Quantitative Biofacies Analysis of the Upper Cretaceous (Maastrichtian) Prince Creek Formation, North Slope, Alaska, USA

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Abstract

Coastal plain deposits of the Prince Creek Formation (PCF) offer a rare glimpse into an ancient, high-latitude, arctic ecosystem from the Late Cretaceous (Maastrichtian) greenhouse. We assess quantitatively the spatio-temporal variability between palynomorph assemblages of nine paleosol horizons from different PCF coastal plain sub-environments. Hierarchical cluster and ordination analyses, two multivariate statistical techniques, graphically demonstrate ecological differences among paleosols and explore underlying mechanisms governing the distribution of taxa along the coastal plain. The cluster analysis revealed five palynomorph biofacies (A-E) differentiated by variations in taxonomic composition and dominant taxa: fern and moss taxa such as Psilatriletes and Laevigatosporites dominate biofacies A and B; algae and exotic pollen including Sigmapollis and Aquilapollenites characterize biofacies C; algae, fern, and moss taxa such as Sigmapollis and Laevigatosporites comprise biofacies D; and the algae Botryococcus and Sigmapollis dominate biofacies E. Ordination results array samples along a primary gradient interpreted to be controlled by moisture level. Samples from lake and swamp margins, and the undifferentiated lower delta plain tend to present negative scores along ordination axis 1. These samples contain fern, moss, and algae taxa of biofacies A, B, and D, indicative of wetter paleoenvironmental conditions. Conversely, samples from crevasse splay, levee, and point bar deposits tend to present positive scores along ordination axis 1. These samples contain members of

biofacies C and E, a higher abundance of hinterland conifer taxa (bisaccate pollen) and suggest periodically dryer or upland conditions. The cluster and ordination analyses are consistent with results from integrated sedimentology, ichnology, paleopedology, geochemistry, and paleontology of the PCF that suggest that soil development and vegetation growth across the coastal plain were controlled by repeated wetting and drying by flashy, possibly seasonal river discharge, and catenary relationships involving variations in topography and drainage related to landscape position and the height of the water table. This research provides a more rigorous, quantitative methodology for assessing the role of paleoenvironmental conditions in controlling palynofacies variability and may provide an additional predictive tool for assessing paleo-location along any ancient coastal deposystem.