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REPORT ON STREAM TERRACES WITH SPECIAL REFERENCE TO SAND AND GRAVEL DEPOSITS AS A PART OF A MINERAL RESOURCE SURVEY IN CLAY COUNTY, TEXAS

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In the north and northeast parts of Clay County an area of approximately 70 square miles is covered by fluviatile deposits including the present stream valleys and the ancient terraces, or flood plain remnants, of Big Wichita and Red rivers.

Terraces Between Big Wichita and Red Rivers

That portion of the county which lies between these rivers is a broad gently rolling tableland covered entirely by terrace material, except along the bluffs bordering the valleys where the underlying bed rock (Wichita clays, shales, and sandstones of lower Permian age) is occasionally exposed. In this interstream area at least three separate terraces or terrace remnants can be distinguished on the basis of their general topographic position and by information gained from gravel tests and well records; however, the terraces are but poorly defined, as they have been partly removed and in places merged by erosion into a gentle slope. Sand dunes along the Red River margin may also effectively conceal terrace boundaries.

These fluviatile deposits which are composed of alluvial clay, sandy loam, sand, gravel, silt, and the secondarily deposited caliche, named in about the order of their abundance, exist in varying thickness due to depositional conditions and to denudations by erosion. The maximum known thickness of the deposits of the third, or highest, terrace of this interstream area is 42 feet; its basal sands and gravels carry an abundance of fresh water which often forms hillside springs at the outcrop. This terrace (114,72—the first number representing the height in feet of the upper surface of the terrace above the average low water level of Big Wichita River and the second number representing the height in feet of the terrace base above the low water level) owes its origin to both rivers, for, in this interstream area, the high terraces of Big Wichita are apparently confluent with those of Red River and probably represent Pleistocene deposition in a single valley occupied by both rivers. This condition is duplicated at the present time in the broad triangular-shaped valley below the interstream divide where the Big Wichita channel is intrenched in the south side and, in places, impinges against the bed rock of the valley wall, while Red River, in making its big bend around the Petrolia uplift, occupies the north margin of the valley. Both rivers have taken part in building this very fertile valley, and their flood waters still cover parts of the lowest terrace during periods of extreme rainfall. From an average based on five measurements made from both rivers, the base of the third terrace in the interstream area is approximately 72 feet higher in elevation than the average low water level.

Terraces South of Big Wichita River

On the south side of Big Wichita River the 114-foot terrace is but sparsely represented. Remnants of coarse basal terrace gravel still form protective caps on some bluffs and on occasional isolated hills bordering the river. The terrace material, because of its greater resistance to erosion, has persisted, while the readily decomposed red beds have been removed.

Terrace 121+,115.—The oldest generation of stream deposition in Clay County of which there is evidence at the present time is believed by the writer to be represented by a partly consolidated sandy gravel from 1 foot to 6 feet thick that caps some

In the Mineral Resource Survey circulars, terraces are designated by the formula X,Y in which X is height of top of terrace and Y, height of base of terrace above average low water level in the streams. Actual values are inserted for X and Y when known.

comparatively high ridges and bluffs on the south side of Big Wichita River about 1½ miles west of Byers. The base of the terrace remnant is resting on Permian bed rock about 115 feet above the low water level of the river. The bluffs and ridges owe their relief partly to the resistant character of these terrace gravels and partly to the somewhat nodular cross-bedded sandstone stratum upon which they are resting. This terrace is not paired with another terrace across the river in the interstream area nor was any other terrace base found at this elevation above the low water level of the river. This locality has been worked to some extent for concrete material, but the conglomeratic layers formed by cementation of the gravels, the intimate mixture of surface soil in much of the unconsolidated material, and the limited quantity present make the deposit of questionable value except for local small-scale use.

In the basal material of this terrace, which is composed mostly of coarse well-rounded quartz pebbles, a number of water-worn pieces of granite and other igneous rock are present. Since both Big Wichita and Red rivers lie between this deposit and the Wichita Mountains of Oklahoma, to which the granite pebbles owe their origin, the igneous material in this deposit must have been derived secondarily from now extinct higher terraces of Red River. Granite pebbles and cobbles are fairly common in all the high terrace gravels of both rivers that were examined but are rare and often entirely absent in the samples taken from the lower terraces.

Terraces of Red River

The best developed terraces in Clay County roughly parallel Red River to the northeast, east, and southeast of Byers. There are at least four of these terraces that in places form a stair-step arrangement above the present river flood plain. Their width east of Byers ranges from 0.4 mile to a maximum of about 1.4 miles, and their thickness, according to a few well records, ranges from 15 feet to about 60 feet.

The terraces of this area cover a territory of six or eight thousand acres in which bed rock is exposed only occasionally by small creeks cutting through the stream deposits and along the bluffs bordering the present river valley. The time at our disposal was not sufficient to determine the average thickness of the several terraces or their elevation above the low water level of Red River, and only a very few measurements were possible. Terrace 20, 2 discussed in a later paragraph, which is found in scattered remnants on both the surface of the flood plain terrace, is not present at this locality. The terrace next higher in succession, however, is present. At one place east of Byers its surface was found to be 55 feet above the low water level of Red River and its base 24 feet above the low water, and it may, therefore, be designated as terrace 55,24. Above this terrace are at least three older terraces, each in succession about 10 or 15 feet higher than the one preceding it. The average thickness of these higher terraces is unknown, but the deposits are as much as 60 feet thick in some places.

Terrace x,**60.**—In northeast Clay County, just above the mouth of Little Wichita River and about 12 miles downstream from the terraces discussed in the above paragraph, two high terraces, occupying different elevations and badly dissected by erosion, still cover an appreciable area of the upland bordering the river. The higher of these terraces attains a thickness of more than 60 feet, and its base is nearly 60 feet above the alluvial valley of Red River. This and other localities will be referred to subsequently in the report under the description of tests made for sand and gravel.

Terrace **20,2.**—The second terrace of both Big Wichita and Red rivers, that is, the first terrace above the present flood plain, exists for the most part as scattered remnants resting on the gently sloping valley walls. This intermediate terrace does not attain the extent or the thickness of the higher terraces. It is best developed in the interstream area northwest of Byers. The average elevation of this terrace above the present river flood plain is about 20 feet, and its average thickness, as estimated from well records and a few measurements, is approximately 18 feet.

Flood Plain Terrace

The lowest terrace of Big Wichita River is its present alluvial valley, and parts of it are still subject to flooding. The valley averages about 3 miles in width in Clay County, and its sediments are known to be as much as 44 feet thick in places, although the average thickness is somewhat less. The river channel meanders widely across its flood plain and has formed several ox-bow lakes within recent years. Except in a few places where the channel cuts into the bed rock of its valley wall, the river is running on its own alluvial fill. The flood plain terraces were for the most part eliminated from the possible sources of sand and gravel, as this material commonly makes up the basal portion of terrace deposits and, in the valleys still in the process of building, is overlain by a relatively great thickness of alluvium. They, unlike the higher terraces, have not been subjected to erosion long enough to have much of the overburden stripped off the basal sands and gravels.

Importance of Terraces

In those parts of the county where stream terraces cover any considerable area, they are economically important land features because of the fertility of their surface soil and the abundance of fresh water in their basal gravels which provides a constant supply for many shallow wells. They are of considerable geologic interest because they represent interruptions of old erosional cycles, that is, before peneplanation was completed, rejuvenation and downcutting of the valley took place leaving these ancient flood plain remnants as evidence of stream history, due either to a marked change in the volume of water carried by the stream or, what seems more likely, to a series of minor uplifts of the region affected. Also the basal sands and gravels of the terraces are important as a potential source of concrete and road surfacing material. It was these last named resources that occupied the chief attention of the mineral survey.

A number of localities were examined in which no actual testing was done. In a few of these, already existing pits, outcrops, and ditches cutting through the deposit supplied sufficient information as to the quality and extent of the material, and in others the value of the deposit seemed too problematic to warrant testing and was passed by for more favorable locations. It should be understood that even though, in some cases, no good deposits were located, the entire possible sand and gravel producing area should not be condemned as lacking in these resources, for actual tests were necessarily restricted by limited time to only such localities as seemed most promising.

A list of locations in Clay County where sand and gravel deposits can be found will be given together with a description of the material, the accessibility of the location, the quantity of workable material and its ratio to the overburden and some observations on the deposit.

1. Locality: A. H. Bevering Survey, about 2 miles northeast of Charlie.

A gravel pit that has been worked at intervals for several years is located in a high stream terrace near the top of a narrow elongated ridge that lies adjacent to and parallel with Red River for about 3 miles. The ridge is separated from the tableland divide between Big Wichita and Red rivers by a broad valley that extends from Red River in a southeasterly direction to Big Wichita Valley and which represents a deserted channel of Red River. Gravel from the Bevering pit has been used fairly extensively for road surfacing material in this county, but has not proven very satisfactory. The gravels lack uniformity of size and contain insufficient binding material and for these reasons will not maintain an even surface under traffic. The strong tendency of road beds made of the material to pit or corrugate may also be attributed in part to the high percentage of fine-grained material present that has no plastic or binding qualities. The best feature of this locality is the large amount of gravel present; tests revealed a considerable area underlain by a stratum of gravel averaging 6 feet in thickness, much of which could be obtained by removing a comparatively light overburden. The material overlying the gravel is composed of alluvial clay, sandy loam, and dune sand, the thickness of which varies with topographical irregularities.

The gravels are composed mostly of variegated quartz pebbles, but quartzite, flint, claystone, silicified wood, and pieces of granite, sandstone, and conglomerate are also present in smaller quantities. Organic and calcareous material is mixed with the gravel and often forms black or gray coatings on the pebbles. The basal terrace deposits contain a number of large cobbles of red granite from the Wichita Mountains of Oklahoma. The terrace is of Pleistocene age and rests unconformably on Permian argallites and sandstones.

From a bluff on the north side of the ridge the following section was taken:

	Thickness in feet
Top of ridge.	
Terrace and dune deposits	22.4
Erosion surface.	
Red clay	3.0
Sandstone	3.7
Red clay with interbedded shale	42.1
Sandstone, thin bedded	7.4
Clay and talus	6.5
River flood plain.	

2. Locality: On S. P. Jackson's farm, 8.2 miles northwest of Petrolia and about 2 miles south of Charlie, 1 mile north of Big Wichita River (18,62 terrace).

A pit at this location has been worked on a small scale for several years by local users of both sand and gravel. The deposit is a high terrace remnant of Big Wichita River, the base of which is resting on Permian clay at an elevation of about 70 feet above the low water level of the river. The terrace deposits consist of gravel with included lentils of sand, alluvial clay, sandy loam, and secondary caliche. The gravel is composed of quartz, quartzite, flint, small igneous pebbles, and a few well worn fossil marine shells. Most of the gravel is of a dark color due to a covering of manganese from decayed vegetation. The sand is composed primarily of well-sorted subangular quartz grains; some of the sand lenses are stained a bright yellow by iron oxide probably derived from the decomposition of some of the highly micaceous igneous rock particles that are abundantly mixed with the sand and gravel.

The workable material is of good quality but is present in too limited quantities to justify the removal of the relatively great overburden, except in cases where only a small amount is needed and the distance of transport is short.

A vertebrate fauna of some diagnostic value, including elephant and horse, was taken from the bottom 3 feet of gravel in this pit.

3. Locality: On the Bob Waggonner ranch, owned by T. P. Duncan, 3 miles west of State highway No. 148, and one-half mile north of Big Wichita River (20,2 terrace).

A number of tests at this locality revealed a bed of gravel making up the basal portion of the second terrace of Big Wichita River, the average thickness of the gravel bed being about 7.5 feet and the maximum thickness being 14 feet. The base of the terrace in which the deposit is located is only slightly above the surface level of the alluvial valley. The gravel is fairly well

sorted and contains a considerable percentage of alluvial clay, organic matter, and sand which have binding qualities that should make this material well adapted for road surfacing material, as the quantity of large pebbles in the gravel is not enough to make it undesirable for that purpose. The overburden which consists primarily of alluvial clay and soil is not great enough to present any serious problem of removal, being only about 3.5 feet thick as estimated from an average of the various tests.

This deposit should be a valuable potential supply of road surfacing material, for the location is immediately adjacent to a good dirt road, the quantity of workable material is large and is covered by comparatively light strippings, and the gravel is of a very durable composition, being made up mostly of quartz, flint, and claystone concretions. The binding material is believed to be present in sufficient quantity and possessed of sufficient plasticity to prevent corrugating of the road surface under traffic as is common of road beds made of inferior materials. The best location for a pit in this deposit would be just south of the valley road in front of the ranch house, and preferably toward the west edge of the ridge (terrace remnant) that extends beyond the road into the field.

4. Locality: On the Glasgow farm, about 0.8 miles southwest of the Charlie bridge on Big Wichita River and about 0.3 miles west of State highway No. 148 (20,2 terrace).

This location was not tested by the survey, as pits opened by local users of concrete material had already proven the sand to exist in workable quantities. The deposit is in a remnant of the second terrace of Big Wichita River and has a surface elevation some 20 feet above the valley level. The sand is composed of medium fine-grained subangular quartz particles mixed with a considerable quantity of gravel and with some clay balls and other foreign matter. When washed and screened, this sand has proven quite satisfactory and makes a good grade of concrete. The overburden or strippings is great enough to be an objectionable feature of this pit as it is now located, but since the deposit is quite large and since the surface is lower in some places on the same terrace remnant, it is highly possible that a great deal of the sand could be obtained by removing a reasonable amount of strippings.

5. Locality: On the W. H. Smith farm, 3.5 miles east-northeast of Byers on a sloping face of a bluff on the south side of Big Wichita River. Elevation of top of the terrace, 110 feet, and of bed rock, 70 feet above low water level. This is probably the 114-foot terrace.

This location is at the outcrop of a high terrace and has been worked from one pit to a small extent. The workable material of this locality is a very good quality sand, being composed of medium coarse subangular to sharply angular quartz particles and is unusually free from foreign matter. The sand, which has an average thickness of 4 to 5 feet, is resting on a thin bed of water-bearing gravel, which, in turn, is resting on Lower Permian argallites and sandstones. The overburden is made up of alluvial clay and sandy loam and varies over the area tested from 3 to 7 feet in thickness. Since the sand apparently lies nearly horizontal beneath the upper terrace deposits, it is only on the slopes near the outcrop that this location could be worked profitably. However, a considerable quantity of good sand could be obtained by working at essentially the same elevation around the slope.

A section taken with a hand level and stadia rod from the low water level of Big Wichita River to the top of the bluff is as follows:

	Thickness in feet
Top of bluff.	
Sandy loam	22.0
Gravel, sand, and alluvial clay	18.0
Erosional surface.	
Clay and shale	5.8
Cross-bedded sandstone	10.5
Red clay	41.5
Alluvium	12.0

The terrace in which this deposit is located in one locality at least reaches a thickness of 65 feet.

6. Locality: Henry Zachry's farm on Red River, about 2 miles above the mouth of Little Wichita River (x, 60 terrace).

The base of a high terrace deposit at this locality contains some of the best concrete material in Clay County. Above the bed rock of the Red River valley walls, the terrace edge has been formed into a gentle slope by erosion, and near the base of the slope most of the overburden has been removed leaving the sand within a few feet of the surface. The sand is composed of coarse angular quartz particles and varies in thickness from 3.5 to 9 feet. To obtain this sand it would be necessary to remove about one yard of strippings for every yard of sand, unless only a small quantity should be desired, in which case a small pit could be made at the outcrop where there is very little overburden present.

A section of the bluff upon which the high terrace is resting is as follows:

	Thickness in feet
Top of bluff.	
Stream deposits	43.5
Erosional surface on bed rock.	
Sandstone	13.5
Clay and shale	40.0
Surface of flood plain.	