

國立臺灣海洋大學
海洋環境與生態研究所 專題討論

題目：Biogeochemical Controls and Feedbacks on Ocean Primary Production

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Abstract

Changes in oceanic primary production, linked to changes in the network of global biogeochemical cycles, have profoundly influenced the geochemistry of Earth for over 3 billion years. In the contemporary ocean, photosynthetic carbon fixation by marine phytoplankton leads to formation of ~45 gigatons of organic carbon per annum, of which 16 gigatons are exported to the ocean interior. Changes in the magnitude of total and export production can strongly influence atmospheric CO₂ levels (and hence climate) on geological time scales, as well as set upper bounds for sustainable fisheries harvest. The two fluxes are critically dependent on geophysical processes that determine mixed-layer depth, nutrient fluxes to and within the ocean, and food-web structure. Because the average turnover time of phytoplankton carbon in the ocean is on the order of a week or less, total and export production are extremely sensitive to external forcing and consequently are seldom in steady state. Elucidating the biogeochemical controls and feedbacks on primary production is essential to understanding how oceanic biota responded to and affected natural climatic variability in the geological past, and will respond to anthropogenically influenced changes in coming decades. One of the most crucial feedbacks results from changes in radiative forcing on the hydrological cycle, which influences the aeolian iron flux and, in turn, affects nitrogen fixation and primary production in the oceans.

中文摘要

海洋初級生產力與全球生物地球化學循環之間的變化息息相關，在這超過 30 億年的時間中，深深地影響了地球化學。在當代海洋中，植物性浮游生物藉由行光合作用將碳固存，每年可形成約 450 億噸的有機碳，其中有 160 億噸儲存至深海。而二氧化碳的總產量和出口量的變化，不僅強烈影響著大氣中二氧化碳的水平（間接影響氣候），且牽動整個海洋漁業資源，而海洋中的營養通量與食物網結構，主要取決於海水混合層的深度。由於海洋中植物性浮游生物之碳循環(CO₂ → 光合作用 → OC → 呼吸作用 → CO₂)的作用時間很短（一周或是更短），因此碳的總產量和出口量對外部極為敏感，很少處於穩定狀態。這篇文章闡述了在生物地球化學調節與反饋下，對海洋基礎生產力的重要性，瞭解海洋生物族群如何響應過去與未來的自然氣候變化。而最關鍵的反饋之一是水文循環中輻射效應的變

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化，這會使鐵的通量產生改變，進而影響海洋中的固氮能力與初級生產力。

參考資料

Paul G. Falkowski, Richard T. Barber and Victor Smeto. 1998. Biogeochemical Controls and Feedbacks on Ocean Primary Production. Science 10 Jul 1998: Vol. 281, Issue 5374, p. 200-206