

LINGUAL¹ DEPOSITION IN THE WOODBINE SANDS ALONG COPPERAS BRANCH, DENTON COUNTY, TEXAS: A STUDY IN MARINE SEDIMENTATION

Ellis W. Shuler and Olin M. Millican

The lack of outcrops in three dimensions often limits the interpretation and understanding of sedimentary structures, the relation of transition beds, and the cycle of sedimentation. The low dips of the Woodbine sands in Denton County, Texas, together with the numerous outcrops in the miniature canyons of Hickory Creek, Bethel and Copperas Branches, offer an unusual opportunity for studies in the sedimentation of these sands.

The report which follows is taken from a more extended survey of the area made by the junior author and the detailed field work is to be credited to him. The problem initially given was to find the direction of prevailing currents during upper Woodbine deposition by determining the direction of the steepest dips of cross-bedded sands over an area of several square miles (Fig. 1).

Woodbine Sands of Denton County

The Woodbine sands, basal upper Cretaceous, outcrop in a north-south belt six to nine miles in width across the east central part of Denton County, Texas. These beds were named by Robert T. Hill², who designated the uppermost division as the Lewisville beds. The Woodbine formation in

¹ The term lingual deposition is used to indicate a delta-like sedimentary lobe or tongue built by along-shore or other marine currents in the neritic zone. It is distinguished from a true delta by the absence of sub-aerial deposition and by prevailingly parallel rather than radial axes.

² Hill, Robt. T., U. S. G. S., 21st ANNUAL REPORT, Pt. 7, 1901.

south-central Denton County attains a total thickness of about 325 feet; the upper beds, Lewisville, have a thickness of approximately 90 feet.

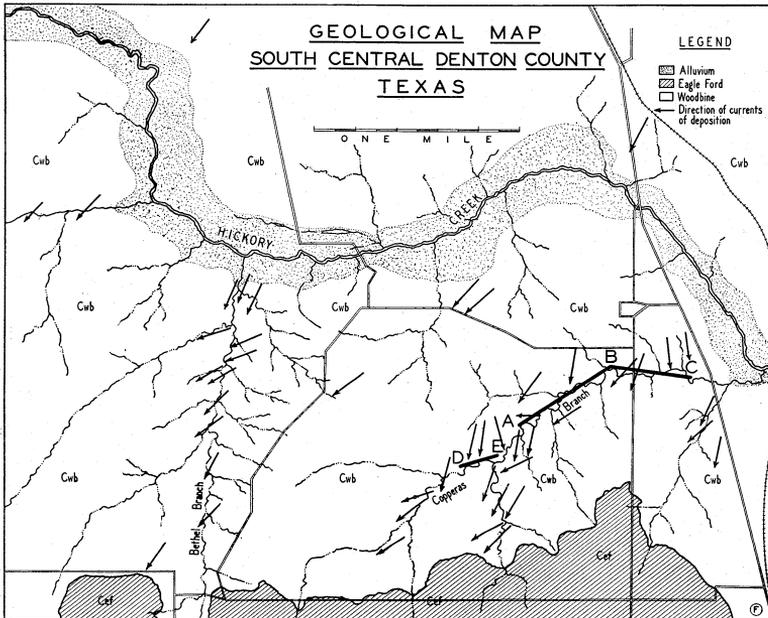


Fig. 1. Geological Map, South Central Denton County, Texas.

The area discussed in this paper is located three miles above the junction of Hickory Creek with the Elm Fork of the Trinity River; six miles north of Timber Creek, the type locality of the Lewisville beds, and four miles northwest of the town of Lewisville.

Outcrops are abundant along Bethel and Copperas Branches. The exposures found usually on the east bank of the bends of the stream channels range upward from the creek bed to fifty feet in height.

Sections in the Lewisville beds show cross-bedded iron-stained sands and sandstones which, near the top, contain localized, thin, cross-bedded, greensand masses; thin, but resistant, reddish ironstone; sandy and bituminous clays; and sandy shales containing selenite, melanterite, and lig-

netized wood fragments. The succession varies widely from outcrop to outcrop. The general strike of the area is about 40 degrees east of north; the dip is estimated at forty-five feet per mile.

Sedimentary Structure

The Lewisville beds appear to be built up of a series of advancing sedimentary tongues or lobes of deposition with accompanying marginal slopes and flats. Frontal areas of the lobes with coarse materials may show foreset beds ranging from eight up to twenty-two degrees, the maximum angles of repose for the type of sand deposited. Marginal slopes may show dips ranging from two to seven degrees. Reversals of dip on opposite sides of large scale lobes have probably given rise to the so-called "domes" or "anticlines" of this division of the Woodbine.

The flats alternating with the lobes become successively centers or loci of new deposition. The tongues vary greatly as to area covered and as to thickness and kinds of material deposited. The scale ranges from small sand tongues of a few feet in cross-section up to the Copperas Creek tongue, whose cross-section is almost five thousand feet. While minor tongues tend to show a double convex trace, the member beds of a major tongue tend to have a concavo-convex lenticular trace upon the plane at right angles to the current direction.

The distribution of materials in a cross-section of a tongue or lobe shows, especially in the larger examples, a central axis of coarser materials at high angles of cross-bedding and repose, and marginal deposits of finer muds

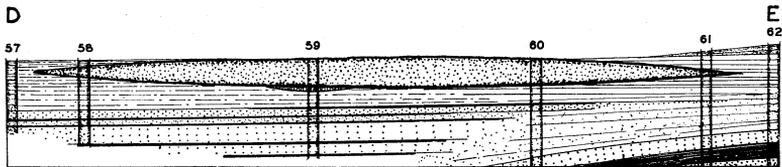


Fig. 2. Cross-section DE of a sand tongue exposed on Copperas Branch. Horizontal distance 50 yards. Figures refer to vertical sections listed in the text.

and lighter materials such as lignitized wood fragments.

As determined by maximum foreset beds the general direction of current action in this area is to the south-west (Fig. 1).

Upper Copperas Branch Sand Tongue

An excellent example of lingual deposition on a minor scale and where only one type of material is involved is found in the section DE of the geological map (Fig. 1) on Copperas Branch. Here the cross-section of a tongue of sand (Fig. 2) appears in convex lens form. The sand lens can be seen almost continuously across a distance of about 50 yards. It begins in a clay structure on the west; swells to a thickness of 2.5 feet, and tapers out in thin, sandy shale on the east.

Measured vertical sections along the sand lens outcrop show the lateral changes even more vividly than Figure 2. It will be noted that the sand tongue overlies a depositional flat and the western slope of a larger tongue to the east, as is shown by the dip of the lignite beds.

Section 57—

Soft gray clay, iron stains, jointed	4.5 feet
Gray sandstone .....	.8 feet
Seam of red sandy hematite.....	.1 feet
Clean gray sand; uniform grain .....	.4 feet
Sandy iron oxides; jointed .....	.1 feet

Section 58—

Gray clay with brown stains .....	.8 feet
Indurated gray sandstone; lens.....	.9 feet
Soft gray clay	3.0 feet
Gray sandstone .....	.8 feet
Red hematite seam .....	.2 feet
Clean gray sand .....	.4 feet
Red hematite .....	.1 feet
Gray sand with bluish streaks.....	1.6 feet
Red iron oxide .....	.1 feet

Section 59—

Indurated red sandstone; lens.....	2.5 feet
Pebble conglomerate .....	.1 feet
Gray clay, streaked	1.5 feet
Red iron oxide .....	.1 feet
Gray sandstone .....	.8 feet
Red iron oxides.....	.1 feet
Gray sand, sharp .....	.4 feet
Red iron oxide.....	.1 feet
Gray sand, streaked.....	1.5 feet

Section 60—

Indurated gray sandstone; lens.....	2.5 feet
Gray black shale.....	1.1 feet
Red iron oxide.....	.2 feet
Dark gray sand.....	.6 feet
Dark sandy shale.....	4.0 feet
Heavy iron-stained sandstone.....	.3 feet

Section 61—

Thin-bedded brown sandstone.....	.4 feet
Dark crumbly sandy shale.....	1.0 feet
Indurated gray sandstone; lens.....	.5 feet
Dark to brown sandy shale.....	5.0 feet
Heavy iron-stained sandstone.....	1.0 feet
Lignitic shale.....	1.2 feet
Brown sandstone.....	.2 feet

Section 62—

Thin-bedded brown sandstone.....	.8 feet
Sandy shale.....	7.0 feet
Iron-stained sandstone.....	1.2 feet
Lignitic shales.....	2.5 feet
Brown sandstone.....	1.0 feet

Copperas Branch Tongue

A more complex tongue is that shown along the line ABC (Fig. 1). Here the Copperas Branch cuts a trench approximately along the strike of the Lewisville beds. The section shown (Fig. 3) is the composite of a large number of sections along the creek for a distance of 4,600 feet. Third dimension outcrops were studied, but it was not possible to justify a continuous section. The section ABC (Fig. 3) cuts a depositional tongue somewhat diagonally, as shown by the difference in dip on the two sides of the section.

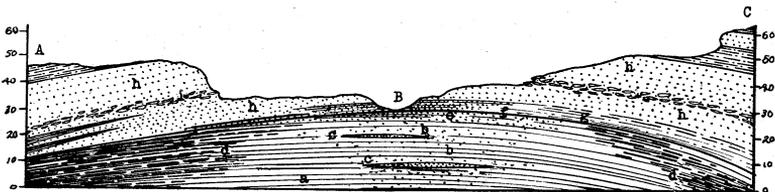


Fig. 3. Cross-section, ABC, of a composite tongue on Copperas Branch. (a) Fine sandy shale, bottom set. (b) Shale. (c) Minor sand tongues in sandy shale. (d) Lignitic fine-grained shales. (h) Gray sands with cross-bedded green sand lenticles. Horizontal distance, 4,600 feet. Dips are exaggerated.

The current remained constant for a length of time sufficient to build up about sixty feet of deposited materials.

The criteria used for the study and interpretation of this section were: the attitude of foreset bedding in the sandstone masses; dip planes of deposition in greensand masses; low marginal dips; sequence of deposition; depositional varves; arrangement of coarse and fine materials in the cross-section, especially the distribution of low dips, fine muds, and lignitic material; ripple marks; and lenticular traces of beds on transverse planes.

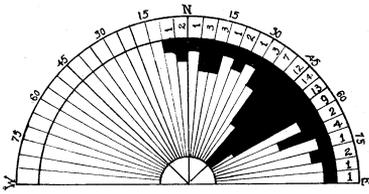


Fig. 4. Directions of currents which deposited 83 greensand masses on upper Copperas Branch.

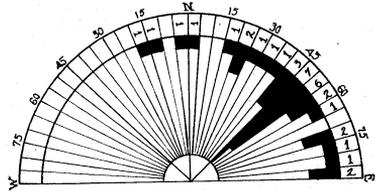


Fig. 5. Directions of currents of deposition as shown by foreset cross-bedding on Copperas Branch, Denton County, Texas.

The cycle of sedimentation appears as follows: The basal sandy shales and clays were laid down as bottom set or pro-tongue deposits. Lignitic materials tended to collect in the calmer waters along the margin of the tongue. Two small sand lenses near the central axis represent short periods of increased current action. The thin, hard oxide of iron member, f, probably deposited during a short period of quiescence, was followed, however, by rapid increase in current strength and in load of sand with the development of steep foreset beds. Dips in the cross bedding of this sand member vary from 7° on the margins up to 22° in the front center of the tongue.

Conclusions

Upper Woodbine time in the Copperas Branch locality was marked by off-shore, south and southwestward advancing shallow lingual deposition. The materials were

transported from the northeast for distances necessary for moderate sorting.

The sediments may have come from continental delta deposits to the northeast or from the reworking of deposits upon the shallow bottoms and margins of the Woodbine sea.

One practical application is suggested from the study above. The maximum production of an oil field will result when wells are spaced with reference to sedimentary deposition rather than the current checker-board style.