Abstract

At Haskells Beach, west of Santa Barbara (CA, U.S.A.), the upper part of the Miocene Monterey Formation is predominantly composed of organic-rich mudstone, which is interstratified with phosphatic laminae and lenses. Minor lithologies consist of dolomite, volcanic ash, porcelanite, chert and condensed phosphate. These sediments date from the end of the Serravallian and almost the entire Tortonian (11.05–7.85 Ma) based on calcareous nannofossils and the $\delta^{13}C_{org}$ record, which correlates well with the global record. Sediments have total organic-carbon values between 2.75 and 9.15 wt.% (average value = 6.48 wt.%; n = 61). Rock-Eval analyses show the dominance of type-II kerogen. The sediment accumulation rate varied between 5.9 and 84.7 m/Ma. Correspondingly, organic-carbon accumulation rates range between 0.08 and 1.43 g/cm^2/ky (average value = 0.48 g/cm^2/ky). Total phosphorus contents in the organic-rich mudstone vary between 0.001 and 3.48 wt.% and C_{org}/P_{org} ratios show high values of up to 4727 (average value = 2232), whereas C_{org}/P_{total} values are low (up to 185; average value = 52). This indicates that early diagenetic organic-matter degradation was a source of phosphate in phosphogenesis. In addition, other sources of phosphate were necessary in order to explain the abundance of phosphate relative to organic matter such as the transfer of dissolved inorganic phosphate into the sediments. Slumps, angular unconformities, erosive surfaces, reworked clasts and nodules, and condensed phosphatic layers suggest that hydrodynamic conditions were important and likely variable, leading to frequent erosion and sediment reworking. Under these circumstances, organic-matter was predominantly delivered during gravity-flow events, which were followed by longer periods of low sediment accumulation and phosphogenesis of the uppermost sediment layer. Associated pore occlusion by phosphate minerals may have considerably enhanced the preservation of organic-matter. During the early Late Miocene, a progressive change is observed from the mixed accumulation of organic, phosphate, biosilica and carbonate sediments, to the predominant accumulation of biosilica-rich sediments. This change is related to more intense upwelling, a shift of the upwelling center to the Californian coastline, and a leveling out of basin topography leading to a more even spread of biosilica.