Forming the primary nitrite maximum: Nitrifiers or phytoplankton?

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ABSTRACT: As intermediary in a number of key biological processes, the dynamics of oceanic NO_2^- concentrations have historically been used as an indicator of the balance between oxidative and reductive pathways in the marine nitrogen cycle. As appreciation of the role of NO_2^- in the marine nitrogen cycle grew through the 1960s and 1970s, and data sets from different ocean basins became available, a common feature was observed in stratified water columns: a peak in NO_2^- concentrations at the base of the euphotic zone, with near zero concentrations both shallower and deeper. These concentrations are significant; they commonly range between 10 and 400 nmol L^{-1} but as high as 4,500 nmol L^{-1}. This peak in NO_2^- concentration is termed the primary nitrite maximum (PNM). Since the 1960s, the mechanisms sustaining the ubiquitous PNM have remained uncertain, with available data supporting either bacterial nitrification or NO_2^- release by phytoplankton. Simple box models have reproduced the PNM feature with nitrification as the source of NO_2^-, whereas others have succeeded solely with phytoplankton. Conclusive identification of the mechanism(s) maintaining the PNM in the world's oceans has yet to be achieved, but the preponderance of data supports phytoplankton excretion, with nitrification likely playing only a supporting role. Furthermore, there are a number of potentially important inconsistencies in the role of nitrification between culture studies and field observations. Biological-physical interactions are likely also important in controlling PNM formation and maintenance.