SECTION B, GEOLOGY

The Washita River, A Preliminary Report

ALEX R. ROSS, Department of Geology, Oklahoma State University

The Geology Department of Oklahoma State University is cooperating with the Agricultural Research Service of the United States Department of Agriculture, Soil and Water Conservation Research Division in a comprehensive study of the Washita River Watershed. The Geology Department is supplying the personnel to investigate the geologic conditions in the watershed, to study the effects of these conditions on channel stability and sedimentation, and to develop the geomorphic history of the river.

During June, 1961, I traveled by boat down the Washita River from mile 538, three miles west of Hammon to mile 519 at the upper end of the Foss Reservoir and from mile 500, just below Foss Dam, to mile 107 at Crusher (Big Canyon) where the Washita cuts through the Arbuckle Mountains. The starting point was determined by the farthest point upstream at which there was sufficient depth of water to travel by a small outboard motor boat, and at which the river could be reached by car and boat trailer. Further examination of the river was made upstream as far as Cheyenne, Oklahoma, at all points that could be cenveniently reached by car.

PURPOSE

The purpose of the trip was to become familiar with the general channel and bank characteristics of the Washita River to aid in programming channel and bank stability studies, sedimentation studies and geomorphological studies. The only suitable base maps immediately available were photo mosaic index sheets with a scale of approximately one inch to the mile. This small scale permitted only general items to be marked on the map. These items consisted primarily of rock outcrops and areas of active bank ersoion. Notes were taken of other items of interest and were locatd by reference to the river mile as shown on the U. S. Corps of Engineers 1939 Washita River Survey.

GENERAL OBSERVATIONS

That part of the Washita River under study can be divided into five reaches as given below:

1. Cheyenne, Oklahoma, mile 570 to mile 545, about six miles west of Hammon.
2. Mile 545, six miles west of Hammon to mile 519 at the upper end of Foss Reservoir (when it fills).
3. Below Foss Dam, mile 500, to the mouth of the Little Washita River, mile 270.
4. Mouth of Little Washita River, mile 270, to mile 118, about three miles south of Davis.
5. Mile 118, three miles south of Davis to mile 107 at Crusher.

Reach #1

In this reach the channel is wide, shallow and sandy. The low and unstable banks have allowed considerable shifting of the channel laterally with resultant destruction of the flood plain. The flood plain has been further damaged by flooding and deposition over it of sandy sediment.

According to the U.S. Bureau of Reclamation studies, these changes have occurred since 1917. Prior to this time, the channel is reported to have been narrow and deep.

Reach #2

The channel in this reach appears to be comparatively stable. The banks are stable and higher than in Reach #1. Trees are denser and more continuous along the banks than in Reach #1. This reach is not a problem area at the present time.

Reach #3

Through this entire reach the channel shows the same general characteristics — steep, high banks and relatively narrow channel. Erosion of the banks is taking place along the outsides of meanders but at a slow and normal rate. Fill occurs opposite the cut banks apparently at the same rate so that there is no marked tendency towards widening of the channel. For a short distance below Barnitz Creek, near Clinton, the channel and banks show some signs of deterioration. Banks here are steeper, channel broader and sandier and more active bank erosion is going on or has occurred. Throughout the entire reach the banks are more or less continuously lined with trees, ranging from a thin row to dense woods. This reach is also characterized, more than any others, by snags and log jams. Wherever the channel is completely on one side or the other of the alluvial valley, bedrock may be exposed. This is true of all reaches. Reach #3 is about 230 river miles and there are about 70 bedrock exposures in this distance. Obviously bedrock control is not the explanation for the stable character of this reach.

Reach #4

Throughout nearly all of this reach, bank erosion, channel widening and excessive changes in channel pattern constitute a serious problem. The channel shifts so rapidly that five-year-old photos often show little resemblance to the present channel pattern. Bank materials appear to be sandier than at any place upstream except in Reach #1. In general, bank and channel deterioration increase downstream from the mouth of the Little Washita. There is a marked increase in bank deterioration and channel instability below the mouth of Rush Creek at Pauls Valley. From Maysville downstream there are fewer trees along the banks, many miles of the banks having no trees whatsoever. From Lindsay downstream many bank protection devices have been used. Stone rip rap appears to be most effective, then old car bodies, Kelner jacks and finally various types of timber piling are least effective in preventing further bank erosion.

Reach #5

Due to the much more extensive occurrence of bedrock in this reach, the channel and banks are highly stable. Trees line both banks nearly continuously. The flood plain areas appear to be largely utilized for grazing, with little cultivated area.

STRATIGRAPHIC SUMMARY

The bedrock exposed along the Washita River from Cheyenne to Davis consists of sedimentary rock of Permian age. From Davis to Crusher, the bedrock is from Pennsylvanian to Ordovician in age.

Table I summarizes the bedrock stratigraphy of the Permian of the Washita Valley from Cheyenne to Davis.

Table I. Permian Formations

Group	*Formation*	*General Character*
Whitehorse	Cloud Chief	Shale, silt stone and gypsum
	Rush Springs sandstone	Fine grained, even to cross-bedded sandstone. Minor amounts of silty shale.
	Marlow formation	Sandy gypsiferous shale — 10′ sandstone (Verden SS) near middle
El Reno	Dog Creek shale and Blaine formation	Shale with interbedded gypsiferous sandstone and, locally, gypsum beds
	Chickasha formation	Heterogeneous mixture of sandstone, shale, siltstone and siltstone conglomerates. Sandstones are lenses enclosed in shale.
	Duncan sandstone	Sandstone with minor amounts of shale and siltstone conglomerate.
	Hennessey shale	Shale and silty shale with some sandstone lenses
	Garber sandstone	Shale, sandy shale, and sandstone
	Wellington formation	Shales, sandstone, and some limestone

Along the Washita River the bedrock is the Cloud Chief formation from Cheyenne to Mountain View, the Rush Springs sandstone from Mountain View to Anadarko, the Marlow formation from Anadarko to Verden, the El Reno group from Verden to Lindsay, the Hennessey shale from Lindsay to Maysville and the Garber and Wellington from Maysville to Davis. Below Davis, the river crosses the north margin of the complex Arbuckle structure, encountering beds older than Permian.

Pre-Permian Formations. The Pre-Permian rocks range from Pennsylvanian to Ordovician in age. No attempt is made here to separate the formations. Lithologically, limestone is dominant, with shales and sandstones also present. These beds are found within an air line distance of twelve miles and are complexly folded and faulted.

General Geology

The dominant geologic structure in southwestern Oklahoma, north of the Wichita Mountains, is the Anadarko Basin. It is an elongated basin with no topographic expression. The axis of the basin trends about west-northwest and the basin is very asymmetrical, steep on the south side and gentle on the north. The Anadarko basin is bounded on the south by the Wichita Mountain uplift and on the southeast by the Arbuckle Mountain uplift.

From the Texas border west of Cheyenne to Clinton, the Washita River flows approximately parallel to, but north of, the axis of the basin.

The bedrock through this area dips very gently southwest.

At Clinton the Washita changes to a more southerly direction, flowing at an angle to the axis of the basin, so that by the time it reaches Mountain View it is more or less on the axis. The dip of the bedrock in this portion changes from southwest at Clinton to west at Mountain View.

From Mountain View to Pauls Valley the Washita flows more or less along the axis of the eastern half of the Anadarko basin. The rocks here dip very gently westward.

At Pauls Valley the Washita again changes to a southerly direction and flows out of the Anadarko basin into and across the Arbuckle Mountain uplift. The complex Arbuckle Mountain structures are first visible in the general vicinity of Davis. The bedrock dips very gently west in the Anadarko basin, but in the Arbuckle complex dips may be in any amount or direction.

For the whole Washita Valley above Crusher, the surface bedrock is youngest at the west end, along the Texas border and becomes progressively older downstream.

With the exception of that portion of the river between Mountain View and Anadarko, the extremely limited outcrops and the lensing nature of the sandstones that are present means there is little possibility of much gain or loss of water to the bedrock. Added to this is the fact that the bedrock dips westward and there are no surface exposures of these beds to the west, except at elevations higher than the exposure in the area investigated. This means that there is no outlet for any ground water in these beds, except through wells; therefore, those beds permeable enough to contain water are probably already saturated and thus will not affect stream flow. In the Mountain View to Anadarko portion, however, the Rush Springs porous sandstone is the surface rock. Throughout this portion of the river, seepage from the alluvium can be observed. This is interpreted as reflecting the better water transmitting character of the Rush Springs sandstone. Precipitation percolates into the sandstone and thence to the alluvium and to the river.

Ground water conditions within the alluvium are essentially unknown at the present time.

Geomorphic History of the Washita Valley

The alluvial deposits in the Washita Valley record three distinct cycles of development, each cycle consisting of erosion followed by deposition. In the first cycle a broad valley was eroded in the bedrock, probably deeper than the present valley. This valley was then filled, beginning with coarse sand and gravels, whose source lay far to the west, followed by finer sediments. The second cycle began with the formation of a new valley within the first but slightly narrower and possibly not as deep. The deposits of the first cycle were extensively removed leaving remnants as terraces. At many places all of the older deposits were removed, at least along the margins of the valley, so that deposits of the second cycle rest on bedrock at these places. This second valley was filled also, partly with reworked sediments of the first cycle, but mainly with fine sand and silt derived from the bedrock in the area. The deposits of the second cycle are at a lower level than those of the first cycle. The third cycle began with the excavation of a valley within the older deposits, but in a few places cut through to bedrock. This is the smallest of the three valleys. It has in turn been partly filled with alluvium, making the present flood plain of the river about ten feet below the terrace of the second cycle and eighteen to twenty feet above the normal river level.

The thickness of these various deposits is only very vaguely known. Most wells on the terraces are generally less than thirty feet deep and do not reach bedrock. One well at Alex has a total depth of 105 feet and ended in gravel. Two others a mile or so north of Verden encountered bedrock at 97 feet. The deposits, therefore, have a known maximum thickness of at least 105 feet.

Whether or not the Washita is still in the third cycle has yet to be determined. In the areas of channel and bank deterioration, it is probable that a fourth cycle is under way.