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Relationship between iron concentrations in the benthic boundary layer and oxygen

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Considerable empirical evidence shows that benthic iron (Fe) fluxes are determined by a combination of carbon oxidation rates at the sediment-water interface and bottom water oxygen concentrations. Severmann et al. [1] determined a threshold of 60-80 micromolar oxygen in bottom waters that was associated with a significant increase in benthic Fe fluxes in hypoxic zones on the Oregon shelf. Evans et al. [2] showed that this was coincident with the threshold for the accumulation of Fe(II) in the overlying water column in the same region. This relationship has been used in regional and global-scale models to assess benthic iron sources. Presumably, the relationship arises because the rate of oxidation is strongly oxygen-dependent. However, Fe(II) oxidation rates are strongly affected by pH and temperature as well. In this study, we calculated the half-life of Fe(II) under the prevailing conditions off the Oregon shelf, rationalizing that the half-life, rather than oxygen per se, is the threshold value that can be generalized and compared with measured rate data [2]. We then calculated what other regimes should be similar. For instance higher bottom water oxygen might be offset by lower temperature. Results are applied to existing data for Fe(II) in benthic boundary layers from regimes with significantly different prevailing conditions than the Oregon shelf. These regimes include seasonally hypoxic regimes in Japan (Ariake Sea, Omura Bay), and the Chukchi Shelf and Amundsen Seas.

[1] Severmann, S., McManus, J., Berelson, W. M., & Hammond, D. E. (2010). The continental shelf benthic iron flux and its isotope composition. *Geochimica et Cosmochimica Acta*, *74*(14), 3984-4004.

[2] Evans, N., Floback, A. E., Gaffney, J., Chace, P. J., Luna, Z., Knoery, J., ... & Moffett, J. W. (2023). The role of seasonal hypoxia and benthic boundary layer exchange on iron redox cycling on the Oregon shelf. *Limnology and Oceanography*.