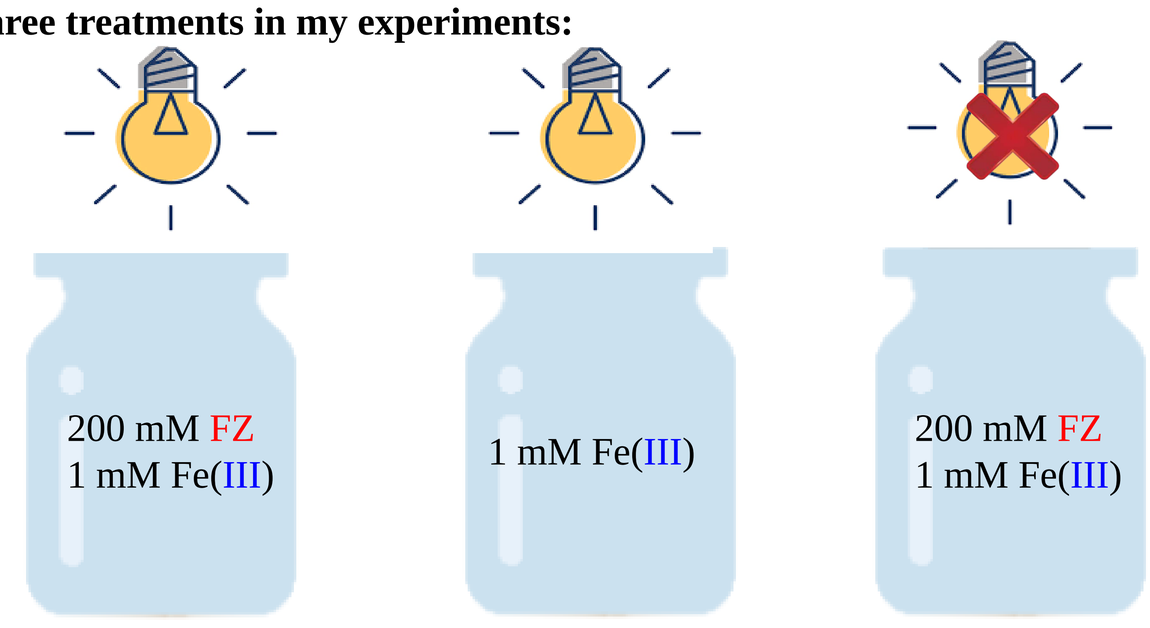
$Fe(III)L_n$ represents the photoreactive organic complexes of Fe(III) in seawater.

In this study, I have carried out photochemical reduction experiments to validate the photoreduction rates of Fe(III) to Fe(II) by UV-B radiation.



UV exposure setup: Experiments were carried out in a HEPA controlled chamber. Samples in 2 liter PE bottles were mixed by stirrer and collected and transferred to 50 mL polypropylene tubes at hr 0, 1, 2, 4, and 5. The collected samples were then measured by spectrophotometer after the treatment shown on the right.

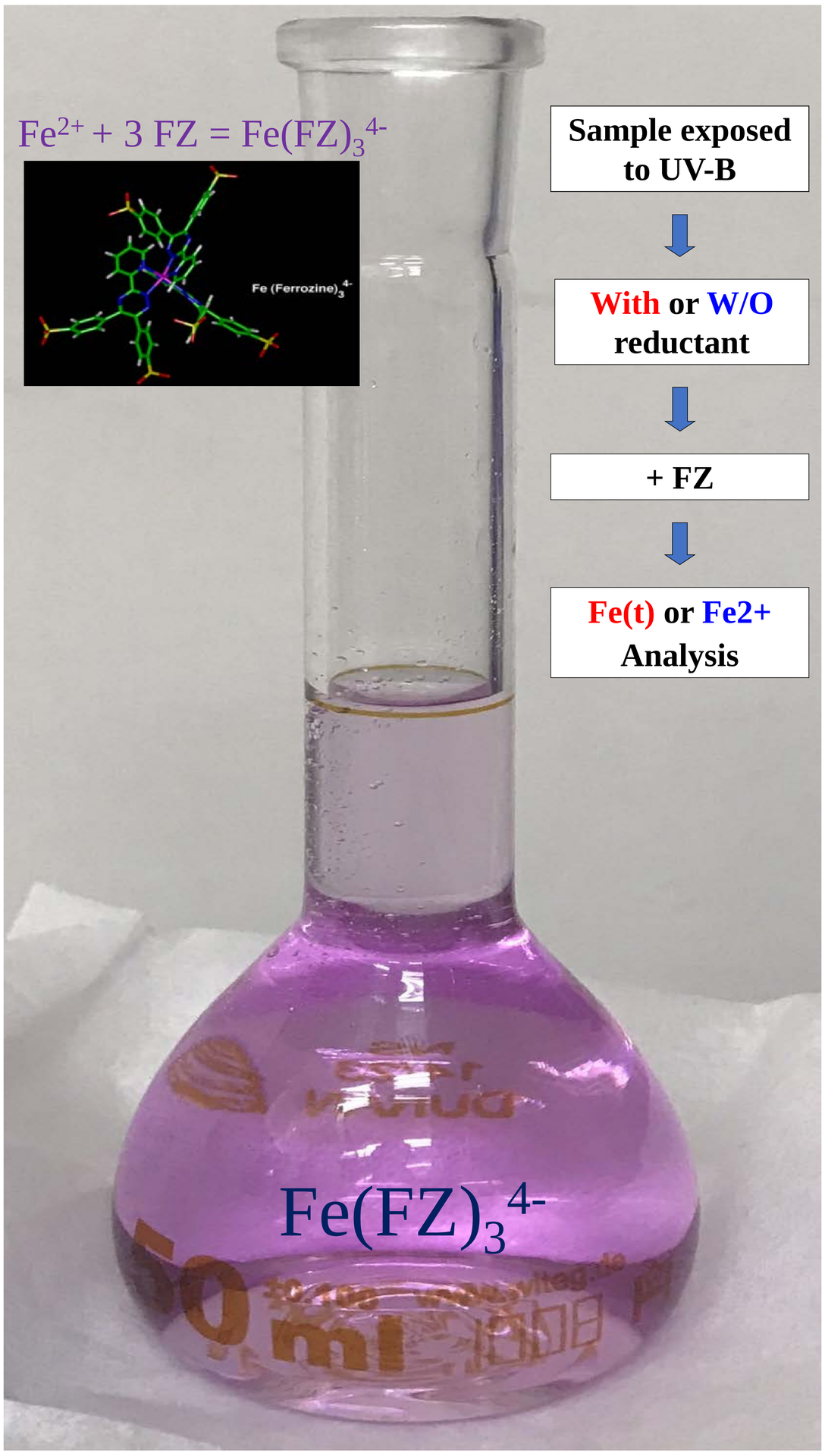
The three treatments in my experiments:

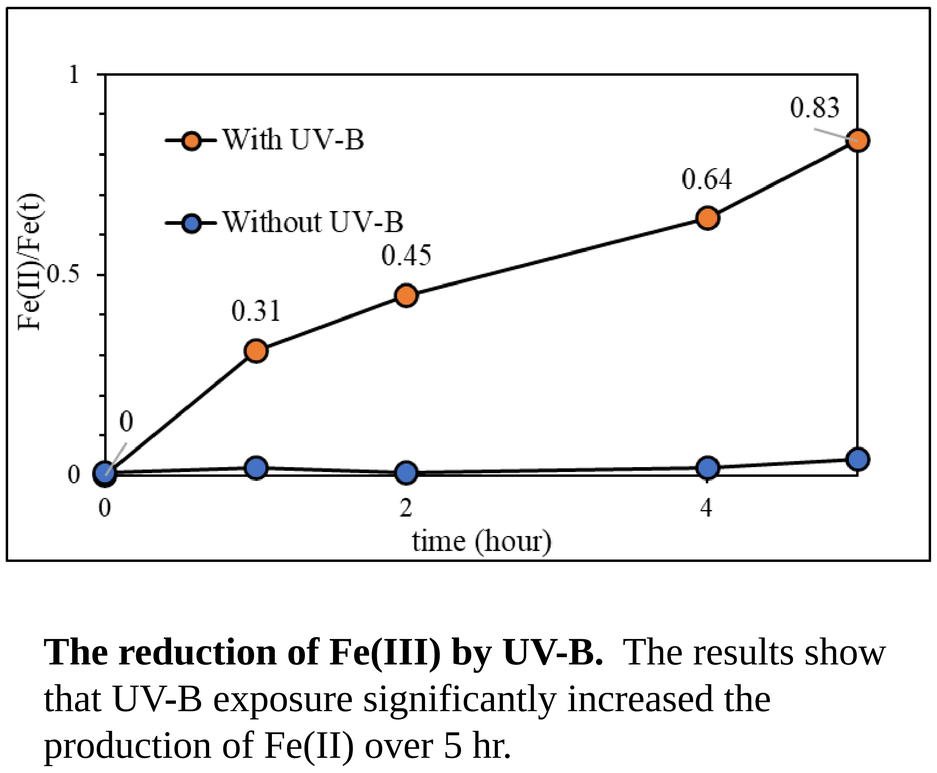


The intensity of UV-B is 1229.03 mW/m^2

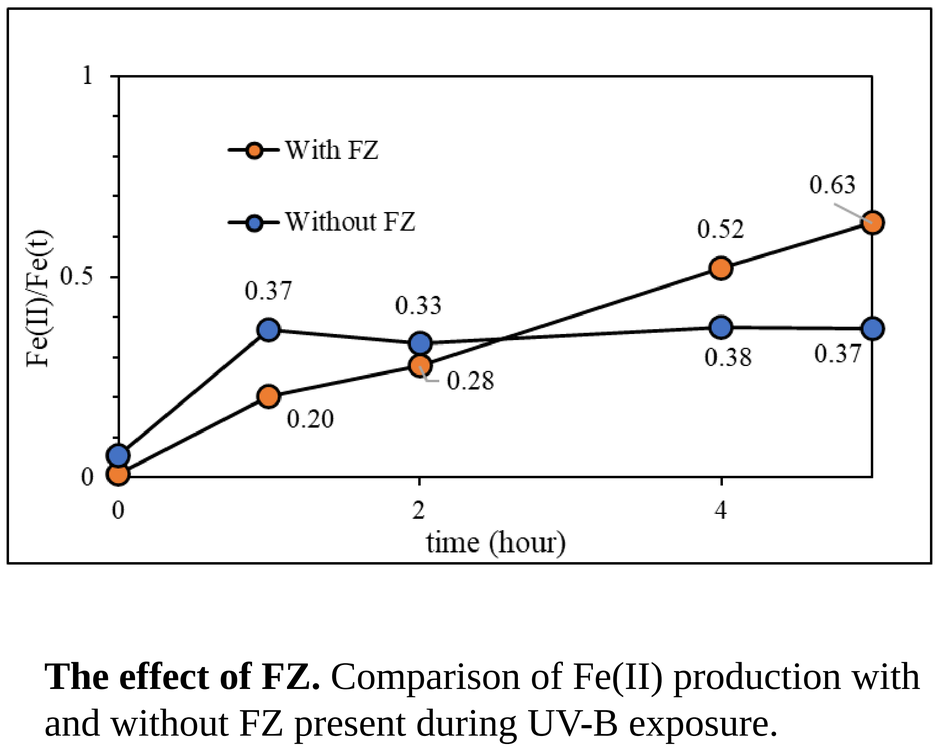
Method

Ferrozine (FZ) is used to chelate Fe(II) reduced from Fe(III) in the experiments. The $Fe(FZ)_3^{4-}$ compound, a pink color complexes, is shown below[6]. Thus, the concentrations of the complex, the reduction rates, can be precisely and accurately measured by spectrophotometer.





The reduction of Fe(III) by UV-B. The results show that UV-B exposure significantly increased the production of Fe(II) over 5 hr.



The effect of FZ. Comparison of Fe(II) production with and without FZ present during UV-B exposure.

Results & Discussion

- For 1st experiment, the results show that UV-B would crucially promote the reduction .
- For 2nd experiment, the treatment with FZ showed it can chelate Fe(II) reduced from Fe(III) ; the treatment w/o FZ showed the net result which is dynamic red/ox equilibrium between Fe(III) to Fe(II).

Conclusion

- I validated significant Fe photoreduction by UV-B.

Acknowledgements: We thank Oliver, Bukin, Mei, Ya-Lan, Hsin-Ting, David, Stephanie and Ian for their kind help on experiment design, experiment method, English writing skills.

Reference: **1**.Wang and Ho 2020; **2**. Madronich 1992; **3**. Cooper et al. 1989; **4**. Zepp et al. 1992; **5**. Ho 1994; **6**. M3LC 2019