

Iron Concentrations and Biological Controls

Reading:

Chisholm S.W. and F.M.M. Morel (1991) What Controls Phytoplankton Production in Nutrient-Rich Areas of the Open Sea - Preface. *Limnology and Oceanography* 36, 1-5.

Morel F.M.M., J.G. Rueter and N.M. Price (1991) Iron nutrition of phytoplankton and its possible importance in the ecology of ocean regions with high nutrient and low biomass. *Oceanography* 4, 56-61.

Coale K.H. and many others (1996) A massive phytoplankton bloom induced by an ecosystem-scale iron fertilization experiment in the equatorial Pacific Ocean. *Nature* 383, 495-501.

Landry M.R. and many others (1997) Iron and grazing constraints on primary production in the central equatorial pacific: An EqPac synthesis. *Limnology and Oceanography* 42, 405-418

1. All students read all four papers before Group Study #2 begins on Wednesday, October 31. There will be three discussion groups for the Morel, Coale and Landry papers. All should read the short introduction to the problem by Chisholm and Morel.
2. After class prepare a no more than 3 page analysis to the Group Study Synthesis Question. This is due Wednesday November 7.

The scientific study question is: **Evaluate John Martin's hypothesis stating that availability of iron limits primary production the HNLC regions of the ocean. What additional factors need to be considered as controls on plankton growth?**

Note: If you are interested in the public policy aspects of iron fertilization as an approach for removing fossil fuel CO₂ from the atmosphere, see the very recent editorial; Chisholm S.W., P.G. Falkowski and J.J. Cullen (2001) Dis-crediting Ocean Fertilization. *Science* 294, 309-310.

Questions:

Morel et al

1. What was Martin's Hypothesis? What did it say and what did it not say?
2. What are the minimum iron requirements for plankton?
3. How is Fe taken up by cells?
4. What form of Fe is taken up?
5. Why is the Fe requirement less if the cells are smaller?
6. What ecological advantage does this provide?

Coale et al

1. What was the experimental strategy?
2. How was the patch followed? What is SF₆ and why was it used?
3. How did the iron concentrations after the spike compare with background seawater?
4. How did the properties of the patch evolve with time? What were the chemical responses? What were the biological responses?
5. What was the response by the biological community?
6. Was there net carbon removal from the patch?
7. What are the applications to paleoceanography?
8. What do you think about this as a test of the Martin Hypothesis? Was primary production limited by iron? Was phytoplankton biomass (e.g. chlorophyll) limited by iron? Did the system reach steady state? Is it possible to sketch a simple box model for the experiment before and after iron addition?

Landry et al

1. What is the definition of an HNLC regime?
2. Does the equatorial Pacific qualify as a HNLC regime?
3. What factors control the concentration of biomass (e.g. chlorophyll) in the euphotic zone?
4. What are the main fluxes of iron in the equatorial Pacific?
5. What does quantum yield tell about iron limitation?
6. Are plankton growth and zooplankton grazing in balance in this region?
7. Is iron recycled with the same efficiency as ammonium?
8. What is meant by the "EqPac Synthesis".