# Origin of Some Channel Fillings in the Austin Formation Around Dallas, Texas*

*William Otis Ham, Jr.*

At many localities along the outcrop of the Austin formation in Dallas County, Texas, channel fillings apparently composed of reworked bedrock occur at levels above the highest stream terraces. If a post-Cretaceous chronology for this portion of Texas is to be formulated, these channel fillings must be taken into account. A more immediate problem, however, is that of the origin of the fillings themselves.

Several excellent sections of the fillings are exposed in the highway and railway cuts around White Rock Lake, seven miles north of Dallas. The fillings are located on divides between existing streams in this area. Thus arises the additional problem of accounting for the apparent shifting of present lines of drainage away from those along which, presumably, troughs containing the fillings were excavated.

In this paper the author describes the channel fillings of the White Rock area and presents the following hypothesis to account for them: Troughs containing the fillings are thought to be remnants of a stream system dismembered by piracies attending the development of subsequent streams with progressive downcutting through the Austin formation.

## General Description of Area

The area studied surrounds White Rock Lake and extends northward from the lake along White Rock Creek for a distance of about three miles. The region is a gently roll-

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Figure 1.—Cross-section of channel filling (dark portion of slope) exposed in a Southern Pacific R.R. cut near White Rock Lake. Contact between the filling and the bedrock is clearly visible in right foreground.

ing prairie to which Hill[1] has quite descriptively applied the term "mammillary plain." The underlying bedrock is the Austin formation which dips gently to the southeast about fifty feet to the mile.

The Austin may be divided into three members: a lower chalk member, a middle marl member, and an upper chalk member. Detailed lithology and thickness of these members remain to be investigated. As the upper member does not underlie the area studied, it need not be described here.

The lower chalk consists of massive beds of gray to white chalk, some up to 3 feet thick, separated by thin, gray shale layers a few inches thick. Characterizing this basal member structurally are minor faults whose displacements do not exceed a few feet, and numerous joints. Many of these joints are limited to areas of a few square feet; however, two sets of master joints, trending approximately N. 30° E. and N. 80° W., seem to persist over much of the area studied. Less persistent sets trend approximately N. 63° E., N. 58° W., and N. 5° W. The frequent curving of

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[1]Hill, Robert T., *Geography and Geology of the Black and Grand Prairies of Texas*, U. S. G. S., 21st Annual Report, 1899-1900, Part VII., pp. 55-58.

joints in the Austin, a feature which Shuler[2] pointed out in his paper on the geology of Dallas County, is readily observable in the massive lower chalk.

The middle marl is composed predominantly of layers of cream colored marl and light gray calcareous shale with interbedded layers of chalk up to 6 inches thick. The marl member in some places contains beds made up of 71% (by weight) clay. Numerous joints occur in the middle marl, two sets trending approximately N. 15° E. and N. 85° W.

*Drainage*—Drainage in the area is by White Rock Creek and its tributaries and is predominantly in a southerly direction. White Rock Creek is a tributary of the Trinity River, which also flows to the south.

Wherever streams flow on the lower chalk, they tend to follow joints in the rock. Figure 2 shows a portion of the White Rock drainage about 3 miles north of the entrance of the creek into White Rock Lake. The control exercised by a set of joints trending north-south and east-west upon the main stream and its tributaries is obvious. The eastward flowing stream in Figure 4 also has its course controlled by joints where it flows on the lower chalk.

Although a roughly rectilinear pattern of drainage is developed by these joint-controlled streams, such is not always the case, for frequently the valleys curve at angles other than ninety degrees. This action is explained, at least locally, by curving joints in the lower chalk. Some streams execute turns as small as ten degrees, following curved joints in their beds.

In contrast to the joint-controlled streams flowing on the lower chalk are those flowing on the middle marl, for the latter do not tend to follow joints, but rather seem to be related in their courses to the inclination of the slopes over which they flow. Figure 3 shows a portion of the stream system on the west side of White Rock Lake. These streams, flowing entirely on the middle marl, have a dendritic pattern.

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[2]Shuler, Ellis W., *The Geology of Dallas County,* Univ. of Texas, Bull. No. 1818, March 25, 1918.

## Description of Channel Fillings

Within a square mile area, three quarters of a mile southeast of Vickery, Texas, and drained by a stream which flows eastward into White Rock Creek about one mile north of the latter's entrance into White Rock Lake, occur excellent cross-sections of two channel fillings (Figure 4).

*Filling 1*—Channel Filling 1 is exposed in a cut of the Southern Pacific Railroad (Fig. 1 and Fig. 4). Although rain wash along the slope of the cut has acted to obscure the contact between the filling and the marly bedrock, measurement showed the maximum width of the filling to be 175 feet and the maximum depth, 28 feet.

The filling is massive and consists almost entirely of rich-brown, compact clay which assumes a buff hue when dry. This contrasts with the whiter hues of the adjacent bedrock, making the outlines of the fillings easily visible. The upper ten feet of the filling is spotted white by abundant caliche nodules up to an inch in diameter. Scattered through the deposit are fragments of chalk, marl, shale and shells. Most of the fragments of chalk, marl, and shale, especially the larger ones, which may be as much as 5 inches across, occur along the bottom of the filling near the bedrock contact. No regularity in the alignment of the long axes seems to exist among these fragments. Some pieces lie with their long axes almost vertical, others with their long axes nearly horizontal, still others with their long axes at various angles between the two extremes.

*Filling 2*.—Filling 2 is exposed in a cut of Northwest Highway (Fig. 4). The highway has not been cut deep enough to reveal the lower bedrock contact; nor is one of the side bedrock contacts visible, having been blurred by soil wash. Consequently, the figures of 195 feet for the width and 12 feet for the depth represent only the maximum exposed width and depth of the fillings.

Consisting of compact brown clay and containing abundant caliche nodules, the filling resembles the upper ten feet of Filling 1. Embedded in the clay mass are fragments of chalk and marl haphazardly arranged.

*Characteristics in Common*—By way of summary the following points may be said to be characteristic of these channel fillings:

(1) In transverse cross-section the fillings possess flat bottoms and steep sides. Furthermore, this cross-sectional shape is remarkably similar to that of present stream channels cut in the middle marl of the Austin.

(2) They are set into the middle marl of the Austin.

(3) They occupy the crests of present interstream divides.

(4) The fillings are brown in color and consist of a compact clay through which are scattered nodules of caliche, shell fragments, and small pieces of chalk, marl, and shale.

(5) The long axes of the chalk, marl, and shale pieces possess no orderly alignment; thus these fragments present a jumbled appearance.

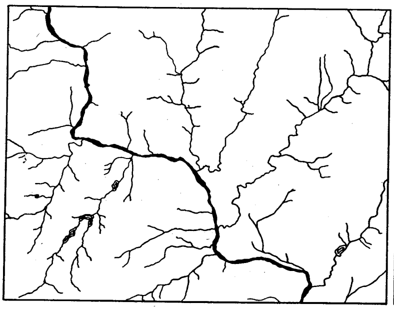

Figure 2.—Drainage pattern of a section of White Rock Creek (heavy black line) showing the control exercised by two sets of joints.

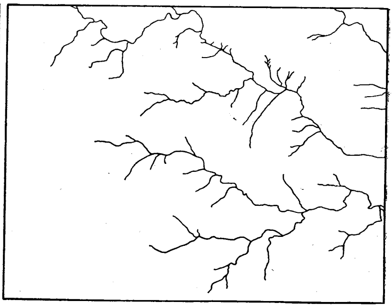

Figure 3.—Dendritic drainage pattern developed by streams flowing entirely on the middle marl, west side of White Rock Lake.

Cross-sections of the fillings do not occur in enough abundance to allow a determination of the drainage pattern formed by the fillings.

## Origin of the Channel Fillings

Any hypothesis which attempts to explain the origin of these channel fillings must account for three things: (1) the agent, or agents, which carved the channel troughs that contain the fillings, (2) the agent, or agents, which later filled these troughs, and finally (3) the process by which the fillings were brought to their present position on the divides.

*Carving of the Channel Troughs*—The channels beneath the fillings possess flat bottoms and steep sides and in transverse profile show a marked similarity to present stream channels cut in the middle marl.

It may be concluded, then, that these ancient troughs owe their indenture in the country rock to the eroding action of streams. Moreover, it is reasonable to assume that these ancient streams, like their modern counterparts, were not controlled in their patterns by joints; hence, they likely had a dendritic drainage pattern.

*Method of Filling*—Three agents of deposition may be appealed to in order to explain the filling up of the troughs: (1) the wind, (2) streams, or (3) some purely mechanical agent, such as slumping.

If the wind had acted as the depositional medium, the fillings would be expected to be relatively homogenous, consisting of fine grains of sand, silt, or clay. Since the fillings are heterogeneous, consisting of a clay matrix in which are embedded pebbles and cobbles of chalk, marl, and shale up to 5 inches across, the wind must be ruled out as the predominating agent of deposition.

In order to determine whether or not streams acted as the depositional medium the character of the channel fillings was compared with that of known stream-laid deposits in the same area, the latter deposits having the same rock source as the channel fillings.

One quarter of a mile north of Filling 1 in a similar railroad cut there is a terrace deposit which is set into one of these channel fillings (Figure 5). The terrace deposit presents a typical terrace profile in transverse cross-section and consists predominantly of a fine-grained, cream-colored sandstone made up largely of calcareous foraminiferal tests. Within the sandstone mass occur lenses of chalk gravel and of finely laminated clays; cross-bedding is also present.

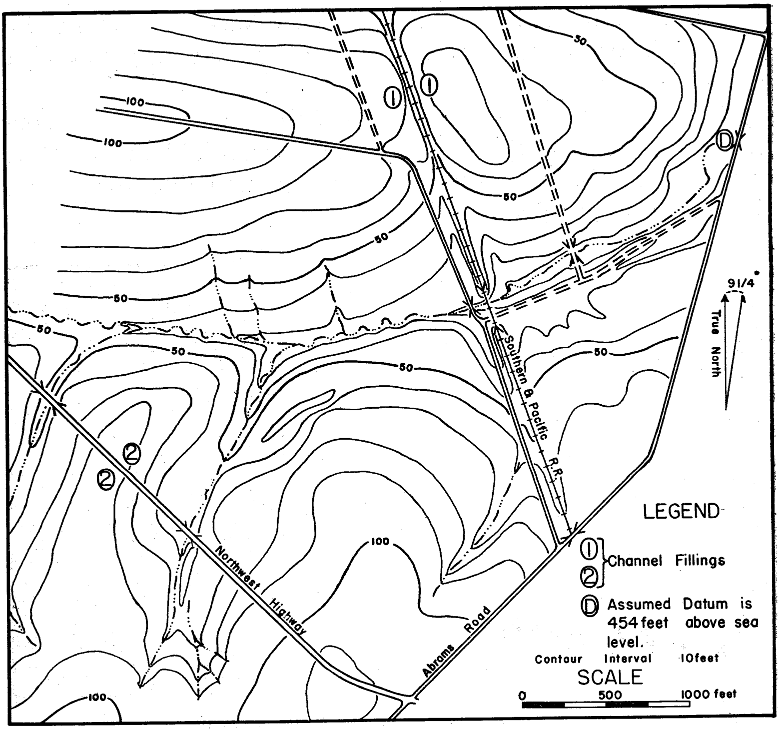


Figure 4.—Topographic map showing position of two channel fillings on the crests of interstream divides.

Other deposits along the banks of some of the present streams in the area are relatively well sorted and rudely stratified in layers and lenses of gravel separated by layers of silt, sand, and clay. Moreover, many of the gravel particles are arranged in imbricate fashion. These deposits are beneath the present flood-plain level, and it cannot be denied that they represent floodplain deposits of the present streams.

The massive channel fillings contrast strongly with the stratified stream-laid deposits, and such depositional features as cross-bedding, imbricate arrangement of gravel particles, and evidences of sorting are entirely lacking in the fillings. It can be seen from Figure 5 that this dissimilarity is further emphasized by the different ways in which the two deposits are being weathered and eroded—

the filling being striated vertically with small rills while the terrace deposit tends to weather along slanting lines of cross-bedding.

In view of the marked contrast in character and appearance between the fillings and the stream-laid deposits, it would seem that streams were not responsible for filling the channel troughs.

Figure 5.—Terrace deposit set into channel filling.

At intervals along the steep banks of some of the present streams flowing on the middle marl there occur small rockfalls in which fragments of the country rock drop into the stream beds. Such rockfalls may have contributed to some extent to the filling of the ancient channel troughs, but it seems a more massive rock movement, approaching slump proportions, would be necessary to fill troughs of the width and depth of these.

So far as has been observed no slumping of the type described by Sharpe[3] is actually occurring in the middle marl today. Yet it is possible that under more humid climatic conditions than now prevailing, heavy precipitation may have so lubricated the argillaceous marl as to cause it to slump into stream gullies and channel-ways. If this action

[3]Sharpe, C. F. Stewart, *Landslides and Related Phenomena,* Columbia Univ. Press, 1938.

continued for a reasonable length of time, the channel-ways would have been slowly filled, at least in their lower parts, with clayey masses of weathered marl and shale together with fragments of chalk, marl, and shale. Moreover, because of the slumping movement, these fragments and the clay surrounding them would undergo no sorting process; hence, there would be a jumbled arrangement of fragments in a clayey matrix.

The character of the channel filling more nearly resembles that of a deposit derived under the above described conditions than that of one deposited by the wind or streams. However, since there is no direct evidence that slumping is now occurring or has ever occurred in the middle marl, such a process of filling must be considered hypothetical.

*Present Position on Divides*—If the same agent which cut the channel troughs did not fill them, the cyclic process of channelling and filling can not be used to explain the origin and present position of the fillings.

In order to understand fully the events which may have taken place in the history of these fillings, three facts should be recalled: (1) the fillings occur in the middle marl of the Austin, (2) present streams flowing on the middle marl possess a dendritic drainage pattern, and (3) present streams flowing on the lower chalk have their courses governed by jointing. With these facts in mind, it is proposed that the following sequence of events may have occurred in the geological history of the area studied.

At some past time on the middle marl in the White Rock area there existed a drainage system of dendritic pattern. When the trunk streams and some of their larger tributaries cut through the middle marl and established courses on the massive layers of the lower chalk, they became influenced by joints in the chalk and adjusted their courses to conform with the jointing. From time to time tributaries were sent off which ate headward into the middle marl, their courses also being governed by jointing in the chalk. Thus began to grow another drainage pattern, roughly rectilinear in character.

Stream piracy followed as the joint-controlled streams gradually encroached upon the streams flowing entirely on the middle marl. Eventually, with continued shifting of drainage lines, piracy reached its peak; the joint-controlled, rectilinear drainage pattern began to destroy the dendritic pattern.

With the action of such a process as this, many of the stream troughs cut in the middle marl came to occupy interstream divides where possibly slumping, rockfall, and soil wash acted to fill their lower parts. Finally, continued subaerial erosion shaped the landscape into its present form.

It is significant that in a sequence of events such as this the area affected is gradually lowered along shifting lines of drainage, rather than lowered continually along the same drainage lines.

## Age of Channel Fillings

Since in the fillings there were found no fossils which would date them, they can only be assigned a relative age. It can be said that they are younger than the Cretaceous Austin in which they are set. Since the terrace deposit shown in Figure 5 is, as far as the author has observed, the oldest White Rock Creek terrace, the fillings can be said to be older than the oldest observable White Rock Creek terrace deposit. The age of the latter deposit is unknown, but probably like the lower Trinity terrace, it is Pleistocene[4].

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[4]Shuler, Ellis W., *Terraces of the Trinity River, Dallas County, Texas,* Field and Laboratory, vol. 3., no. 2., pp. 44-53.