Lithographic Facies Analysis of the Western End of La Loma, Murcia Province, Spain

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Introduction

The purpose of this study is to understand the sedimentologic facies on a ridge, informally called La Loma for our study. It is located about 2.2 km southeast of Abanilla in Murcia, Spain. Lithographic facies analysis was used to define facies and to aid in correlation of the rock layers along the ridge. Samples were collected in the field for thin-section point counts. The point-count data were analyzed by computer to interpret the depositional environments and to correlate lithologic facies. This information was used in conjunction with the stratigraphic column to provide the basis for reconstructing the sedimentologic history of the area.

Geologic and Geographic Setting

The Spanish geologic map of Fortuna, Spain (Fortuna 892) covers this area in the southeast of Spain where Miocene strata are exposed. Coordinates 38 degrees 11' 20" N, 1 degree 00' 40" W pass through La Loma in the Fortuna Basin. According to the geologic map, the ridge is composed entirely of gypsum. However, our fieldwork in June of 1989 showed the ridge to be composed of; calcareous marls, bioturbated sandstones, and conglomerates of quartz, limestone, and shale. Thin veins and clasts of gypsum were occasionally within the marls, and knolls were capped with discontinuous beds of coral reef.

The ridge trends northeast /southwest, parallel to the trend of the nearest mountain in the Betic Range, located about 1.5 km north. The ridge is asymmetrical with a steep slope on the northwest side and a gentle dip-slope on the southeast. Each side is cut by man-made terraces showing present and past agricultural use. There are 21 knolls along the ridge which range in elevation from 241 m in the southwest to 173 m at the northeast end with a general increase in knoll height to the southwest. Most of the knolls are capped with resistant layers of Porites and /or Tarbellastraea corals. Caliche- and rubble-covered surfaces made it difficult to find good exposures and to correlate beds between adjacent outcrops. Fortunately, the beds along the ridge are not folded and had a uniform strike of 070 degrees and dip of 15 degrees.

I concentrated my studies on the southwestern third of the ridge, bounded to the east by a recent roadcut through the ridge. The roadcut provided a continuous fresh section which started just above the basin floor and continued nearly to the ridge top. Good exposures are also present in a pit which was being actively excavated for a reservoir. Although there are fewer coral reefs in this area than are found to the northeast, the exposures of fluvial channels running parallel to the ridge are exceptionally preserved in the reservoir excavation.

Field Work

In June 1989, 260 meters of rock were measured within 15 stratigraphic sections. Seventy-two hand specimens were collected from the rock layers not covered by caliche or rubble. Bed thickness, continuity along strike, lenticular or wedge shapes, sedimentary structures, fossil components, and grain descriptions were recorded for each layer. We also attempted to walk out individual layers between adjacent sections and to correlate measured sections while in the field.

Laboratory Analysis

In the laboratory 31 thin sections were point counted to determine the composition of the units. Using a petrographic microscope, 600 points were counted on each thin section. Components which were counted include rock fragments (quartz, shale, sandstone, clay, and limestone), fossils (coral, mollusks, foraminifera, and wood), and interstitial material (sparite cement, pore space, and micrite matrix). On thin sections where the original micrite matrix was recrystallized into microspar, the microspar was counted with the matrix. In some instances the matrix contained pellets which were also counted with the matrix.

A numerical taxonomy computer program (NTSYS-pc) was used to cluster the variables and samples into meaningful groups (Rohlf, 1988). The analysis consisted of two parts, R-mode analysis in which the variables (rock fragments, fossils, and interstitial material) are clustered, and Q-mode analysis in which the samples are grouped together. In R-mode analysis the first step is to generate a matrix of correlation coefficients among the variables. Next, a dendrogram is formed by joining variables with high correlation coefficients into pairs, and pairs into successively larger clusters (Harbaugh and Merriam, 1968). In Q-mode analysis, the same general procedure is used to group samples. However, the distance coefficient is used in place of the correlation coefficient to generate the similarity coefficent matrix (Harbaugh and Merriam, 1968). A dendrogram was also produced to group together the stratigraphic units which contained similar rock, fossil, and interstitial components.

Discussion

The R-mode and Q-mode cluster analyses provided a basis for understanding the lithofacies and correlating the rock units. In the R-mode analysis, the thin section components were grouped into four major clusters: 1) sparite cement and interstitial porosity, 2) quartz, shale, clay, and sandstone particles, 3) limestone, corals, and mollusk fragments, and 4) micrite matrix, foraminifera, and wood (Figure 1). Sparite cement and high porosity are indicative of a high-energy environment where calcareous mud has been winnowed out leaving pore space between the grains. During diagenesis some of the pore space was filled in with sparry calcite cement. Quartz, shale, clay, and sandstone fragments represent ancient channels which cut across the subaerial exposed landscape and extended into the shallow-marine environment as deltas. Limestone, coral, and mollusk fragments may represent an ancient beach deposit in which organic material formed lag deposits in layers along the shore. Matrix, foraminifera, and wood may represent a near shore quiet water environment where plant matter and microfossils were deposited in calcareous mud.

In the Q-mode analysis, the dendrogram can be divided into two major groups, the upper group containing the quiet water facies and the lower group containing channel, beach, and high-energy environments (Figure 3). The quiet water facies can be subdivided into an upper group (Facies A) high in micrite matrix, foraminifera and woody fragments, and a lower group (Facies B) high only in micrite matrix. The bottom half of the dendrogram is characterized by high amounts of sparite cement and interstitial porosity. It can be subdivided into three clusters. The first cluster (Facies C) is high in quartz, shale, and sandstone fragments and represents channel environments. The second cluster (Facies D) is high in limestone, coral, and mollusk fragments, indicating carbonate beach environments. The third cluster (Facies E) is the highest in cement and porosity and also contains substantial amounts of quartz fragments. It was a quartz-sand beach.

The facies determined by the cluster analyses were plotted on the stratigraphic section to interpret the depositional history of the region (Figure 2). Facies A lies at the bottom of the stratigraphic section, indicating a period of lagoonal deposition. The lagoon is overlain by facies B, which represents a supratidal environment. Above is facies E. Facies D lies within Facies E, and indicates a beach environment with near-beach environments to either side. An unconformity is formed here where subaqueous channels of facies C downcut from above and are overlain by near shore subaqueous fan deposits also of facies C. The subaqueous fans are interbedded with facies E, sands which have been carried with the channels. This interbedded sequence shows a transgression.

Uplift and erosion occurred before the formation of an unconformity. Facies C is deposited along the southeast side and represents a subaerially exposed channel which ran roughly parallel to the reef, cutting off layers of older, continuous strata.

Conclusions

Point-count data were analyzed with both R-mode analysis, which grouped thin-section components, and Q-mode analysis, which grouped rock samples into facies. In conjunction with the stratigraphic column, we used this information to interpret the sedimentologic history. The strata records a transgression, uplift and erosion, and the deposition of a major channel which produced an unconformity.

References Cited

Harbaugh, John W. and Merriam, Daniel F., 1968, Computer Applications in Stratigraphic Analysis, John Wiley & Sons, Inc., New York, 282p.

Rohlf, F. James, 1988, NTSYS-pc Numerical Taxonomy and Multivariate Analysis System, version 1.40, Exeter Publishing, Ltd., New York.

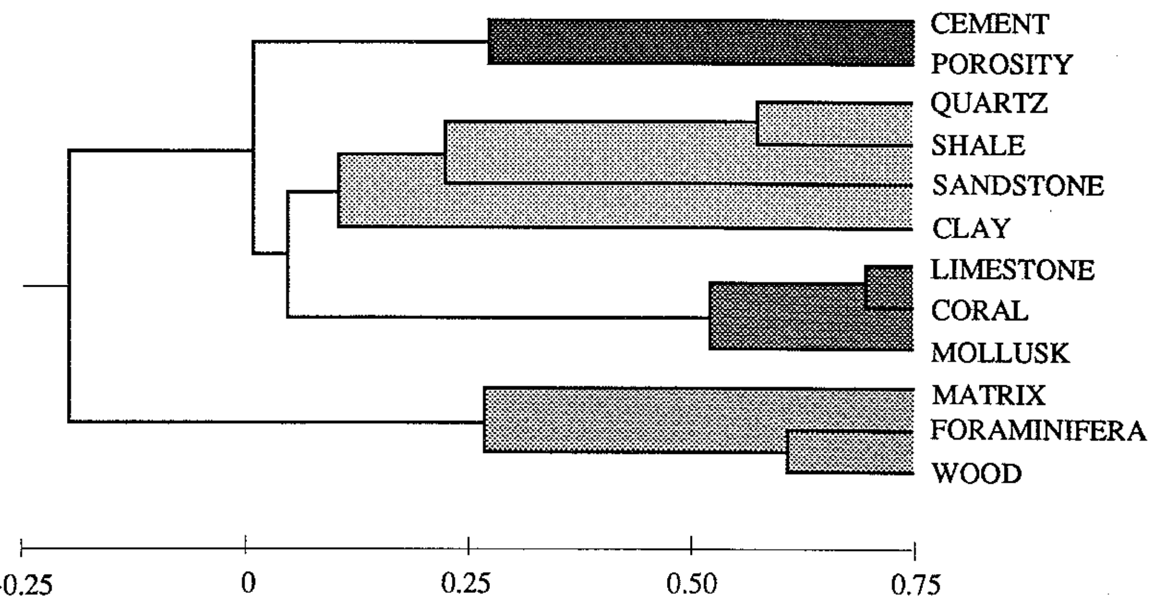

Figure 1
R-mode Analysis Dendrogram

Thin section components are listed on the vertical axis. Numeric scale represents correlation coefficient, with a value of one as the highest degree of correlation.

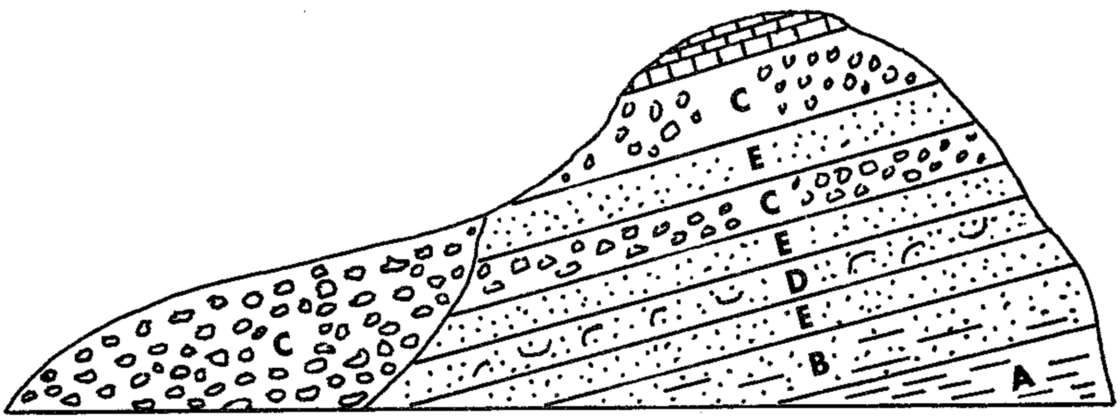

Figure 2
Generalized Cross Section through the Ridge
Letters represent lithofacies in figure 3.

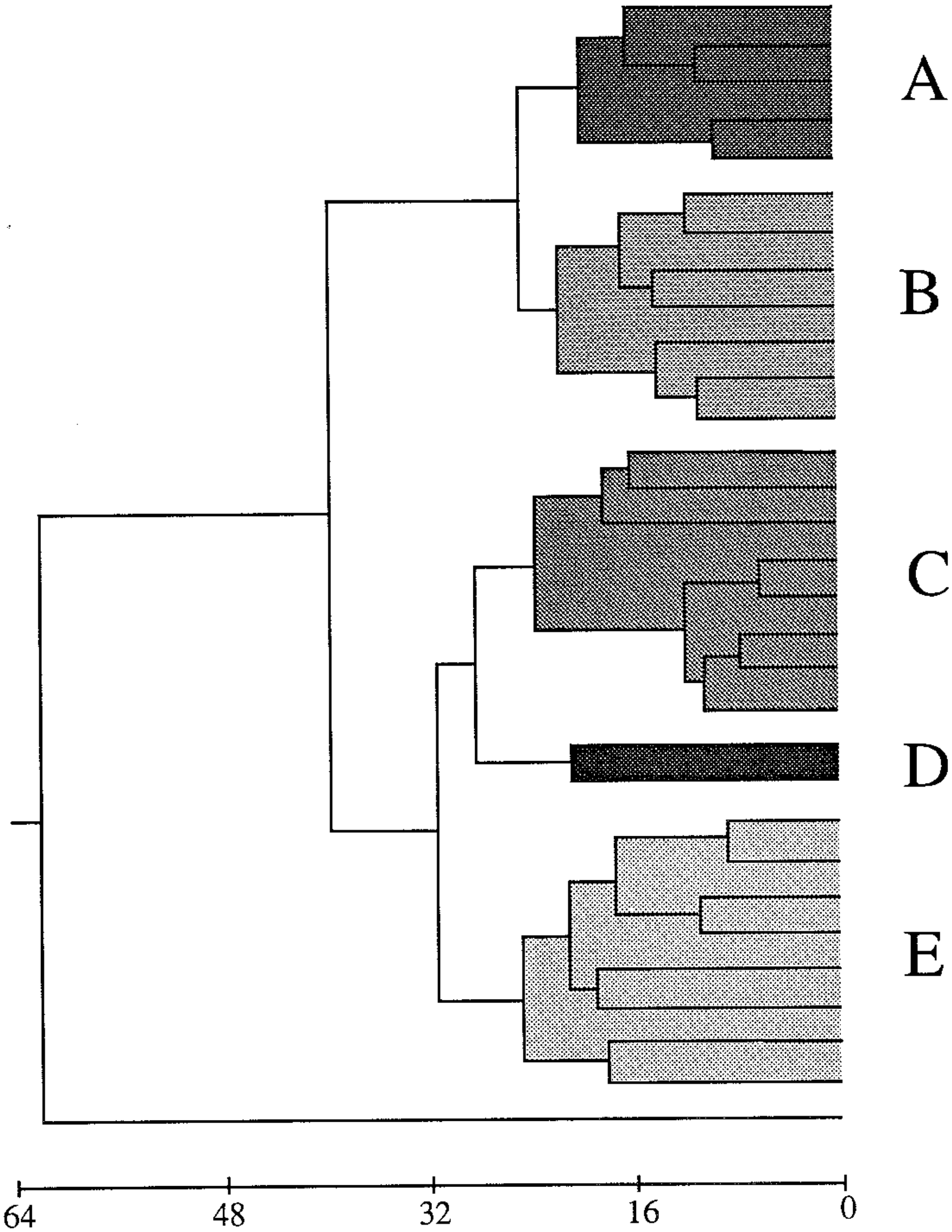

Figure 3

Q-mode Analysis Dendrogram

A through E represent facies. Numeric scale represents distance coefficient, with a low distance representing similar samples.