Sedimentary Signals of Enhanced Nutrient Cycling in Anoxic Ocean Basins

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Organic carbon rich sediments of some modern and many ancient "black-shale" forming marine basins are characterized by high orgC/Ptot and orgC/Ntot ratios, in many cases much higher than Redfield stoichiometry. This suggests preferential release of phosphate and nitrogen from particles in the water column or during early diagenesis as a result of anaerobic degradation of organic matter and reduction of metal oxide particles. For example, recent research suggests that a substantial proportion of what has typically been considered "organic P" is sorbed to metal oxide coatings on cell walls and, therefore, is easily liberated in dysaerobic to anaerobic conditions. Such rapid recycling of P, in particular, could be a strong positive feedback to productivity in surface waters of anoxic basins. However, availability of N is limited because of N consumption during denitrification or annamox reactions in the shallow chemocline of such basins. Thus, without further addition of N, productivity is limited. However, N isotope and limited biomarker data from some black shales indicate that N fixation becomes a dominant mode of organic matter production because of the enhanced P availability and N limitation. We present a globally extensive Cretaceous geochemical data set that illustrates these principles, supplemented with data from Devonian and Proterozoic examples.