Sedimentation Model for Episodic Continental Margin Phosphogenesis Reflecting Third-Order, Sea-Level Cyclicity

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A classic debate has raged for decades concerning authigenic vs secondary reworked formation of phosphate-rich sediments. In reality, both processes are important in the formation of major deposits as demonstrated within the deposits of SE US. Detailed bio-, litho-, and Sr isotope chronostratigraphic analyses defined four third-order, sea-level cycles of phosphate sedimentation on the North Carolina continental margin. Three Miocene (23.3-7.1 Ma) cycles (I, II, and III) are each dominated by authigenic phosphate formation with an uppermost reworked phosphate unit. The Pliocene-Quaternary (5.3-0 Ma) episode (IV) consists totally of reworked phosphates derived from cycles II and III.

Marine transgression produces a fining-upward siliciclastic sequence with critical changes in phosphate grain types, deposited on the previous sea-level lowstand unconformity. During early-stage transgression, a basal microsphorite crust is locally eroded producing rip-up intraclasts that are reworked into the basal portion of overlying sediments. Mid-stage transgression is dominated by authigenic phosphate, including skeletal grains and fine sand-sized peloids, which form as disseminated grains below the sediment-water interface with no sediment reworking. Phosphogenesis is terminated during late-stage transgression as oxygen-depleted environments migrate landward across the shelf forming organic-rich dolosilts or foraminifer-rich/diatom-rich muds with little to no phosphate. Sea-level highstand is characterized by carbonate-rich sediments deposited under normal marine, open-shelf conditions. The subsequent regression erodes and reworks portions of the transgressional facies to form beds of extensively reworked phosphate-rich sediments.