SEDIMENTATION OF CROSSBEDDED MEGARIPPLE TROUGH-FILL NEAR SEWANEE AND SIGNAL MOUNTAIN, TENNESSEE

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ABSTRACT

Two unusual exposures showing lee slope megaripple trough-filling in Pennsylvania sandstones were discovered near the town of Sewanee and on Signal Mountain, Tennessee. These trough-fillings are presumed to have formed parallel to Pennsylvania paleocurrent flow. Foreset, tosets and bottomset bedforms were recognized and taken as supportive field evidence for laboratory studies of lee slope sedimentation by Alan V. Jopling.

Information gleaned from these two unusual exposures should enable one to determine the direction of sediment transport regardless of the given view of Pennsylvania trough-filling.

INTRODUCTION

Two roadcut exposures of Pennsylvania sandstone, belonging to the Sewanee Conglomerate and Warren Point Sandstone and exhibiting foreset, toset and bottomset trough deposits formed on the lee side of a megaripple, have been located at the entrance to the University of the South, Sewanee, Tennessee (Fig. 1) and near the juncture of Shoal Creek Road and Taft Highway, Signal Mountain, Tennessee (Fig. 2).

It is the purpose of this study to discuss the formation of these unusual examples of Pennsylvania megaripple trough-filling in the light of a laboratory model of lee slope sedimentation developed by Alan V. Jopling.

Understanding at least part of the process of sedimentation in these unusual Pennsylvania megaripples may lead to a better understanding of the sequence of most Pennsylvania megaripple trough-filling.

STRATIGRAPHY

Figure 3 shows a generalized stratigraphic sequence for the Pennsylvania System on the Cumberland Plateau in southeastern Tennessee.

FIG. 1: Location of roadcut exposure along U.S. 64, Sewanee, Tennessee.

FIG. 2: Location of roadcut exposure along Taft Highway, Signal Mtn., Tennessee.

FIG. 3: Generalized stratigraphic sequence in Southeastern Tennessee.

DISCUSSION

Pennsylvanian Deltaic Complexes

John Ferm and Robert Ehrlich (1967) proposed that Pennsylvania rocks in Alabama were deposited as part of a huge deltaic complex with offshore quartz sand
barrier bars, or spits. This complex prograded generally northward during Pennsylvania time.

Further, it appears that this deltaic complex in Alabama was dwarfed by a much larger deltaic mass that encompassed the modern geographic area of eastern United States, which includes a large part of the states of Pennsylvania and West Virginia, plus part of eastern Ohio, western Virginia, eastern Kentucky and Tennessee, northeastern Alabama, and northwestern Georgia (Ferm, Milici, Eison, and others, 1972). Therefore, it is suggested that this eastern United States-Pennsylvanian deltaic complex gradually encroached to the northwest, west and southwest (Fig. 4).

Thus, two masses of deltaic sediment were depositing at essentially the same time during the Pennsylvania Period. Further, one was building generally northward and the other generally westward. Therefore, it follows that they should overlap in a given area, during a given time. According to John Ferm (personal communication), the area of overlap is in the vicinity of Cullman, Alabama.

Pennsylvanian Sandstone Bedforms

David Hobday (1969) refined and supported the marginal marine portion of the regional model suggested by Ferm and Ehrlich (1967), by distinguishing a number of bedforms in Pennsylvanian sandstone units. In order to communicate readily with other geologists, Hobday arbitrarily assigned letter designations to various bedforms. Of particular interest are the megaripple trough-fillings which Hobday considered as festoon or "B" beds. B beds have curved bases that are concave upward and are filled with cross-bedded, laminated sandstone. These deposits may range from several to tens of feet in length and may show a wide range in degree of concavity of the base. Hobday considered B beds to have formed on shoals, atop tidal deltas, or by longshore currents moving essentially perpendicular to beachface deposits.

Joplimg Model

A. V. Joplimg (1965-A) used a laboratory study of fluid flow over a forested slope to develop a sedimentational model (Figs. 5A, 5B). Joplimg figure 5A indicates the hydrodynamic flow model of Joplimg where three different hydrodynamic zones have been recognized:

1. Zone of no diffusion
2. Zone of mixing
3. Zone of backflow

Zone of No Diffusion—Joplimg considers this zone as a remnant stream flow (remnants expanding jet flow) that carries suspended sediment over and beyond the lee slope.

Zone of Mixing—The fluid in this zone contains vortices, or eddies, and displays rapidly changing longitudinal velocity.

Zone of Backflow—This zone shows a return flow, usually referred to as reverse circulation, or backflow; i.e., a counter current forms and flows along a de- positional interface and up a foreset slope.

Joplimg figure 5B shows a bedform model in which three types of lee slope bedding have been observed:

1. Forest (tabular or planar) crossbeds.
2. Toeset beds.
3. Bottomset beds, with or without asymmetrical sand ripples.

Joplimg figure 5C shows a bedform model in which three types of lee slope bedding have been observed:

A. Hydrodynamic flow model

B. Bedform model

Sedimentation of Cross Bedded Megaripple Near Sewanne

TABLE 1: Weight percent sieve analysis, Pennsylvanian quartzose sandstone near Sewanne, Tennessee

<table>
<thead>
<tr>
<th>PARTICLE SIZE</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>A2</td>
</tr>
<tr>
<td>Fine Pebble</td>
<td>0.04</td>
</tr>
<tr>
<td>Coarse Pebble</td>
<td>0.06</td>
</tr>
<tr>
<td>Sand</td>
<td>Very Coarse</td>
</tr>
<tr>
<td>Medium</td>
<td>0.00</td>
</tr>
<tr>
<td>Fine</td>
<td>1.86</td>
</tr>
<tr>
<td>Very Fine</td>
<td>23.62</td>
</tr>
</tbody>
</table>

FIG. 6: Western end of roadcut in Pennsylvania Sewanne Conglomerate along U.S. 64, Sewanne, Tennessee.

As previously stated, forest beds tend to be coarse grained because they form by bed load particles avalanching down megarripple lee slopes, whereas bottomset beds tend to be fine grained because they form by suspension sedimentation in the zone of backflow.

Data on Table 1 verify that these bedform sets are finer grained than the forest beds.

Furthermore, Figure 7 shows the location of dip direction readings on cross-beds in this exposure near Sewanne, Tennessee. Figure 7 summarizes these data and indicates that the general direction of sediment transport in this outcrop was between 50°-60° to the southwest.

FIG. 7: Generalized drawing of roadcut in Pennsylvanian Sewanne Conglomerate along U.S. 64, Sewanne, Tennessee.

Also, these beds appear to be arranged in a cyclic, or repetitive, manner (Fig. 6). It may be considered that the cycle begins with a relatively steeply dipping forest beds, followed by foreset-toe set beds, and ending with foreset-toe-bottomset beds (well-developed tangential beds).

Joplimg (1965-B) reports that relatively steeply dipping forest beds indicate low current velocities; whereas, well-developed tangential beds indicate increased velocity.
Jones supported the marginal marine model of Ferm, Milici, Eason and others (1972) and indicated that the regional direction of sediment transport was to the south and southwest.

**Exposure on Signal Mountain, Tennessee**

Figure 9 (A-B) shows two views of a single megaripple trough-fill in the Warren Point Sandstone (Fig. 3) located near the juncture of Taft Highway and Shoal Creek Road, Signal Mountain, Tennessee (Fig. 2).

Figure 9A indicates the larger of the two views that is essentially parallel to Taft Highway and has a northwest azimuth. It shows part of the concave base of this very large megaripple. At first sight, it would appear that this view shows steeply dipping foreset cross-beds that formed parallel to a southeasterly paleocurrent flow; however, such is not the case.

The view on Figure 9B is essentially perpendicular to the view on Figure 9A and the azimuth of this rock face is toward the southwest. This view shows foreset, toest and bottomset trough-filling dipping to the southwest which is arranged in a cyclic, or repetitive, sequence reminiscent of the exposure near Sewanee, Tennessee. However, here the cross-beds contain no granules or pebbles; the bottomset beds have asymmetric backflow ripples on their upper surface, and the trough height is not as great. In addition, visual inspection of these well lithified rocks reveals that the foreset beds are coarser grained than the bottomset beds.

Presumably this view shows lee slope cross-bedded deposits that formed essentially parallel to paleocurrent flow.

**FIG. 9-A: Rock face parallel to Taft Highway, Signal Mtn., Tennessee. Note large size of megaripple trough.**

**FIG. 9-B: Megaripple trough fill, Signal Mtn., Tennessee—showing Forest, Toeset and Bottomset beds. (F) (T) (B)**

**SUMMARY AND CONCLUSIONS**

It is suggested that the two unusual roadcut exposures examined in this study support and verify laboratory studies of Alan V. Jopling on lee slope deposition.

Further, it is likely that these unusual exposures present a view of bedforms that were deposited essentially parallel to the direction of flow of Pennsylvanian paleocurrents.

Most outcrop views of Pennsylvanian megaripple trough-filling are likely at an oblique angle to paleocurrent flow, it should be possible to ascertain the sequence pattern of trough filling is difficult.

However, armed with information derived from trough-fillings that likely formed parallel to paleocurrent flow, it should be possible to ascertain the sequence of bedform filling, or formation, in most Pennsylvanian megaripple troughs no matter which view of the trough-fill is presented.

Finally, several statistical studies, such as the one by M. L. Jones (1972), of the dip direction of Pennsylvanian cross-bedded units have been made in order to determine regional or local direction of sediment transport. Presumably, these statistical studies include the dip direction of any view of megaripple trough-filling based on the idea that, with large numbers of readings, an average value may be used to interpret sediment transport direction.

However, the authors maintain that if one is able to examine any view of Pennsylvanian megaripple trough-filling and utilize the ideas presented in this paper, then one should be able to determine the sequence, or pattern, of trough filling. Therefore, these data should enable one to indicate the direction of ancient sediment transport with greater precision (Fig. 8) than the statistical approach based on averages.

Apparently, this problem in sedimentation is similar to a structural geology problem involving determination of true versus apparent dip.

**LITERATURE CITED**


