New Mexico Geological Society

Downloaded from: https://nmgs.nmt.edu/publications/guidebooks/19

Character of part of the Hermosa Formation (Pennsylvanian), San Juan Mountains, Colorado

W. Arch Girdley

1968, pp. 150-158. https://doi.org/10.56577/FFC-19.150

in:

San Juan, San Miguel, La Plata Region (New Mexico and Colorado), Shomaker, J. W.; [ed.], New Mexico Geological Society 19th Annual Fall Field Conference Guidebook, 212 p. https://doi.org/10.56577/FFC-19

This is one of many related papers that were included in the 1968 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual Fall Field Conference that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

CHARACTER OF PART OF THE HERMOSA FORMATION (PENNSYLVANIAN), SAN JUAN MOUNTAINS, COLORADO

By

W. Arch Girdley
Indiana State University, Terre Haute, Indiana

INTRODUCTION

The Hermosa Formation in the southwestern San Juan Mountains is an exposed portion of the southeastern shelf sediments of the Paradox basin and consists of a thick sequence of alternating carbonate and terrigenous detrital strata. Repetition of alternating sandstones, siltstones, and limestones through a thickness of nearly 2000 feet is suggestive of cyclic deposition which characterizes Pennsylvanian strata in many parts of North America.

The investigation on which this paper is based deals with a selected thin interval of the Hermosa Formation exposed in the vicinity of Molas Pass and adjacent areas including the northern end of the Hermosa Cliffs (Fig. 1). the original study was undertaken to determine, insofar as possible, the nature of the conditions of deposition of the repetitive detrital-carbonate sequence—especially the nature and origin of some of the limestones.

It is the purpose of this paper merely to describe some of the general characteristics and features of the interval studied and to summarize conclusions as to the environment of deposition based upon field and laboratory study of the rock types.

LOCATION

The strata investigated are exposed along a generally northeast-southwest trend beginning near Molas Lake (Figs. 1 and 2) and extending southward into the Hermosa Cliffs escarpment. The principal outcrops occur on either side of Highway 550, and exposures are especially prominent and readily accessible west of the highway at Little Molas Lake and along Lime Creek (See Fig. 3) where they can be traced nearly continuously. Several excellent exposures also occur between Andrews Lake and Highway 550 (Fig. 4).

INTERVAL STUDIED

Several excellent descriptions of the regional stratigraphic framework of the Pennsylvanian System of the Paradox basin and vicinity have appeared in the literature, and the interested reader is referred to papers by Wengerd and associates (1954, 1958, 1962), Clair (1958), Ohlen and McIntyre (1965), and especially Baars *et al.* (1967) for summaries of the stratigraphic nomenclature. Rock-stratigraphic terms commonly used for Pennsylvanian rocks in the Paradox basin are those recognized by Wengerd and Matheny (1958, p. 2056) at Hermosa Mountain north of Durango, Colorado and include:

- Hermosa Group:
  - Honaker Trail Formation
  - Paradox Formation
- Pinkerton Trail Formation
- Molas Formation

These subdivisions are recognizable principally because of the presence of evaporites in the Paradox Formation; but since the Molas Pass region lies beyond the limit of evaporite deposition where the individual formations become indistinguishable, use of the term "Hermosa Formation undifferentiated" as suggested by Baars *et al.* (1967) is more appropriate. It is in this sense that "Hermosa Formation" is used in this report.

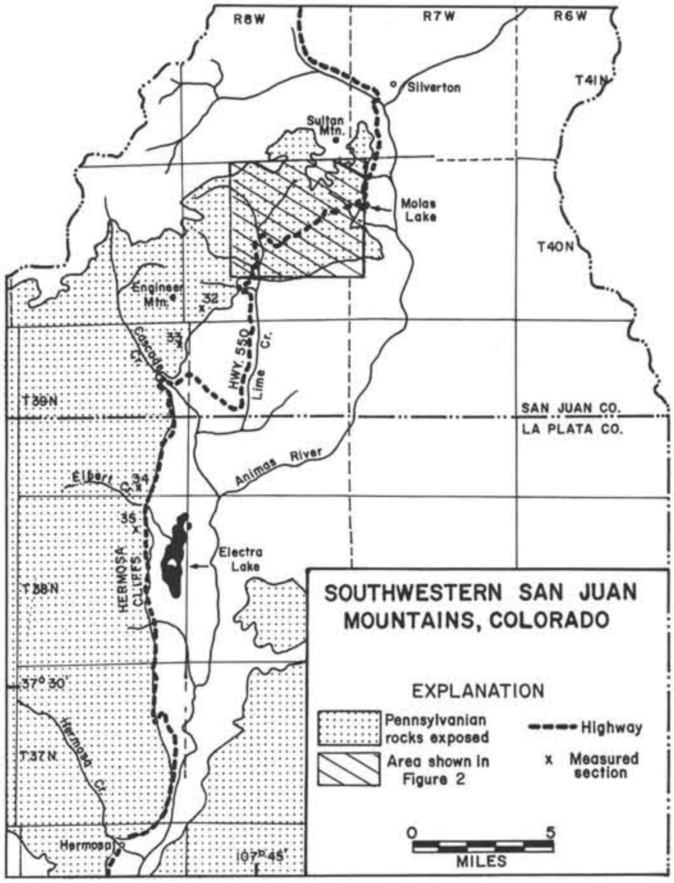

FIGURE 1.
Index map to southwestern San Juan Mountains. Area covered in this report is chiefly that shown by diagonal ruling.

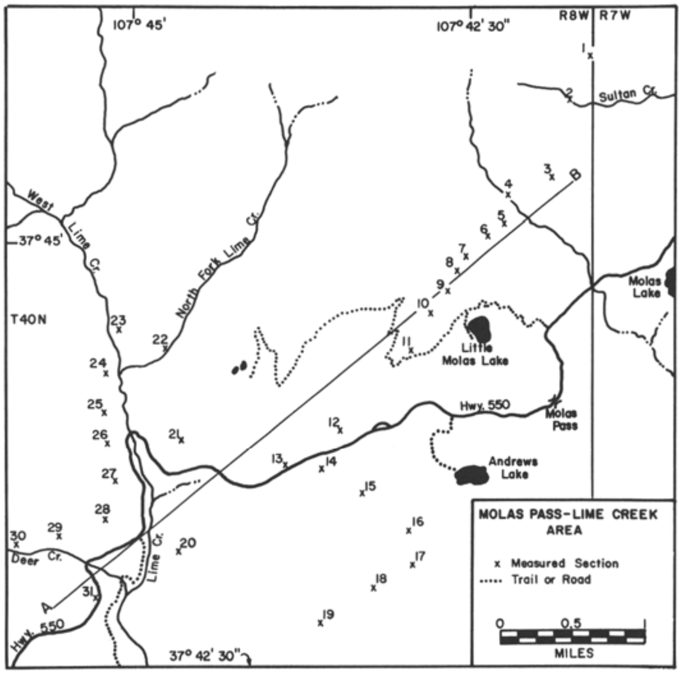

FIGURE 2.
Index to measured sections in the Molas Pass-Lime Creek area.

In physical aspect the rocks studied are like those assigned to the Honaker Trail Formation at Hermosa Mountain (Wengerd and Matheny, 1958, p. 2075). However, as indicated by an excellent microfauna they are early Desmoinesian in age and are correlative with part of the Paradox Formation. It is probable that they are equivalent to rocks contained in what Baars *et al.* (1967) term the "Akah Substage" and may occur stratigraphically as high as the lower part of the Desert Creek Substage.

FIGURE 3.
Exposure of interval studied in west valley wall of Lime Creek above prominent hairpin turn in Highway 550 (locality 25). This section contains well developed arkosic sandstone between limestones B (lower, thick resistant unit) and D (upper light-colored resistant unit).

FIGURE 4.
Locality 20 viewed from Highway 550 looking eastward across Lime Creek toward Andrews Lake. Limestones B and D are the two prominent resistant layers across middle of photo.

An excellent section of the Hermosa Formation is exposed west of and above Coalbank Pass on Highway 550 at Engineer Mountain (Fig. 1, locality 32; and Fig. 5) . Most or all of the visible sequence is Desmoinesian in age (Ohlen and McIntyre, 1965, p. 2030), and the interval to which detailed attention has been given (Fig. 5) probably belongs to the upper part of the Lower Desmoinesian Series as indicated by fusulinids. The interval studied consists of several limestones with intervening arkosic sandstones and siltstones. Limestones are assigned letter designations as indicated, although the lowermost one (Unit A) is not present at this locality. The interval shown is readily traceable over the Molas Pass-Lime Creek area which constitutes the principal area described here.

CHARACTERISTICS OF LIMESTONES

Limestones within the interval investigated contain two principal constituents: skeletal and pelletal grains and lime-mud matrix. Sparry calcite cement is locally present in minor quantities, and otilites are found in only one local situation. The principal differences between and within the limestones lie in the changing character of the skeletal components and in the grain/matrix ratio.

Of the four limestones indicated in Figure 5 only Units A, B, and D are well exposed. A close similarity in extent and in constituent distribution exists between Units B and D; and although descriptions given here are chiefly for Unit B, they will suffice equally well for D. Unit C is so poorly exposed that it could not be properly examined and thus is neglected here.

UNIT A

The most distinguishing characteristic of the lowermost limestone in the interval is the abundance of the colonial coral Chaetetes milleporaceus. Abundant coralla of this typical Pennsylvanian form constitute the basic framework of this unit. Most of the coralla are in growth position (Fig.

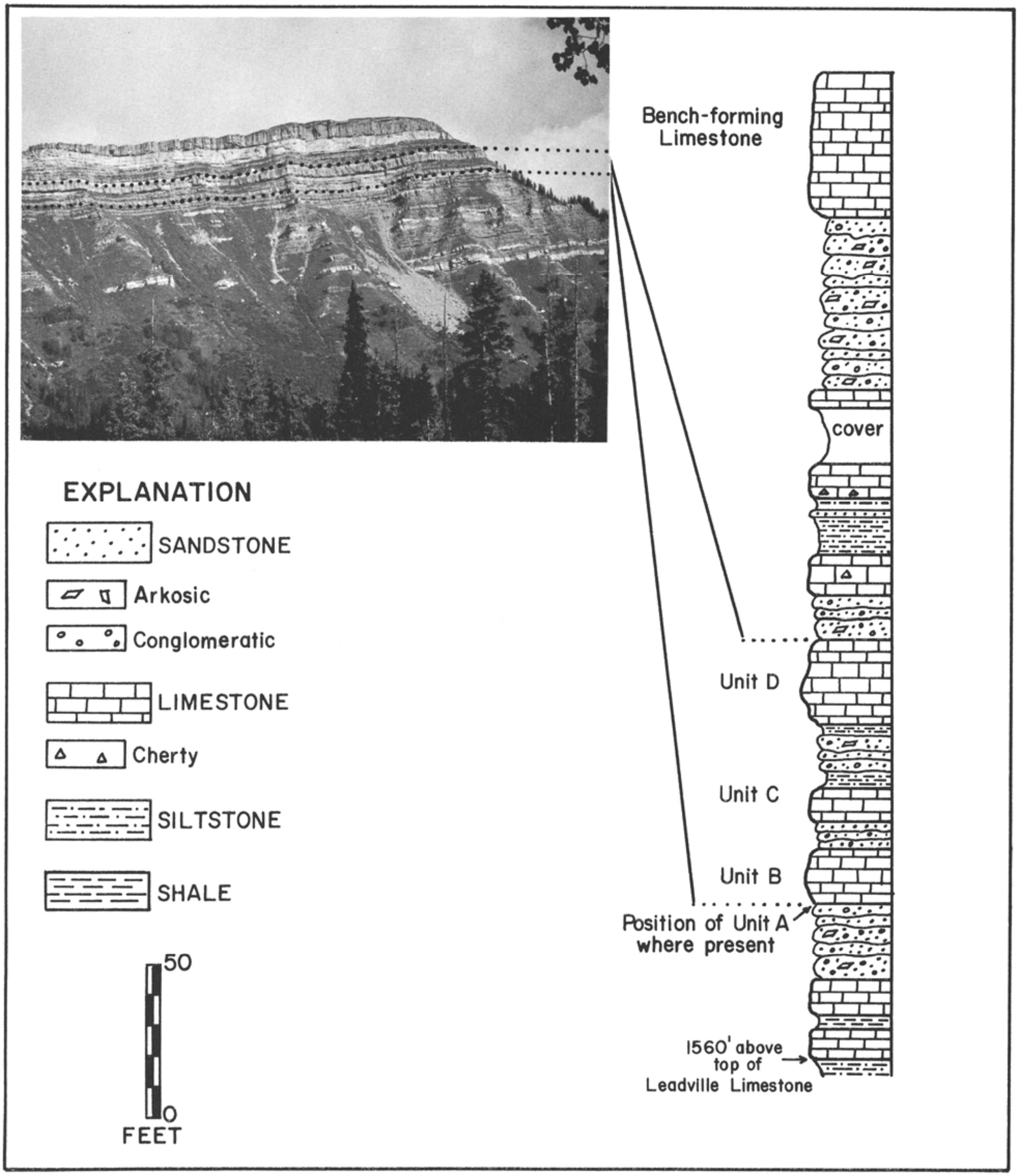

FIGURE 5.
Section exposed above Coalbank Pass (Engineer Mountain section, locality 32 in Fig. 1) indicating interval investigated.

FIGURE 6.
Chaetetes biostrome exposed between localities 12 and 13. Note large corallum near bottom center (arrow). Nodular brachiopod-bearing zone at base of Unit B is immediately above scale.

6) and commonly there is vertical accretion of several superimposed coralla which develops a 2-4 feet thick biostromal layer. The coralla are encompassed in and overlain by fossiliferous lime-mud (biomicrite).

This unit is well developed throughout most of the area shown in Figure 2 but gradually disappears near the extreme south portion and thus is absent at Engineer Mountain. In the Molas Pass-Lime Creek area it is underlain by arkosic sandstone and is overlain by maroon-and-green siltstone which forms a wedge (thinning toward the south) that separates Units A and B.

This *Chaetetes* biostrome can be traced as far north as Sultan Creek (Fig. 2), although its maximum thickness does not exceed five feet. Such thin coralline biostromes are present at other levels of the Hermosa Formation in this region and have been reported in rocks of similar character and age on the southwestern shelf of the Paradox basin (Ohlen and McIntyre, 1965, p. 2030).

At the time of deposition *Chaetetes* coralla must have formed a carpet on the shelf bottom which was covered by clear, shallow water of normal salinity. The fine-grained carbonate-mud now filling interstices between coralla was probably produced *in situ* by biological processes. No substantial wave and current action is indicated as skeletal remains are not abraded, and strong winnowing action would have selectively removed the lime-mud from around fixed corals. Production of lime-mud was initially very slow as indicated by the abundant corals in the lower 3-4 feet and the confinement of mud to only the relatively small spaces between coralla. However, the absence of corals in the upper one foot and their apparent replacement by matrix-like micrite similar to that occurring between corals below suggest that the rate of production of fine material accelerated to a level in which the corals were literally smothered.

Units B and D

The most interesting limestones from the standpoint of lithologic variation are Units B and D. Both are a complex of varying carbonate types dominated by an abundance of lime-mud and skeletal grains. The most obvious differences within either of these units occur in a vertical sense and consist of bedding changes. The basal few feet, for instance, exhibit highly irregular, nodular bedding (Figs. 6 and 7). This changes gradually upward to a massive-appearing aspect, although a hint of rude, thin bedding persists (Fig. 7). This massive zone is overlain by carbonate material of varying thickness and bedding characteristics.

Lithologic variations identified in Unit B are depicted schematically in Figure 8. Many of these are recognized only after study of thin sections and are not readily identifiable by bedding and textural characteristics seen at the outcrop.

The basal nodular portion of the limestone forms a recessed zone below the massive part (Fig. 7) and is characterized by an abundant brachiopod fauna including especially such genera as *Composita* and *Phricodothyris*. A productid brachiopod, *Antiquatonia*, is locally present, and spines are

FIGURE 7.
Exposure of limestone B at locality 12 above and west of rest stop turnout off Highway 550. This section illustrates the massive nature of the *Komia*-dominated zone. Nodular, smooth-shelled brachiopod zone is in recess near base. *Chaetetes* biostrome is immediately below recess.

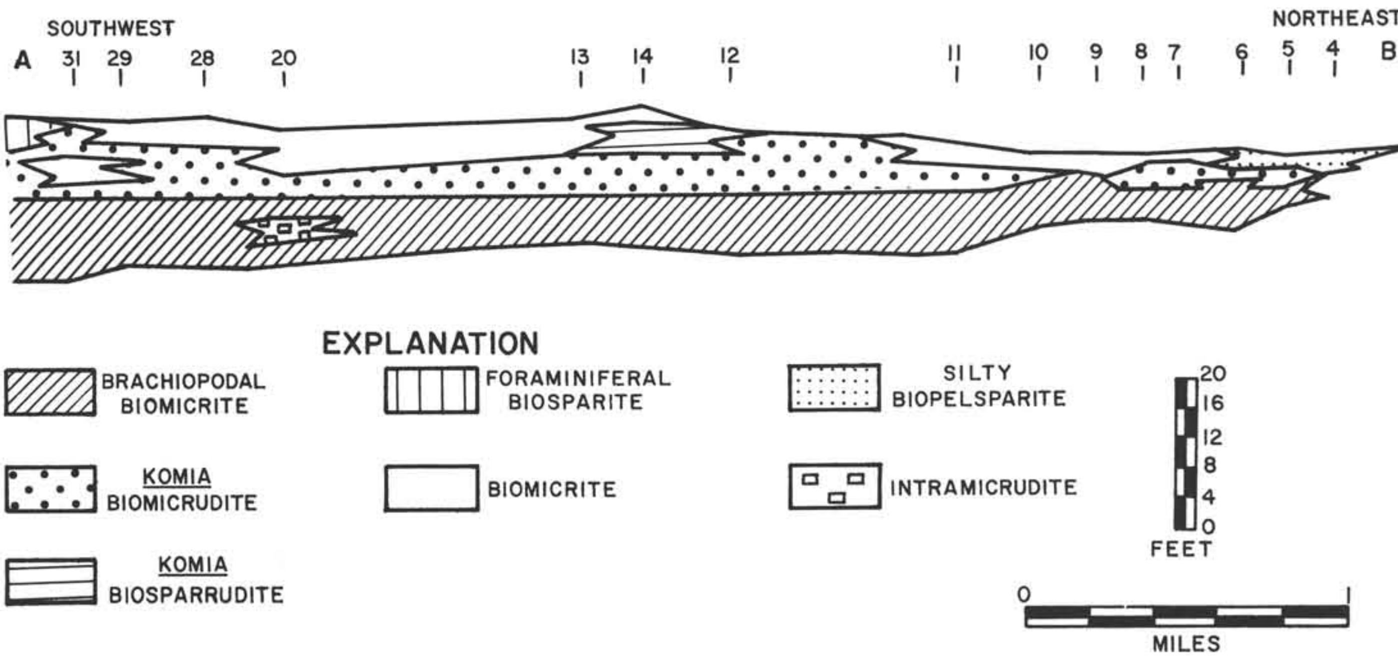

FIGURE 8.

Schematic cross section showing lithologic variations common in limestones B and D. Line of profile is indicated in Figure 2. Sections are projected to line of profile.

commonly numerous even where shell casts are absent. The matrix of this basal zone is dense, fossiliferous micrite (Fig. 9A). In one location (section 15) numerous phylloid algae (Fig. 9B), similar to those which comprise reservoir rock in the Four Corners region, were found to occur about six feet above the base of the nodular zone. Burrowing effects are common throughout.

The medial portion of the limestone forms a massive appearing bulge (Fig. 7) which overhangs the nodular brachiopod-bearing micrite. This zone is characterized by a prolific amount of *Komia* (Figs. 9C and 9D), which has been called a problematical red algae by Johnson (1961, p. 86), but which more recently has been assigned to the Stromatoporoidea by Wilson, Waines, and Coogan (1963). The matrix is mostly micrite (Fig. 9C), although sparry calcite appears locally (Fig. 9D). Several fossil types including crinoids, Foraminifera, and brachiopods appear throughout the limestone, but there is a decrease in these where *Komia* is abundant.

Locally the *Komia*-bearing zone increases in thickness which suggests rude mounding (see schematic cross section and Fig. 7). One such thickening occurs where the beds cross Highway 550 at locality 13. This zone has been interpreted as a biogenetic bank constructed by the prolific contribution of *Komia* twigs to the sediment. The *Komia*-bearing interval is mostly biostromal in character elsewhere. The occurrence of sparry calcite cement around *Komia* on the southwestern margin of the thickened intervals (Fig. 9D) may indicate the more active seaward margin of banks. Near the top of a mound-like buildup exposed on Deer Creek (locality 30) there is a pronounced increase in pelagic and encrusting Foraminifera which suggests that sea level rise may have become too rapid for bank-type growth to keep pace. Such biogenetic banks were thus killed off by "drowning."

Over the tops of and between the thickened *Komia*-bearing zones occurs a dense carbonate-mud which shows effects of extreme disturbance by burrowing organisms (Fig. 9E). This disturbed micrite formed in the deeper, quieter water adjacent to the low banks where burrowing organisms flourished but eventually spread over the banks as water deepened with rise in sea level.

Both Units B and D can be traced to zero-edges where they show signs of having formed in a more active environment than elsewhere. The northern margin of Unit B consists of a silty and sandy limestone (biopelsparite) with numerous Foraminifera and thick-shelled mollusks (Fig. 9G), but it grades rapidly to terrigenous detrital lithology a short distance northeastward. The northernmost margin of Unit D contains replaced oölites (Fig. 9H) and exhibits cross stratification which attest to the relatively higher energy conditions present in a near-shore zone above wave base.

Both major limestones are traceable into the Hermosa Cliffs as far south as Elbert Creek (locality 34, Fig. 1), but they are indistinguishable farther south where they apparently change to basinal dolomites. Both formed in very shallow water, although very little or no current activity existed as demonstrated by the dominance of lime-mud and by the lack of primary current structures. The common presence of phylloid algae, and especially the prolific abundance of *Komia* (assuming *Komia* may also be an alga), demonstrates a shallow water environment with good sunlight penetration.

TERRIGENOUS DETRITAL STRATA

Material intervening between the limestones consists of terrigenous detrital rocks which are not generally well exposed in areas where they are also readily accessible. Excellent exposures are in the eastern face of the Hermosa Cliffs, but they are inaccessible by normal methods. The detrital strata are poorly exposed in the Molas Pass-Lime Creek area except locally in roadcuts and ravines. Thus, they have not been examined as thoroughly as the alternating limestones.

Intervening between the *Chaetetes* biostrome and the next limestone above (Unit B) is a wedge of maroon-and-green siltstone which is highly micaceous and which thins to a zero-edge between Little Molas Lake and Deer Creek. South of this wedge-out Unit B rests directly on the Chaete*tes* biostrome until the latter also disappears. The micaceous siltstone thickens northward where it extends an unknown distance. Near the northernmost extent to which the siltstone was traced it was found to contain polygonal desiccation cracks, worm trails, ripple marks, and fragments of the plant Calamites which probably represent either a deltaic or perhaps intertidal environment.

Separating limestones B and D is a thick (50-80 feet), very irregular wedge of siltstone, similar to that described above, with an arkosic sandstone well developed in the upper half (Figs. 3 and 10). This sandstone is nearly identical with those found throughout most of the Hermosa Formation of this region and is characterized by being coarse, poorly sorted, conglomeratic, and without noticeable vertical size gradation. Angular to subrounded pink feldspar grains and granite pebbles occur sporadically throughout any particular arkosic unit. Cross stratification and lenticularity are highly characteristic; and although current directions indicated by foreset beds are variable, they all show strong southwest components (Fig. 10) which suggests a paleoslope rising toward what is now the Uncompahgre plateau.

At locality 13 the clastic zone below the Chaetetes biostrome is exposed where the strata cross Highway 550. It consists of a thick, massive, cross-stratified arkose exhibiting cut-and-fill at its lower contact with maroon mudstone suggestive of fluvial deposition. In a few places local lenses of light-and-dark laminae were observed within the generally coarse sandstone and micaceous siltstone intervening between limestones B and D. These probably represent varve-like deposits formed in local ponds on an otherwise alluvial plain formed of arkosic sand and micaceous silt.

At locality 31 all units in the interval are exposed in a roadcut, and a very thin coaly stringer occurs within the detrital zone between limestones B and D indicating that temporary swamp conditions occurred.

CONCLUSIONS

While the limestones were forming, the southeastern shelf of the Paradox basin was covered by very shallow water of normal salinity as suggested by the abundant biota. The benthonic biota is *in* situ as demonstrated by its intimate association with lime-mud which would have selectively by-passed the larger skeletal grains had both been current transported. The limestones are thus believed to be principally products of prolific biologic activity which created in *situ* biostromal and locally biohermal accumulations.

The most pronounced difference within the two prominent limestones (B and D) is related to the restriction of Komia to certain zones. Komia contributed abundant twig-like skeletal fragments when sea level rise was slow enough for upward growth to keep pace. This resulted in the biostromal and biohermal geometry that developed as relatively rapid carbonate buildups in only a few feet of water. Presence of lime-mud matrix and some mud-supported texture demonstrate that quiet, though probably very shallow, waters covered the area. The Komia buildups are believed to have been "drowned" as suggested by their relatively abrupt disappearance upward and their replacement by either foraminiferal-rich or highly reworked lime-mud sediment.

Repetition of similar conditions indicated by the close similarity in Units B and D is in accord with the cyclic character of Pennsylvanian rocks throughout the continent. Cyclic deposition in the Paradox basin is described in numerous papers notable among which are those by Ohlen and McIntyre (1965) and Peterson (1966). The latter (1966, p. 2077) related the orderly repetition observed in the Paradox Formation of the southwestern shelf principally to eustatic sea level changes. Such sea level alternations may have been in turn related to glaciation in the southern hemisphere as suggested by Wanless and Merrill (1951) concerning the Pennsylvanian cyclic nature in the southwestern United States. The conditions of sedimentation on the southeastern shelf appear to have been more complex as evidenced by the numerous clastic wedges which separate carbonates, and tectonic influnce of sediment supply and basin subsidence may be superimposed on a simple eustatic sea level change.

Although very few exposures occur where one can examine the contact between limestones and associated terrigenous detrital strata, there nevertheless is a fairly consistent relation shown. The basal few inches of the carbonates are generally silty or sandy and contain more numerous Foraminifera including both fusulines and encrusting forms. This suggests gradual transition from elastic to carbonate accumulation. At the top of the limestones, however, the contact with overlying arkosic sandstone is very distinct and even and suggests temporary emergence with possible accompanying sub-aerial erosion.

More work is necessary to determine the geometry and detailed internal characteristics of individual terrigenous detrital strata intervening between limestones. Insufficient attention was given to these rocks to allow confident conclusions as to their exact origin. However, based on their observed contact relations with the limestones investigated and on their superficial characteristics the writer suggests the following:

1. Clastic wedges accumulated chiefly as rapid-fill detritus along or slightly landward of the southeastern margin of the basin. Based on characteristics of the terrigenous materials already described including lenticularity, poor sorting, immaturity, and lack of fossils in the

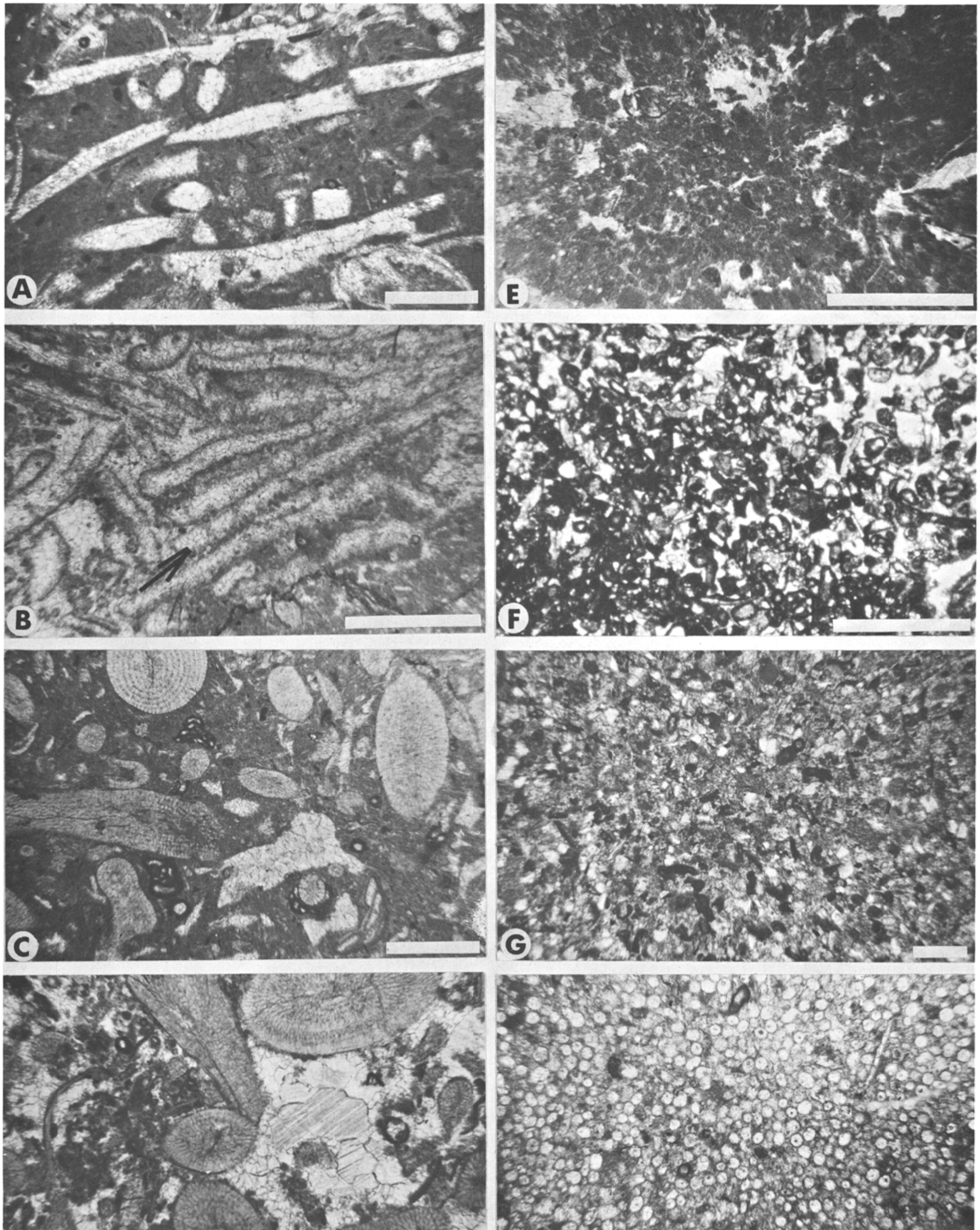
A
E
B
F
C
G
D
H

FIGURE 10.
Coarse arkosic sandstone occurring between limestones B and D and typical of those throughout Hermosa Formation. Cross stratification indicates transport from northeast (right). Locality 26.

sandstones it is suggested that the basin margin was emergent between times of lime accumulation. An alternate possibility is that the elastics were periodically flushed into the basin too rapidly to be sorted and thus smothered the marine lime-producing organisms.

2. During carbonate accumulation sea level had risen sufficiently to inundate the shelf which was then relatively free of detritus except for minor silt grains. Carbonate materials were produced by the prolific biologic activity in the warm, quiet, very shallow waters which covered the broad shelf. Wave and current activity was negligible and only slight, infrequent winnowing affected the back shelf.
3. Lowering of sea level or westward regression caused by rapid influx of elastics brought cessation to lime deposition. Shifting distributary patterns may account for the lenticularity of sandstone interbeds separating the limestones.
4. Rising sea level shifted the shoreline northeastward again. Only minor depletion of sediment supply is indicated, as the elastic material is relatively coarse throughout its thickness except for a thin (six inches) zone at the extreme top. Thus the waning period of terrigenous supply is transitional to carbonate sedimentation. The topmost few inches of the elastic zone is better sorted and is calcareous, and thus demonstrates that with rising sea level the topmost layer of elastics became awash due to position above wave hace

FIGURE 9.
Photomicrographs illustrating limestone lithologic variations on which some of the subdivisions depicted in Figure 8 are based. White bar scales each represent one millimeter. A. Brachiopodal micrite common in basal few feet of limestones B and D. Tabular skeletal fragments (light) are probably recrystallized phylloid algae; B. Phylloid algae found in basal few feet of limestone B at locality 15. Partly preserved wall structure in one larger fragment (arrow) indicates it is probably Ivanovia; C. Typical association of skeletal grains and carbonate-mud (micrite) in Komia biomicrudite. Excellent cross section of Komia near upper left; black fragments are tubular and encrusting Foraminifera; foraminifer Tetrataxis left of bar scale; spar-filled burrow at lower center; D. Komia-bearing zone dominated by sparry calcite cement. Note pelleted nature of remaining lime-mud matrix; E. Badly disturbed, sparsely fossiliferous micrite lithology typical of uppermost zone of limestone B. Material reworked by burrowing organisms; F. Foraminiferal biosparite at top of thickened Komia-bearing zone at locality 30 indicating slightly higher energy conditions. Note good sorting due partly to original size and partly to winnowing activity; G. Silty and sandy fossiliferous limestone (silty biopelsparite) characterizing northernmost edge of limestone B. Quartz and feldspar (white); Foraminifera (black); rest is fine crystalline calcite; H. Recrystallized oblites occurring at northernmost limit of limestone D.

The conclusions stated here are simplified considerably, as there probably were many minor fluctuations both in sea level and in accompanying tectonic activity as suggested by the complexity of the strata. Nevertheless, based on the observations possible in the few accessible exposures it is believed that these conclusions are reasonable or at least may serve as working hypotheses which should guide further work with this interesting stratigraphic interval.

ACKNOWLEDGMENTS

I wish to thank Donald L. Baars for suggesting the investigation on which this paper is based. My thanks to Tracy Vallier and Donald Owen for offering helpful criticisms of the manuscript. Mr. L. D. Holcomb of the Shell Oil Company was kind enough to identify some of the microfossils.

REFERENCES

Baars, D. L., Parker, J. W., and Chronic, J., 1967, Revised stratigraphic nomenclature of Pennsylvanian System, Paradox basin: Am. Assoc. Petroleum Geologists Bull., v. 51, no. 3, p. 393-403.

Clair, J. R., 1958, Subsurface stratigraphy of the Pennsylvanian of the Paradox Basin *in* Symposium on Pennsylvanian rocks of Colorado and adjacent areas: Rocky Mtn. Assoc. Geologists 10th Ann. Field Conf. Guidebook, p. 31-46.

Cross, Whitman, 1899, Telluride folio: U. S. Geol. Survey Geol. Atlas, Folio 57.

Folk, R. L., 1959, Practical petrographic classification of limestones: Am. Assoc. Petroleum Geologists Bull., v. 43, no. 1, p. 1-38.

Johnson, J. H., 1961, Limestone-building algae and algal limestones: Colo. School of Mines Publication, 297 p.

Ohlen, H. R., and McIntyre, L. B., 1965, Stratigraphy and tectonic features of Paradox basin, Four Corners area: Am. Assoc. Petroleum Geologists Bull., v. 49, p. 2020-2040.

Peterson, J. A., 1966, Stratigraphic vs. structural controls on carbonate-mound hydrocarbon accumulation, Aneth area, Paradox basin: Am. Assoc. Petroleum Geologists Bull., v. 50, no. 10, p. 2068-2081.

Wanless, H. R., and Merrill, W. M., 1951, Evidence of eustatic change in sea level in the Pennsylvanian of the southwestern United States (abst.) : Geol. Soc. America Bull., v. 62, no. 12, p. 1487.

Wengerd, S. A., 1962, Pennsylvanian sedimentation in Paradox basin, Four Corners region in Pennsylvanian System in the United States: Am. Assoc. Petroleum Geologists symposium, Tulsa, Okla., p. 264-330.

, and Strickland, J. W., 1954, Pennsylvanian stratigraphy of the Paradox salt basin, Four Corners region, Colorado and Utah: Am. Assoc. Petroleum Geologists Bull., v. 38, no. 10, p. 2157-2199.

, and Matheny, M. C., 1958, Pennsylvanian System of Four Corners region: Am. Assoc. Petroleum Geologists Bull., v. 42, no. 9, p. 2048-2106.

Wilson, E. C., Waines, R. H., and Coogan, A. H., 1963, A new species of Komia Korde and the systematic position of the genus: Paleontology, v. 6, pt. 2, p. 246-253.