(Fig. 12-D). A sharp contact with the overlying Clark Reservation Member ends the cycle. The distinctive Clark Reservation lithology is a uniform biopeloosparite with ostracode, brachiopod, and bivalve fragments (Fig. 12-E).

Both of these Perryville cycles closely resemble Pillara Formation cycles which contain stromatoporoid-rich subtidal deposits grading upward to intertidal/supratidal cryptalgal laminites (Fig. 6). Cycle B begins at the transgressive surface separating underlying cryptalgal laminites and continues to within the upper intertidal zone to another transgressive surface (Fig. 10). Subtidal deposits in Cycle B (Fig. 11-B) closely resemble the stromatoporoid-dominated lower subtidal packstones and wackestones in Pillara Formation cycles. The overlying crenulated, well-preserved, dolomitic cryptalgal laminites (Fig. 11-C) are interpreted as representing deposition in the upper intertidal zone (Compare with Lyell and Baumann Fiord Formation cycles, Fig. 6). Both of the subtidal and intertidal deposits in Cycle C (Figs. 12-B & C) closely resemble those in Cycle B. However, unlike any other Elmwood cycle studied in detail, the uppermost lithology in Cycle C (Fig. 12-D) represents a middle to upper supratidal environment similar to the intraclast pavements and breccias of the supratidal zone at Shark Bay (Fig. 5).

Munnsville (Cycle D)

In contrast to Cycles A to C, Cycle D at Munnsville Quarry (Fig. 13) consists predominately of a very thick sequence of dolomitic cryptalgal laminites. Beneath the sharp contact at the cycle base, well-sorted, dolomitic laminites (Fig. 14-A) form the top of the underlying cycle. The lower two feet of Cycle D consist of bioturbated, intraclastic biosparites containing impunctate brachiopods, bryozoans, crinoid stems, stromatoporoids, and an abundance of dasycladacean algae (Fig. 14-B). Overlying this lithology both smooth and crenulated dolomitic cryptalgal laminites (Fig. 14-C) containing vertical burrow traces in the upper portions (Fig. 14-D) comprise the remaining five feet of the cycle. A sharp contact terminates Cycle D (Fig. 13), and fossiliferous fine calcarenites form the base of the overlying cycle (Fig. 14-E).

An environmental sequence from restricted subtidal to lower supratidal is attributed to this cycle. The subtidal zone is recognized by the thin (≈2 feet) biosparite at the cycle base. The first appearance of dolomitic cryptalgal laminites marks the lower intertidal zone similar to the Trucial Coast and Shark Bay sequences (Fig. 6). The upper intertidal zone is represented by the vertically burrowed horizon near the cycle top, and the upper foot of poorly-preserved laminites represents the lower supratidal zone.

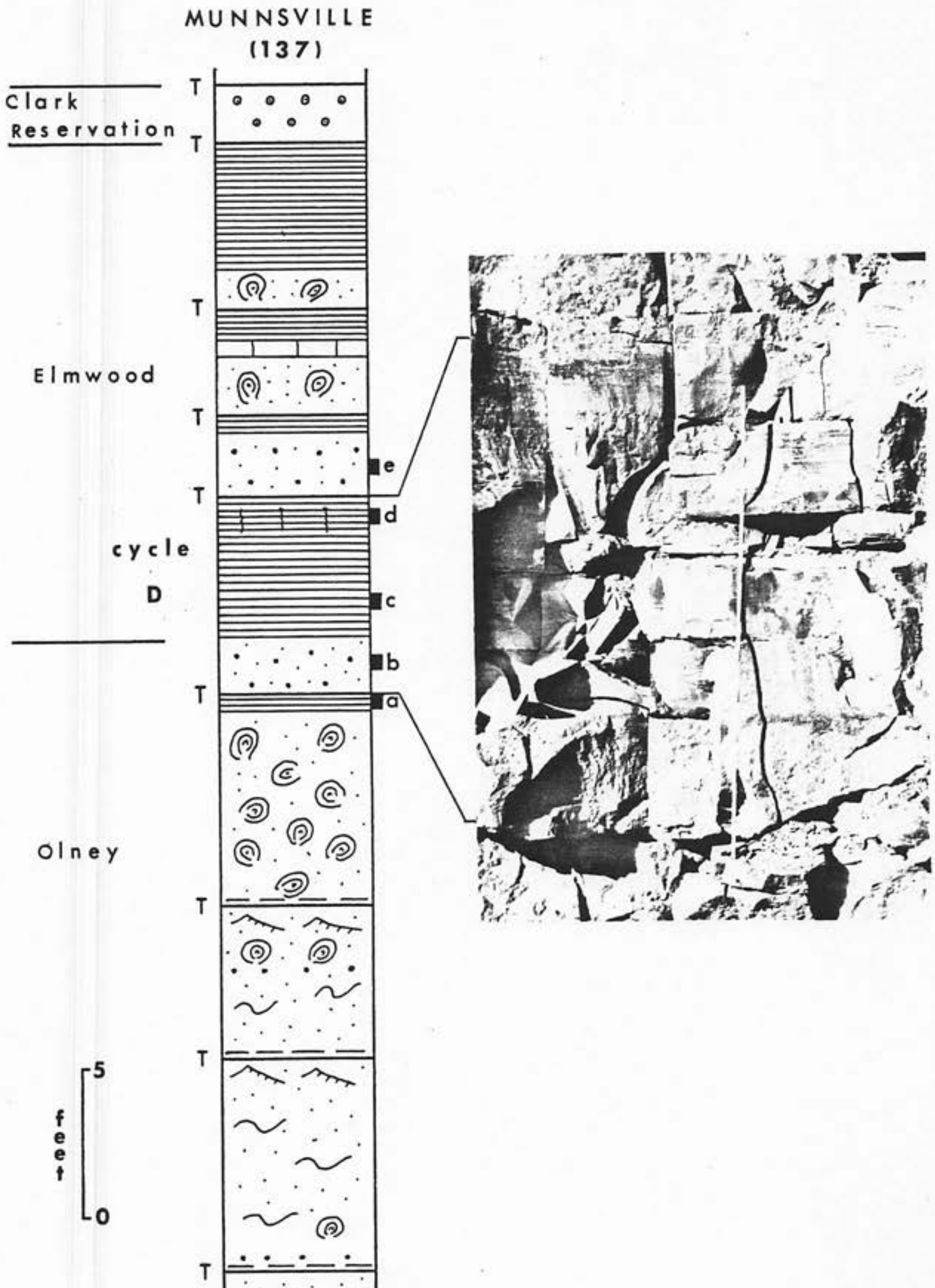

Figure 13 - Cyclic stratigraphic section at Munnsville Quarry. Letters refer to Fig. 14A to 14E.

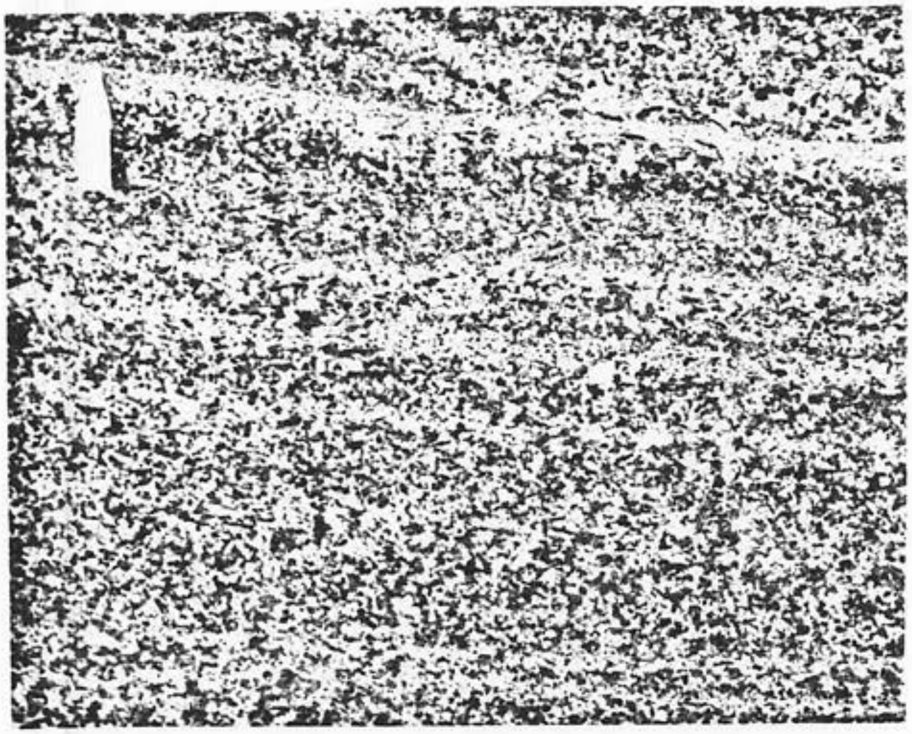

Figure 14-A. Top of underlying cycle.

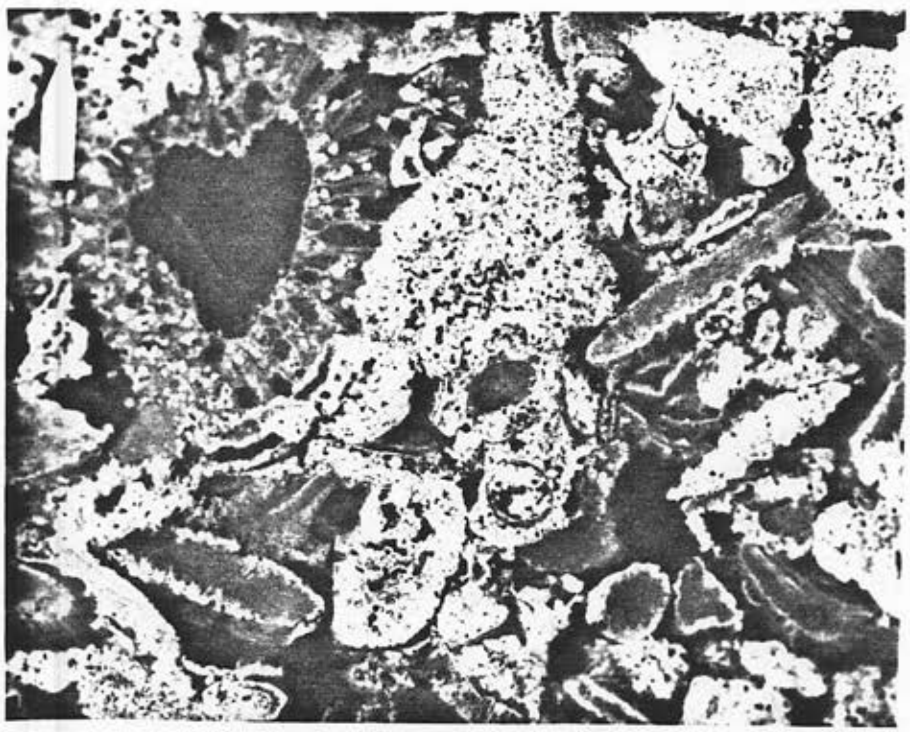

Figure 14-B. Base of Cycle D.

Figure 14 - Photonegative prints surrounding and within Cycle D. Arrow = 1.0 mm. in length.

Figure 14-C. Middle of Cycle D.

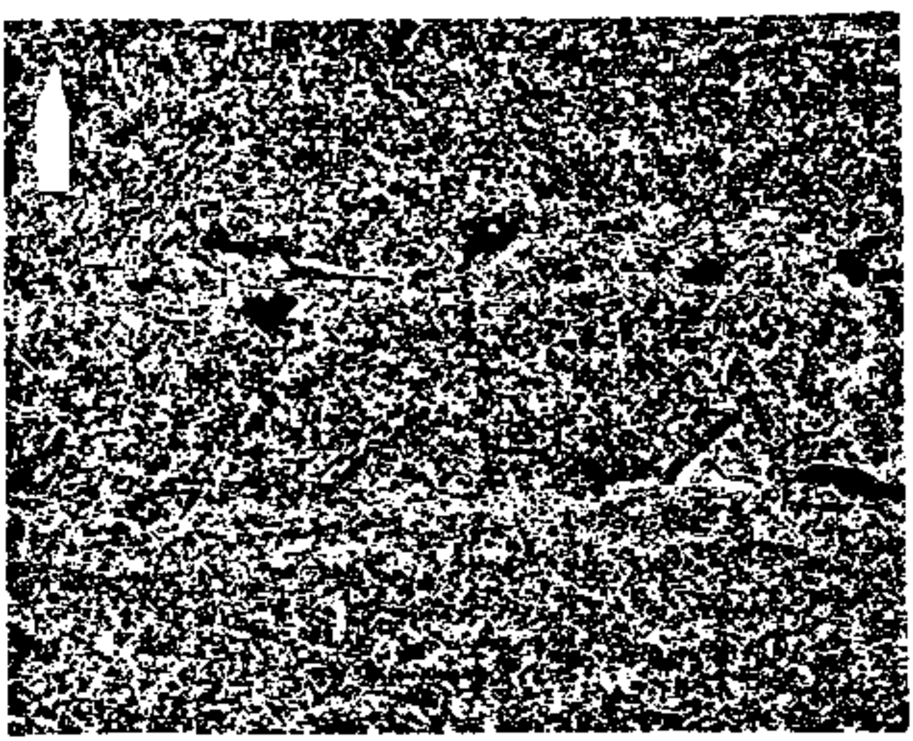

Figure 14-D. Top of Cycle D.

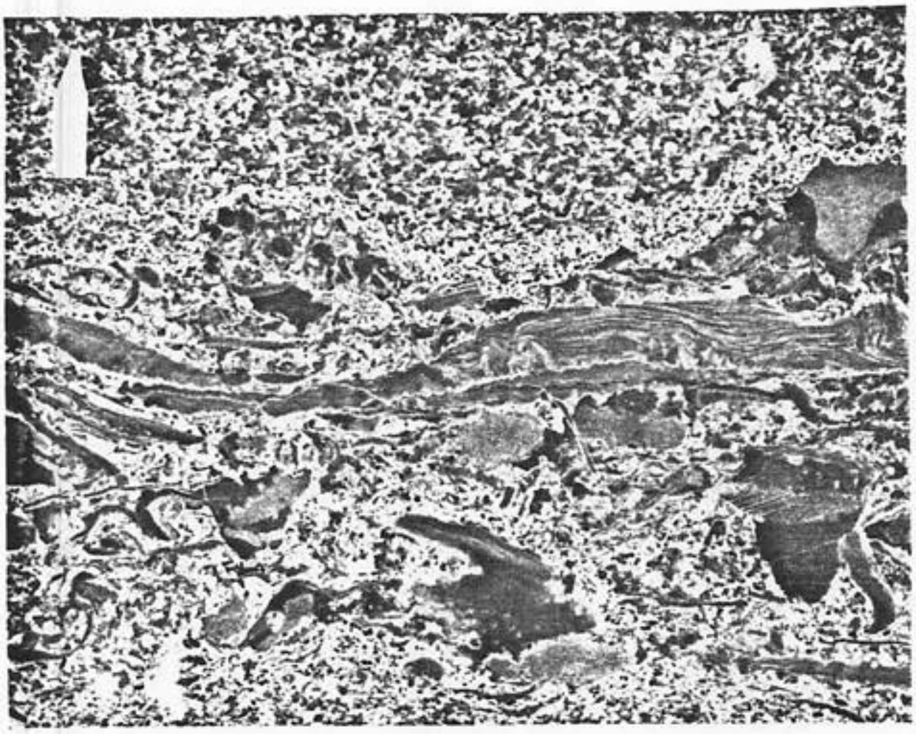

Figure 14-E. Base of overlying cycle.

Oriskany Falls (Cycle E)

Cycle E at Oriskany Falls (Fig. 15) has been selected as representative of dominantly subtidal cycles with fossiliferous micrites in the lower portions and current laminites in the upper portions. Current-washed, skeletal calcarenites with crinoid stems, brachiopod and ostracode fragments, and other rounded fossil fragments form the top of the underlying cycle (Fig. 16-A). A sharp contact separates this lithology from the overlying lithology at the base of Cycle E. These basal deposits consist of mixtures of fossiliferous calcarenites and micrites (Fig. 16-B). Pseudopunctate brachiopods, ostracodes, and crinoid stems comprise the faunal assemblage. Higher in the cycle these micritic beds are replaced by bioturbated, fossiliferous calcarenites again containing brachiopods, crinoids, and ostracodes (Fig. 16-C). Finer-grained calcarenites with coarse calcarenite lenses (Fig. 16-D) succeed the lower lithologies. The faunal assemblage remains unchanged. Well-sorted, vertically burrowed, current laminated very fine calcarenites (Fig. 16-E) complete the cycle. A sharp contact separates Cycle E from the lower deposits of the overlying cycle. These deposits consist of fossiliferous coarse calcarenites (Fig. 16-F) with the same fossil fragments seen in Cycle E but including bryozoans.

Cycle E is interpreted as containing facies representing a gradation from subtidal to lowest intertidal environments. Unlike the cycles previously described, subtidal lithologies dominate this cycle. Cycles of this variety become much more

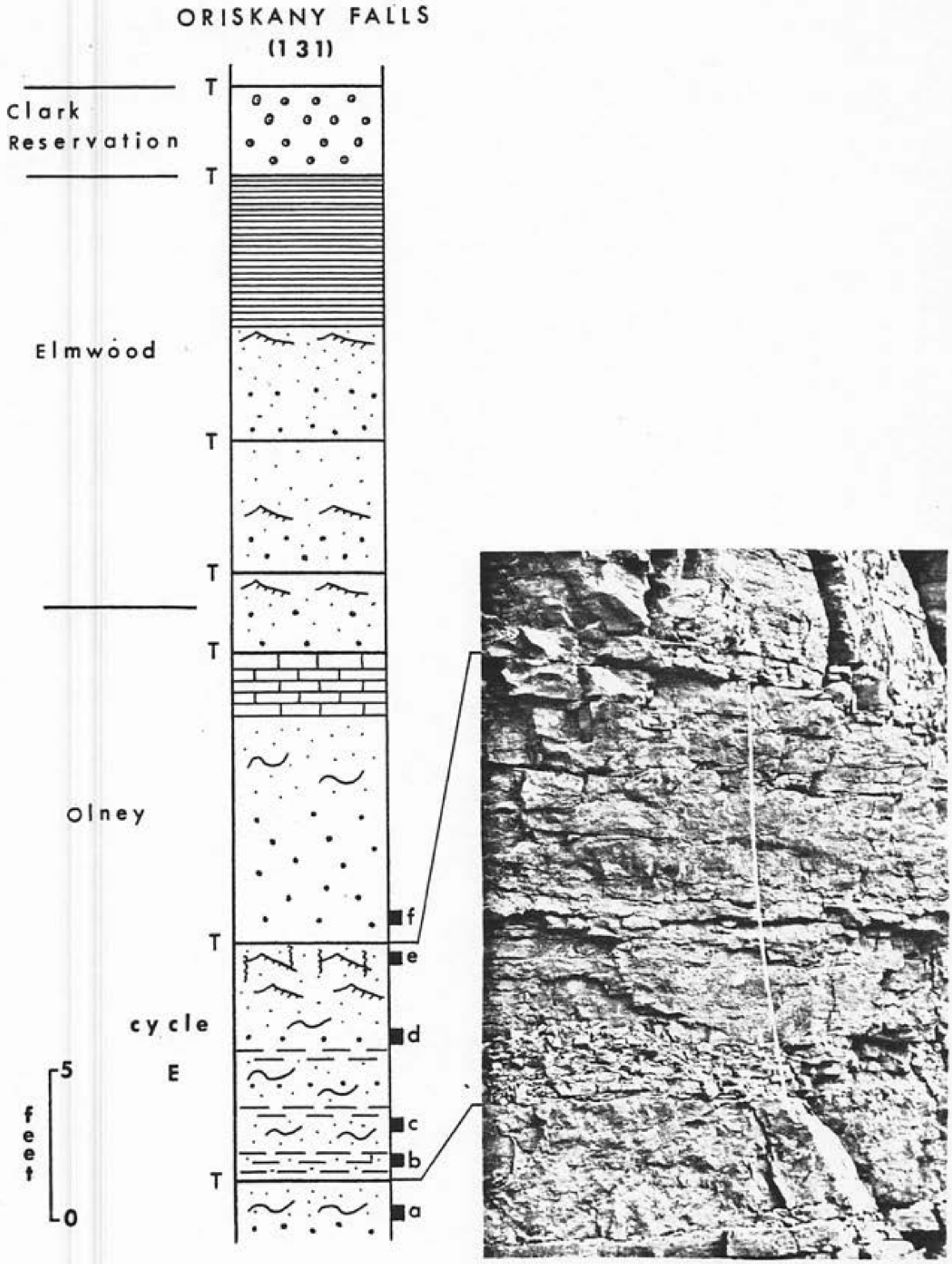

Figure 15 - Cyclic stratigraphic section at Oriskany Falls. Letters refer to Fig. 16A to 16F.

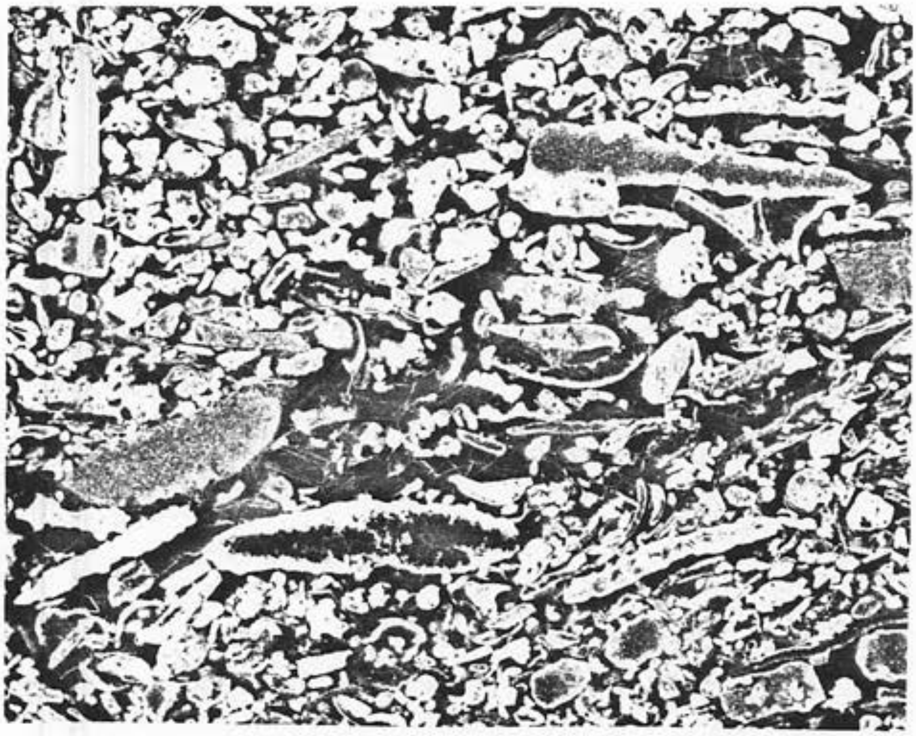

Figure 16-A. Top of underlying cycle.

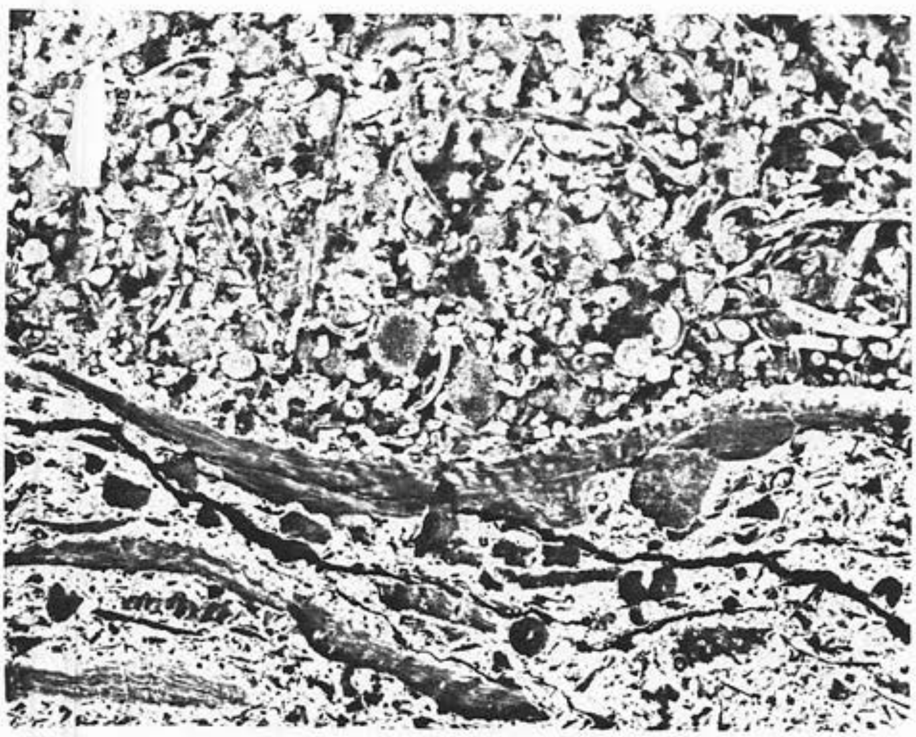

Figure 16-B. Base of Cycle E.

Figure 16 - Photonegative prints surrounding and within Cycle E. Arrow = 1.0 mm. in length.

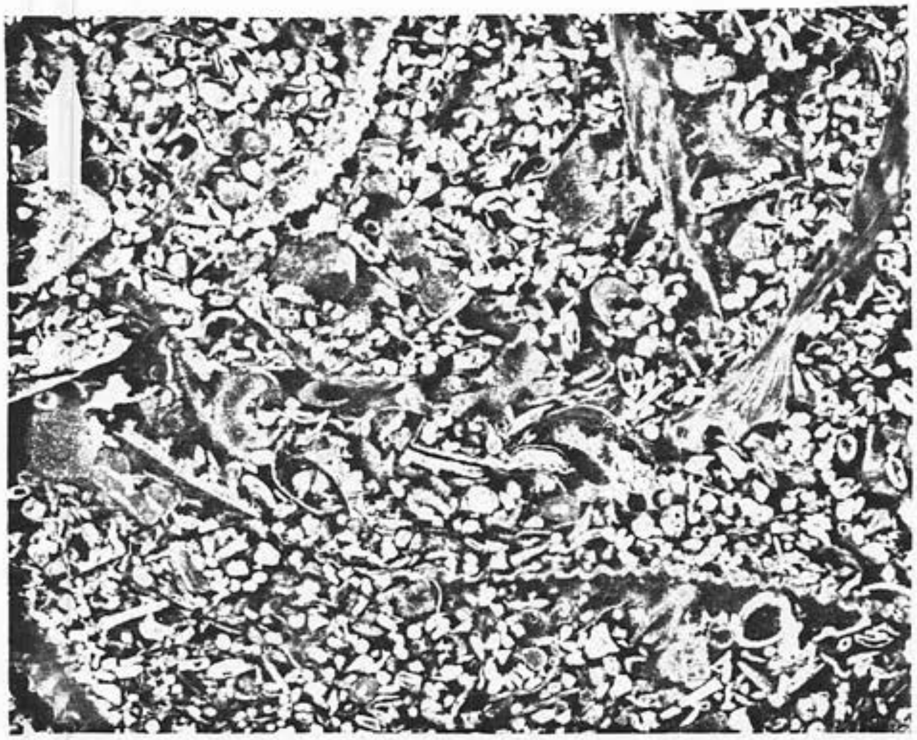

Figure 16-C. Lower middle of Cycle E.

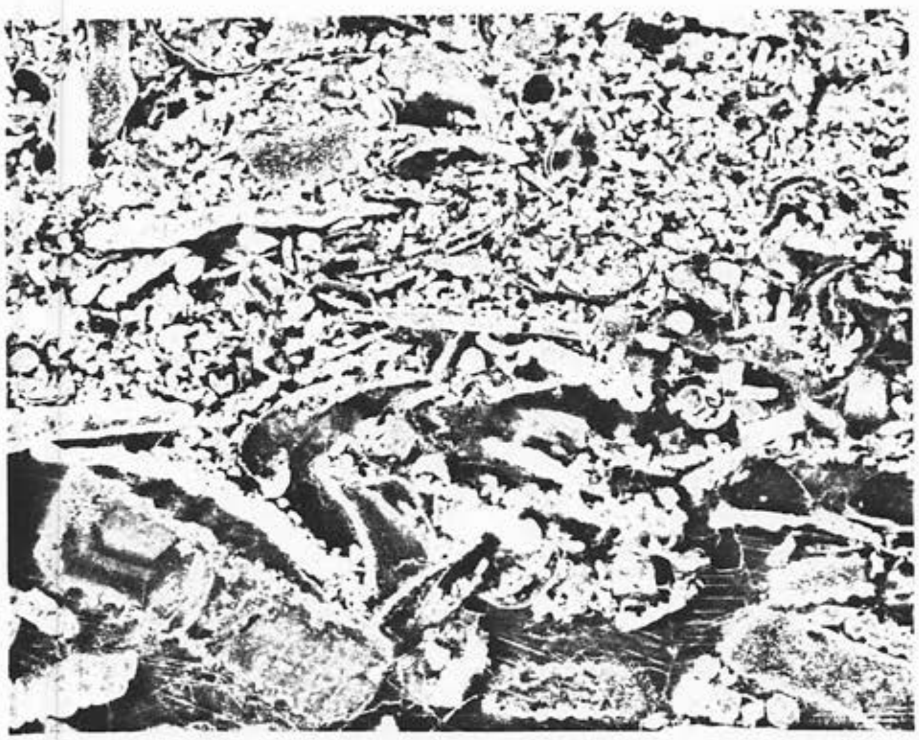

Figure 16-D. Upper middle of Cycle E.

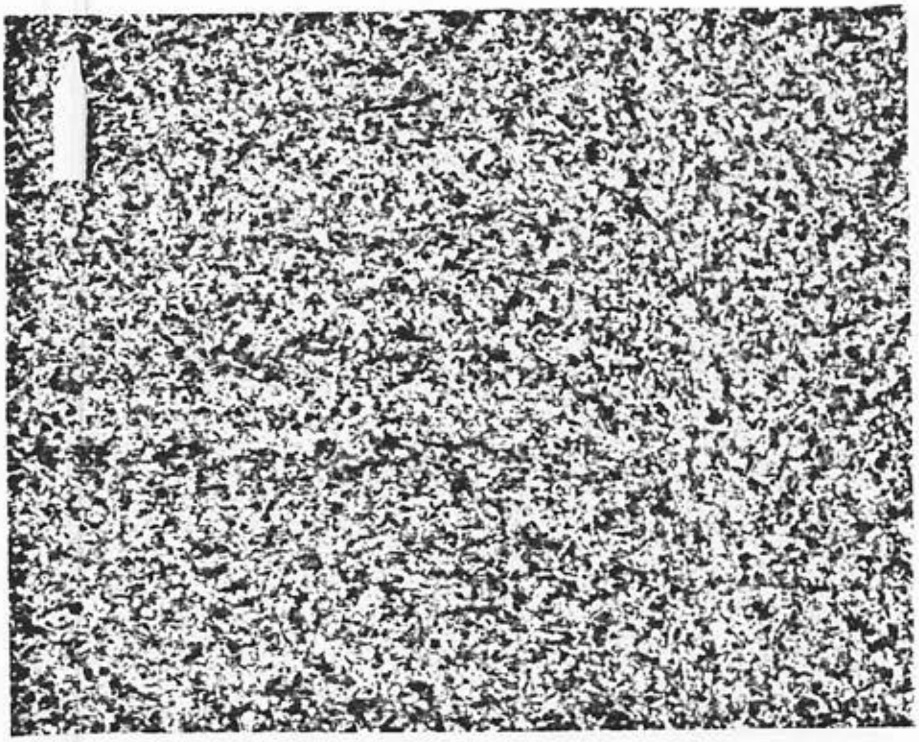

Figure 16-E. Top of Cycle E.

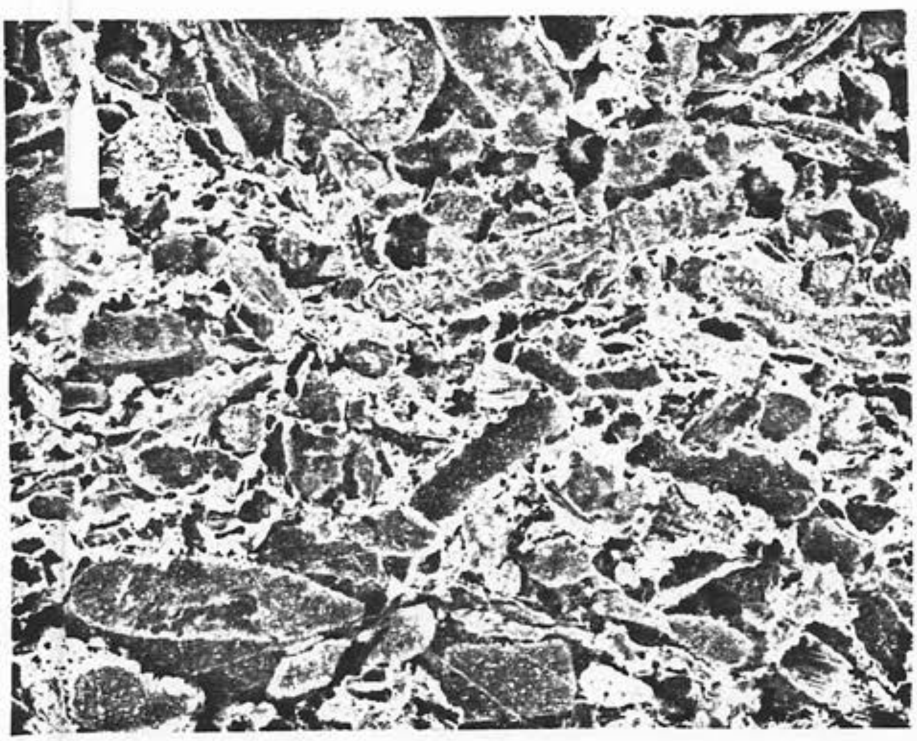

Figure 16-F. Base of overlying cycle.

prevalent from Oriskany Falls eastward and are thought to reflect a more offshore position in the Helderberg basin. Diverse fauna and current-dominated lithologies persist nearly throughout the cycle. Only the upper two feet of Cycle E are interpreted as being intertidal on the basis of vertical burrowing (e.g. see Howard, 1972).

Jordanville (Cycle F)

The last cycle (Cycle F) to be described occurs in the easternmost locality of the study area, Jordanville quarry (Fig. 17). As one of several thick cycles in this stratigraphic section, Cycle F represents largely calcarenitic subtidal cycles with current laminites in the upper portions. Below Cycle F the upper deposits of the underlying cycle consist of well-sorted, current laminated coarse calcisiltites and very fine calcarenites (Fig. 18-A). The deposits forming the base of Cycle F consist of fossiliferous calcisiltites with brachiopods, crinoid stems, gastropods, and trilobite fragments (Fig. 18-B). These are replaced higher in the cycle by fossiliferous very fine calcarenites (Fig. 18-C). Crinoid stems still occur but pseudopunctate brachiopods and ostracodes now dominate the fossil assemblage and gastropods are absent. Well-sorted, current laminated very fine calcarenites (Fig. 18-D) comprise the uppermost beds of the cycle. The basal deposits of the overlying cycle, separated from Cycle F by a sharp contact, consist of fossiliferous very fine calcarenites with crinoid stems, thin impunctate brachiopods, and ostracodes (Fig. 18-E).

Cycle F is interpreted as representing a wholly subtidal paleoenvironment typical of those in this most offshore paleogeographic position. Its similarity to Cycle E at Oriskany Falls is confined to the general pattern of thick subtidal deposits underlying well-sorted current laminites. Unlike Cycle E, in which thin lenses of both fossiliferous calcarenites

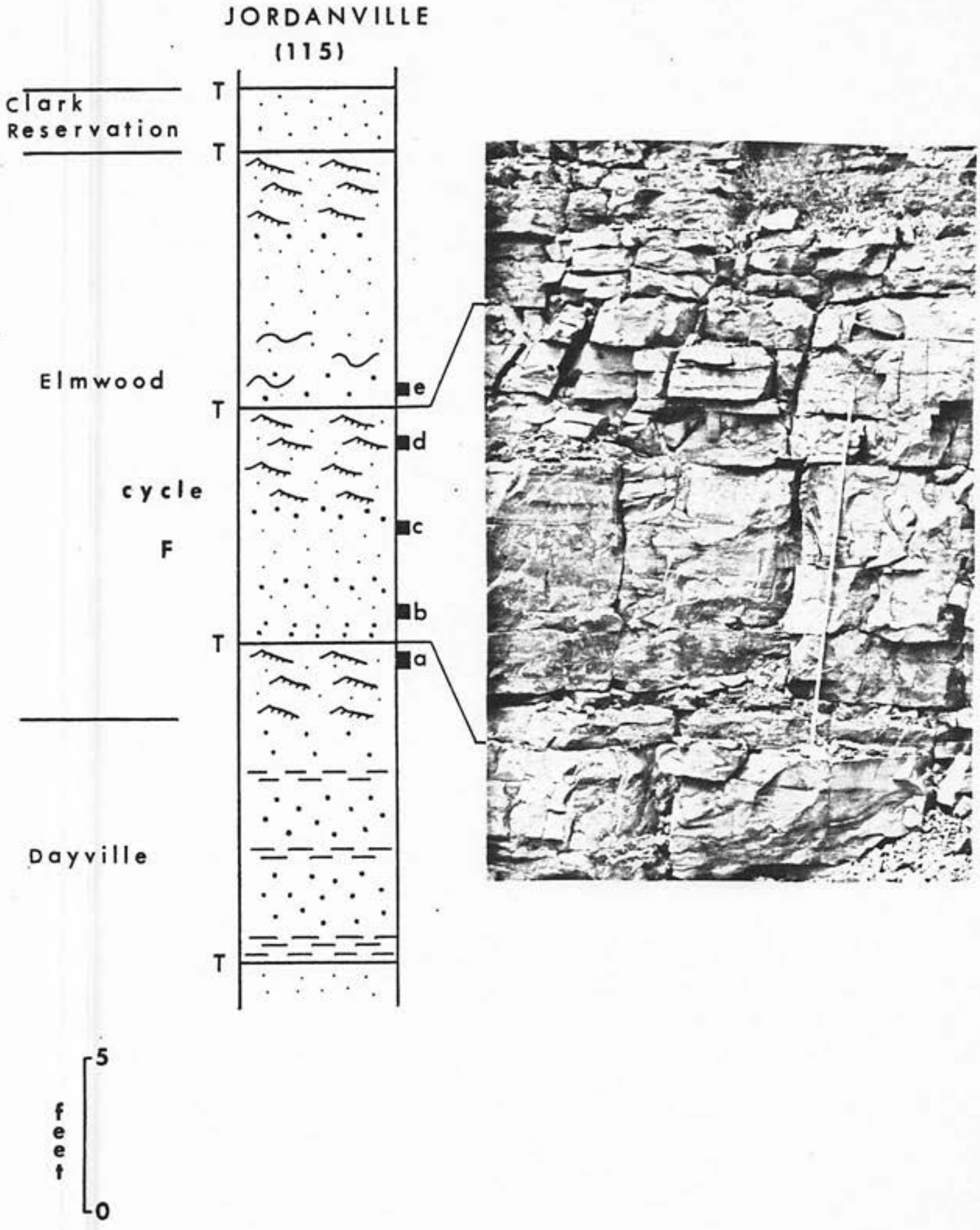

Figure 17 - Stratigraphic section at Jordanville quarry. Letters refer to Fig. 18A to 18E.

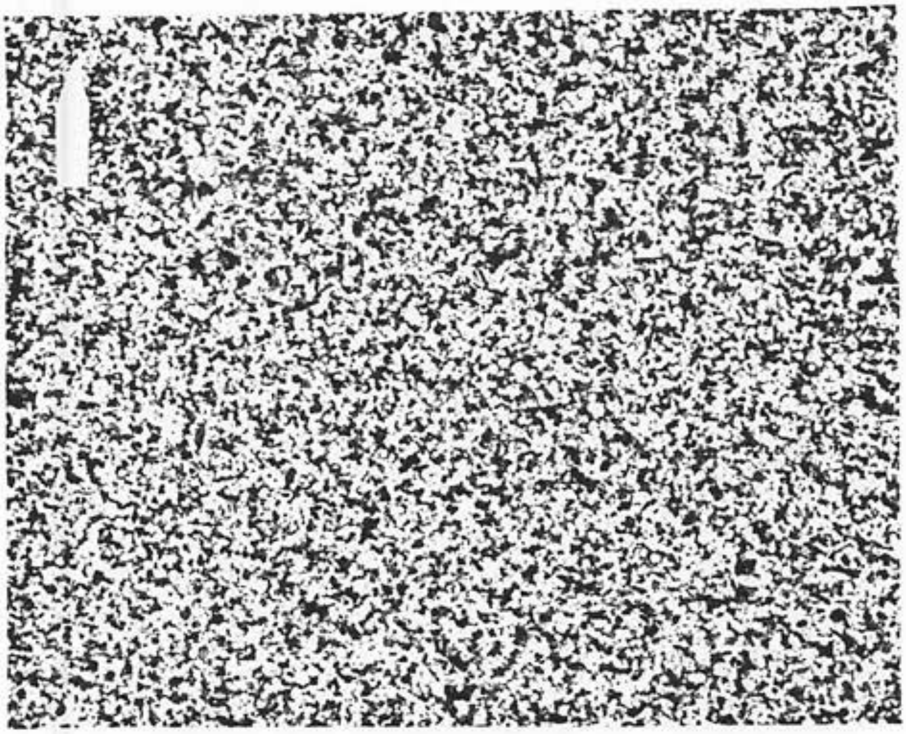

Figure 18-A. Top of underlying cycle.

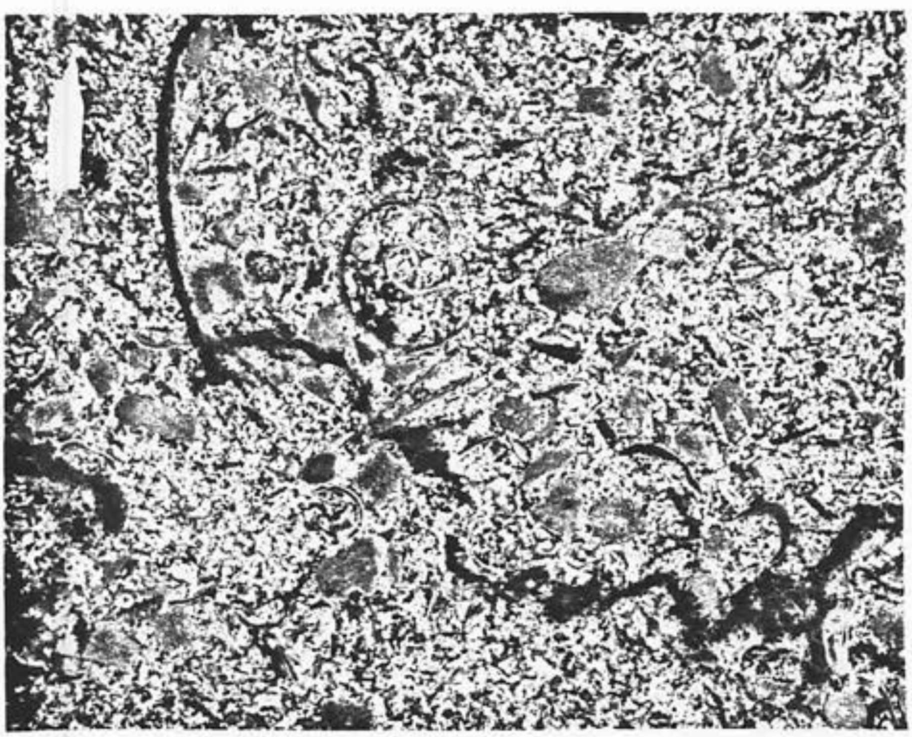

Figure 18-B. Base of Cycle F.

Figure 18 - Photonegative prints surrounding and within Cycle F. Arrow = 1.0 mm. in length.

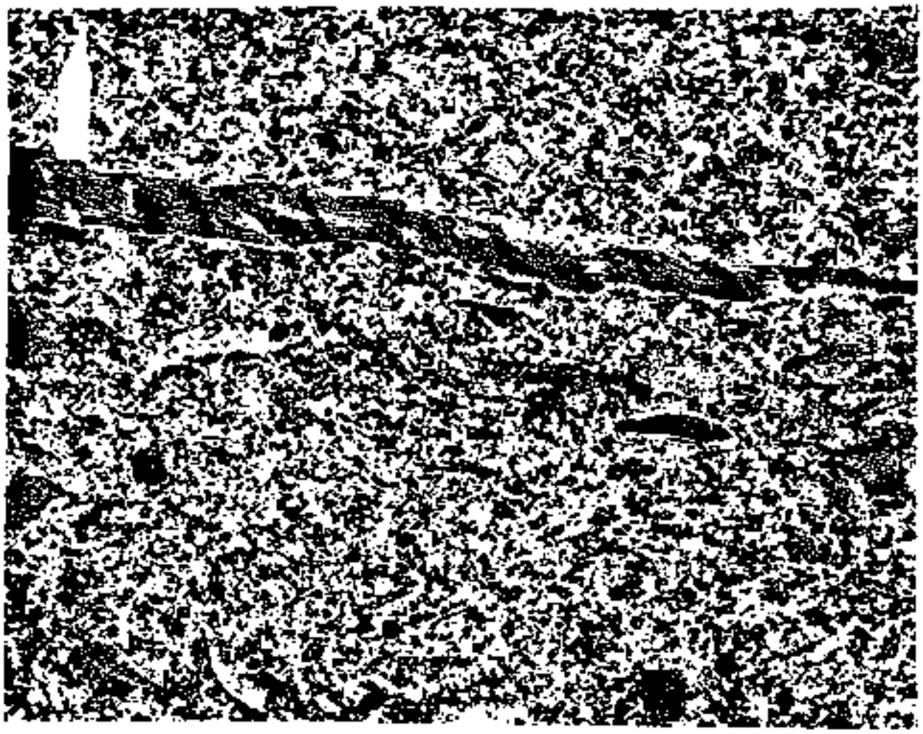

Figure 18-C. Middle of Cycle F.

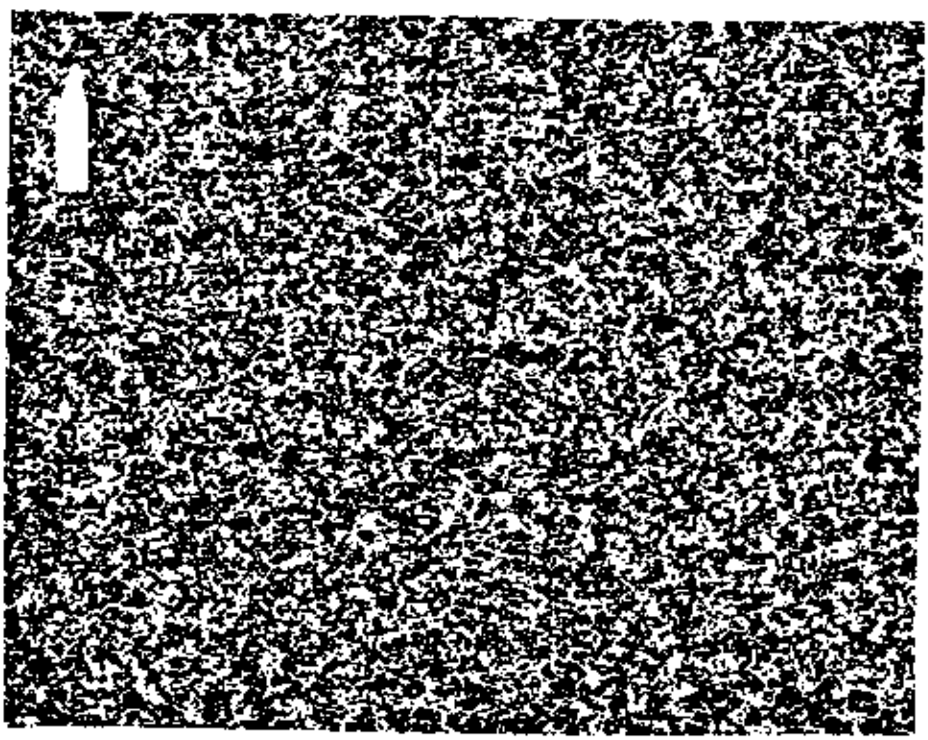

Figure 18-D. Top of Cycle F.

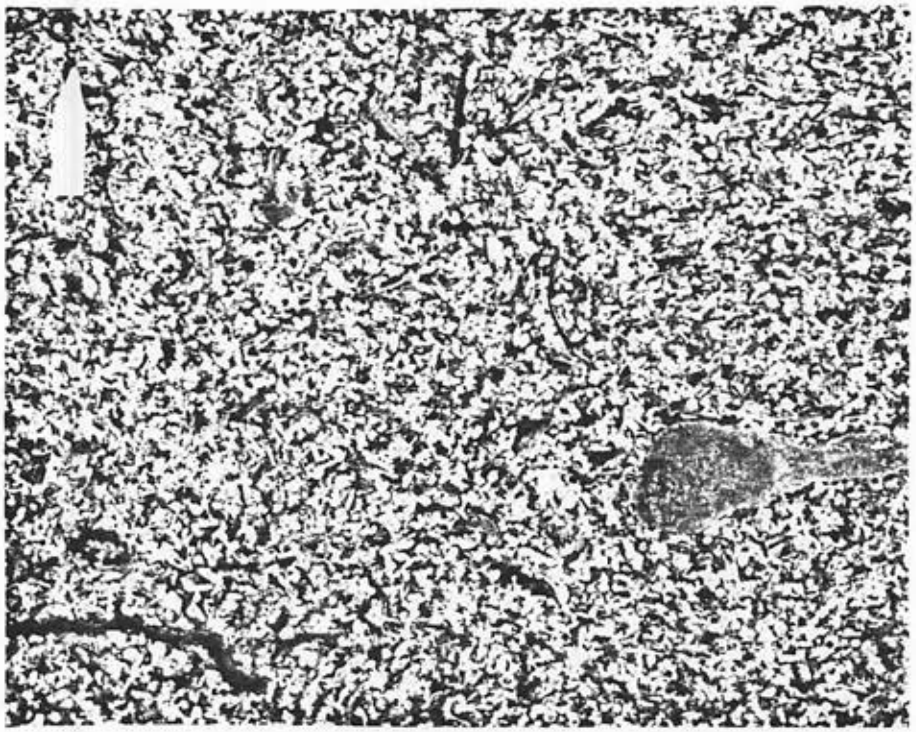

Figure 18-E. Base of overlying cycle.

and micrites dominate the lower portion, the lower half of Cycle F is characterized by relatively uniform coarse calcisiltites and very fine calcarenites. This is thought to represent an overall higher energy environment for Cycle F and one largely unaffected by variations in current activity. Persistence of this relatively high energy environment into the upper portions of Cycle F is reflected by the continued occurrence of the uniform facies similar to the lower portion of the cycle. In contrast to Cycle E at Oriskany Falls, this upper facies, while lacking skeletal components, contains no evidence of vertical burrowing and possesses poorly-defined current laminations. For these reasons an intertidal paleoenvironmental interpretation seems unwarranted for the upper beds of Cycle F. Therefore, although exhibiting the upward-shallowing motif demonstrated in the previous examples, Cycle F represents a totally subtidal cycle.

Using these representative cycles (A to F) as models, the entire stratigraphic interval can be divided into similar upward-shallowing cycles representing a spectrum of tidal environments (Fig. 19). For example, many of these are upward-shallowing subtidal to intertidal/supratidal cycles similar to Cycles A,B,C, and D. These are typically thin and represent aggradation to an environmental position essentially at sea-level. Others, similar to Cycles E and F, are entirely subtidal in nature beginning in fossiliferous lagoonal deposits and aggrading to a shallower, though still subtidal, environment. The pervasiveness of this upward-shallowing motif indicates that the Olney-Elmwood interval, which consists entirely of PACs, accumulated episodically in a manner consistent with the PAC hypothesis.

STRATIGRAPHIC RELATIONS & PALEOGEOGRAPHY

Comparison of stratigraphic sections (Fig. 19) reveals both vertical and lateral patterns of cycles (PACs) which contribute greatly to an understanding of the dynamics of accumulation in the Olney-Elmwood interval. This comparison shows that the western sections are dominated by tidal-flat cycles and the eastern sections are characterized by subtidal cycles. Vertically, each stratigraphic interval constitutes a shallowing PAC sequence; lateral comparison of these sequences reveals an overall progradational trend from west to east. Within each PAC of the sequence, paleoenvironments and paleogeographic patterns evolved uniformly and were abruptly altered by punctuation events between PACs.

PACs represented by Cycles A through D, in which mid-intertidal to supratidal deposits are recognized, are termed tidal-flat cycles. While these types of cycles commonly possess unique lithologic features, they are generally characterized by a lower subtidal portion and an upper portion composed of cryptalgal laminites. These upper laminites represent deposition in a paleoenvironmental position closely approximating mean sea-level. Cycles E & F, and other cycles of this type, are referred to as subtidal cycles. They are generally recognized by thick accumulations of bioturbated to current-dominated skeletal deposits. Cycles of this type may show aggradation to a lower intertidal position, as in Cycle E, but most commonly they represent aggradation confined to the subtidal zone. It is on this basis that both types of cycles are recognized elsewhere in the interval (Fig. 19). Tidal-flat cycles occur most frequently in the sections from Munnsville westward, and subtidal cycles dominate the stratigraphic intervals from Oriskany Falls eastward. This observation is in support of the general basin configuration established by previous workers (Rickard, 1962 and Laporte, 1967 & 1969) and illustrated in Fig. 3.

The first occurrence of tidal-flat cycles is interpreted to represent the first appearance of the ancient shoreline at each locality. They appear earliest, lowest in the stratigraphic section, in the Split Rock quarry column and appear later, higher in the stratigraphic section, at the next three eastward localities. Once these tidal-flat cycles are encountered at each locality, they continue to occur throughout the remainder of the interval. Thus, each stratigraphic interval demonstrates a shallowing PAC sequence. In addition, these shallowing PAC sequences demonstrate an overall eastward progradational trend in which the ancient shoreline prograded to a position just west of the Jordanville locality (Fig. 19). As predicted by the PAC hypothesis, this overall progradational trend is composed of discrete units (PACs) formed during short periods of base-level stability separated by rapid deepening events and is therefore an episodic and not continual progradation.

Recognition of reliable environmental indicators in terms of the PAC hypothesis within each stratigraphic interval allows one to view paleoenvironmental succession as an ordered, episodic process. When the progradational trend of PACs across all of the intervals is recognized, a similar episodic process regarding paleogeographic reconstruction is established. Previously, Laporte (1967) described the Manlius paleoenvironment as a facies mosaic that included a complex of subtidal, intertidal, and supratidal environments shifting laterally within the littoral zone. Although the paleoenvironments were clearly recognized, the confines of the model could not provide an understanding of the process of paleoenvironmental succession. The PAC hypothesis, on the other hand, permits this formerly disarrayed complex of paleoenvironmental successions to be clearly understood and even predictable. Similarly, paleogeographic reconstructions are more readily obtained within the predictions of the PAC hypothesis. The most clear example of this is the Elmwood/Clark Reservation boundary (Fig. 19). This genetic boundary, unlike the Olney/Elmwood contact in Fig. 19, is coincident with a PAC boundary. The well-developed Elmwood tidal-flat was thoroughly inundated by a major punctuation event different only in magnitude from those events occurring earlier. This major event resulted in the deposition of the biopeloosparite Clark Reservation lithology that dramatically replaced the Elmwood cryptalgal laminites. Thus, not only a new paleoenvironment but an unique paleogeography, tentatively interpreted as a low-relief subtidal shoal, occupied a position formerly occupied by a broad tidal-flat.

CONCLUSIONS

The techniques for outcrop study described by Anderson & Goodwin (1980b) are readily applied to the Olney and Elmwood Members of the Manlius Formation. Conclusions resulting from this application are:

1) The Olney-Elmwood interval consists entirely of Punctuated Aggradational Cycles (PACs).
2) Olney and Elmwood Member PACs represent tide-dominated paleoenvironments, many of which are similar to modern analogues.
3) At each of the localities studied, the Olney and Elmwood Members demonstrate a shallowing PAC sequence recognized by the first occurrence of tidal-flat cycles.
4) The composite shallowing PAC sequences represent an overall west to east progradational trend.
5) New paleoenvironments are established by punctuation events and are developed by aggradation between these events.
6) Punctuation events introduce paleogeographic settings distinct from those which previously existed.

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