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The Carbonate Mud Mounds of the Lower Cretaceous Cupido Formation: An Unusual Occurrence of Microbial-Dominated Carbonate Buildups Cropping Out Remarkably in NE Mexico

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Traditionally, the Lower Cretaceous Cupido/Sligo carbonate system has been considered as a typical rimmed shelf both in the US Gulf Coast region and Mexico. However, detailed field work in superb exposures of the Cupido Formation in NE Mexico provided information on local variations of the depositional profile along its perimeter as occurs in modern carbonate platforms. The complete exposure, from base to top, of the Cupido Formation along approximately 6 km shows the platform-basin transition in the Bustamante Canyon, State of Nuevo León. The mapping of low-angle stratal geometries and vertical and lateral facies variations in the lower part of the Cupido Formation in that canyon indicate that this carbonate platform had a homoclinal ramp-type depositional profile. Numerous carbonate mud mounds dominated by microbial constituents and other metazoans, mainly sponges, occur throughout the deep ramp and decrease in number and characteristics toward the ramp crest. Based on stratigraphic distribution, morphologies, dimensions, and facies relationships of the carbonate mud mounds of the Cupido Formation can be grouped into four types: Type 1, siliceous sponge-microbial mud mounds; Type 2, sponge-microbial mud mounds; Type 3, sponge-microbial-coral mud mounds; and Type 4, skeletal-rich calcisponge-microbial-coral biodetrital mud mounds. Type 1 mounds are the oldest and more abundant microbial buildups developed along deep ramp lime mudstone facies. This type of mounds resembles outstandingly those Upper Jurassic microbial mounds well known in Europe. Type 2 mounds grew adjacent to outer-ramp packstone/wackestone facies. Type 3 mounds developed nearby to outer-ramp packstone facies. Whereas Type 4 biodetrital mud mounds grew within outer-ramp packstone and ramp-crest rudist-rich packstone facies. Siliceous sponges are an important component in Types 1 and 2 mounds. Calcisponges are common in Types 2, 3, and 4 mounds; whereas corals occur only in Types 3 and 4 mounds. Microbial components decrease systematically as mounds developed in shallower-water conditions. Encrusting organisms (agglutinating and serpulid worm tubes, bryozoans and foraminifers), sponge spicules, pelecypods, small benthic foraminifers, ostracodes, and echinoderm fragments are found in Types 1, 2, and 3 mounds. Larger benthic foraminifers and calcareous algae are common in Type 4 mounds. Shape of Types 1 and 2 mounds are commonly lenticular (bioherm) while Types 3 and 4 mounds show a tabular (biostrom) shape. Both the length and height of individual mounds range from a few to tens of meters indicating that they developed a significant topographic relief on the sea floor, mainly Types 1 and 2 mounds. Only biodetrital mounds reach several hundred meters in width and are up to 90 m thick. Additionally, some Type 1 mounds developed into larger-scale mound

complexes with shingled mound cores and complicated internal geometries. At least four mud-mound complexes were identified at Bustamante Canyon. These mound complexes are up to 100 m thick and are more than 200 m wide. Locally, the mounds are affected by deep-burial dolomitization, mainly Types 3 and 4 mounds. Other location where the microbial mud mounds were documented is Potrero Chico, State of Nuevo León.

The systematic change in size, shape, stratigraphic position, abundance, and fossil content of the Lower Cretaceous mud mounds was controlled primarily by the low-angle depositional profile that the Cupido Formation developed in NE Mexico. This allowed the establishment and development of numerous Type 1 siliceous sponge-microbial mud mounds in the deep part of the homoclinal ramp below the fair weather base level and probably above the storm wave base. Additionally, the large-scale variation en accommodation space and consequent progradation of the carbonate platform was other important control. As the carbonate mounds developed under shallower-water conditions their number decrease significantly with a simultaneous change in shape, size, and biogenic constituents. The excellent exposure of the Lower Cretaceous mud mounds at the Bustamante Canyon represents a handy outcrop analog of microbial mud mounds for understanding carbonate reservoirs associated with this kind of carbonate buildups.