E

MORPHOLOGY OF THE SALT RIVER: STEWART MOUNTAIN DAM TO PHOENIX, ARIZONA

Troy L. Péwé
Department of Geology
Arizona State University
Tempe, Arizona

Registered Geologist
State of Arizona
Registration No. 6445

October 24, 1966

REGISTERED GEOLOGIST
CERTIFICATE NO.
6445
TROY L.
PEWE
Date Signed 10/24/66
ARIZONA, U.S.A.

IA Phx Area Office
ights Protect. Div.
alt River Res.
orphology of Salt River, Stewart Dam

MORPHOLOGY OF THE SALT RIVER: STEWART MOUNTAIN DAM TO PHOENIX, ARIZONA

Troy L. Péwé
Department of Geology
Arizona State University
Tempe, Arizona

INTRODUCTION

The Salt River is a major tributary of the Gila River, and received its name from the large saline content that it carries. The Salt River was first named by the Spaniards who called it Rio Salina.

From its head in Arizona's Central Highlands region, to its junction with the Gila River in the Basin and Range Lowlands, the Salt River travels a course of more than 175 miles. The reach of the river reviewed in this report is from Stewart Mountain Dam to Phoenix -- a distance of 35 miles. A series of 5 dams, Roosevelt, Horse Mesa, Morman Flat, Stewart Mountain, and Granite Reef, with a total reservoir capacity of 374,755 acre feet, cause the river in this reach to be without water most of the time. Prior to the construction of the dams the river was also classed as unnavigable.

GEOLOGIC DESCRIPTION

Lee's (1905) classic description of the geomorphology of this region more than suffices to summarize the Quaternary geologic history. "The so-called valleys of the Salt and Gila Rivers are but parts of a broad plain occupying a large portion of southwest Arizona. The valleys are in part surrounded by mountainous peaks, and they themselves, in turn surround isolated peaks in groups of mountains which rise abruptly from their surface."

In keeping with this characteristic of the desert stream, the flow of the Salt River through the Basin and Range regions, except in times of flood, was (even prior to dam construction) generally underground through the Quaternary clastic deposits. In the area of Tempe, however, bedrock lies close to the surface and the water may flow at the surface, but elsewhere be subsurface. The average run off for the Salt River system above Roosevelt is about 600,000 acre feet per year (Cross, Shaw, and Scheifle, 1960, p. 102).

Flooding in the Central Highlands region is usually caused by storms that move eastward from the Pacific Ocean in the winter and early spring. Many large floods have occurred, as in February of 1891 when the Salt River's peak flow reached 300,000 cubic feet per second. Other large floods have occurred in 1937, 1941, 1952, 1954, 1958, 1960 (Cross, Shaw, and Scheifle, 1960). In 1966 there was a flood in the Salt River through this reach, and measurements by the U. S. Geological Survey show that the peak flow of the 1965-66 flood at Tempe was 66,000 cubic feet per second (Aldridge, 1966).

The Salt River is a braided stream; it has a series of anastomosing channels, although only one or two are occupied except in time of flood. The stream is split into a number of intertwinned channels separated from each other by low islands, or channel bars.

The river has a floodplain that ranges from 500 feet to about 7,000 feet in width. The floodplain is defined as a strip of relatively smooth land, bordering a stream and over-flowed at time of high water (Leopold, Miller, and Wolman, 1964, p. 317). Despite the fact that the floodplain is built by the river as an overflow area, civilization has crowded its buildings onto this smooth lowland, and has been distraught when flooded. The floodplain of the Salt River is rarely flooded at present because of the dams upstream from Mesa, but nevertheless, floods and flooding still occur and always will.

A river shifts from one side of its floodplain to another, and the Salt River is no exception. Some streams may shift from one side to another in five years, while others take tens of years, and others take hundreds of years. Although no definite information is available, it would appear that from published observations, the Salt River shifts from side to side in the magnitude of 50 to 150 years. But this is an estimate because of artificial flow conditions imposed upon the river since the early 1900's.

As the regimen of the river changes, the result of climatic changes or tectonic activity (land uplift) in the area, the stream may cut down into the flat plain and create a new, more narrow floodplain at a lower level, leaving the fragments of the older upper floodplain as flat, bordering terraces standing above the modern floodplain. Such is what happened at least three times in the reach of the Salt River under discussion. The city of Mesa, for example, is on one of the upper terraces.

The edge of the lower terrace marks the outer edge of the modern floodplain of the Salt River and is prominently marked on Plates I, II, and III. The limits of the modern floodplain were determined by geologic study of the floodplain morphology from vertical overlapping aerial photograph coverage of 1936 and 1966. The Salt River has not flowed beyond these limits (the modern floodplain) for hundreds of years, if not thousands of years.

During the 1965-66 flood, the Salt River was confined to this limit and almost completely covered the floodplain (Plate I).

SALT RIVER SURVEYS AND MAPPING

The earliest record of a survey of the Salt River in the reach under consideration was that of Ingalls and Pierce of 1868. Although applying the most accurate methods of the day, when compared to the present map of the area made from aerial photographs (U. S. Geological Survey, Topographic Division, Washington, D. C., 1951) it is revealed that the river located by Ingalls and Pierce was placed outside the floodplain in at least 12 places (Plate II). In one place a river was placed 30 feet up on bedrock in the Usery Mountains. In 1888 Chilson "meandered" the TLP? ~~Left~~ right (north) bank with a series of stations connected by straight lines (Plate III). This was also done in 1910 in the Farmer survey (Plate III). At the northern end of the Farmer survey, the survey appears to follow a river terrace escarpment rather than the channel.

The most accurate map of the early period was made in 1902 and published in 1905 (Lee, 1905). This map (1902) shows the main channel following close to the southern border of the floodplain in certain areas. It is rather strange that Lee and his topographic engineers would place the river nearer the southern border of the floodplain and 8 years later

Farmer would place it near the northern border of the floodplain.

It is interesting to note that the successive positions of the main channel of the Salt River (Table 2), as measured in feet south of the north geologic border of the floodplain at Pima Road (on Range line between Ranges 4 and 5 east), for the last 88 years, reveals a progressive southward shifting of the river at about 150 feet per year (Figure 1). The shift is not regular and this figure is only a rough one because of the scale of the map; but nevertheless, a southward shift is apparent at this point.

CONCLUSIONS

Because of the methods used in early surveys of the position of the Salt River in the reach under consideration, the exact location of the river during those times is uncertain. The first modern map of the river was compiled by the U. S. Geological Survey in 1902.

The geologic borders of the present floodplain, as determined from aerial photographs and investigations in the field, have been in existence for several hundreds of years and the main channel of the river has no doubt been confined to these geologic boundaries during this period of time. Inasmuch as the river does meander continually from edge to edge of the floodplain, it is possible to call the entire floodplain the domain of the river. Therefore, the center of the floodplain, which is a line equidistant between the north and south geologic borders of the floodplain can rightfully be considered as the center of a braided river and its geologic domain when speaking geologically. The center of the river at any point in time is based on actual survey. Since the construction of Roosevelt Dam in 1911 the flow, meandering, and general characteristics of the Salt River downstream from the dam has been modified, and therefore, unnatural. Any attempt to use the position of the river for a boundary since construction of the dam (1911) would be resorting to artificial river conditions.

The most accurate survey of the position and condition of the Salt River in the reach between Phoenix and the mouth of the Verde River prior to 1911, and therefore under natural river conditions, is that by Lee and associates of 1902 published by the U. S. Geological Survey in Water Supply Paper No. 136 in 1905. The U. S. Geological Survey has been since its inception in 1879 the major topographic and map making agency of the federal government.

Table 1. - Salt River north bank positions

(In feet south of the edge of the north geologic border of the floodplain at range line between ranges 4E and 5E. Measured from Plate III.)

Date	Source	Distance (feet)
1868	Ingalls and Pierce survey	250
1888	Chillson	650
1902	Lee survey	275
1910	Farmer survey	75
1936	Aerial photographs	1000
1954	Aerial photographs	1500
1966	Aerial photographs (thread of main channel flow)	1800

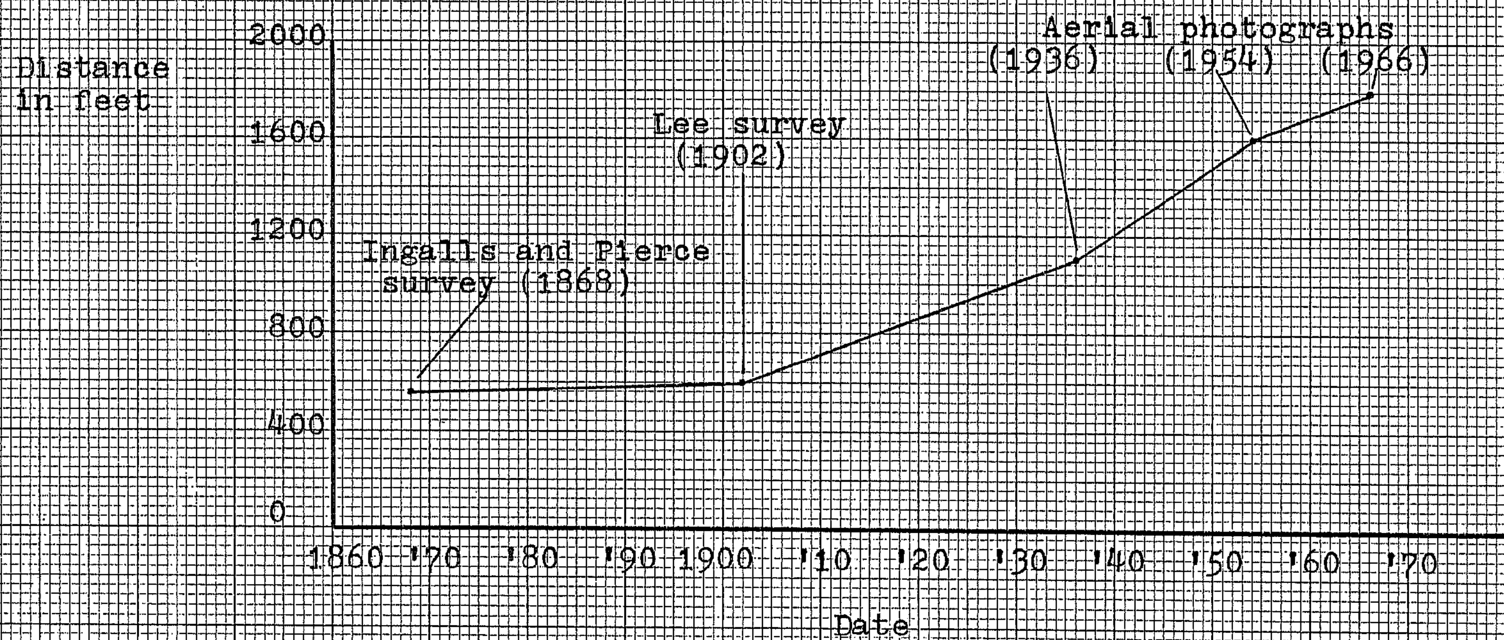
Table 2. - Salt River, center of main channel

(In feet south of the edge of the north geologic border of the floodplain at the range line between ranges 4E and 5E. Measured from Plate II.)

Date	Source	Distance (feet)
1868	Ingalls and Pierce survey	550
1902	Lee survey	600
1936	Aerial photographs	1100
1954	Aerial photographs	1600
1966	Aerial photographs (thread of main channel flow)	1800

Figure 1. - Position of Salt River channel

(In feet south of the edge of the north geologic border of the flood plain at the range line between ranges 4E and 5E)



REFERENCES CITED

Aldridge, B. M., 1966, Floods of December, 1965, to January, 1966, in the Salt and Gila Rivers downstream from Granite Reef Dam: U. S. Geol. Survey Open File Report.

Cross, Jack L., Scheifele, Kathleen, and Shaw, Elizabeth H., 1960, Arizona, its people and resources: The Univ. of Ariz. Press, Tucson, Ariz., 385 p.

Davis, Arthur Powell, 1897, Irrigation near Phoenix, Arizona: U. S. Geol. Survey Water Supply and Irrigation Paper No. 2, 98 p.

Lee, Willis T., 1905, Underground waters of Salt River valley, Arizona: U. S. Geol. Survey Water Supply and Irrigation Paper No. 136, 196 p.

Leopold, Luna B., Miller, John P., and Wolman, M. Gordon, 1964, Fluvial processes in geomorphology: W. H. Freeman and Co., San Francisco and London, 522 p.

MAPS USED

Chillson, L. D., 1888, Survey of meanders of right bank of Salt River, Township No. 1 North, Range No. 5 East of the Gila and Salt River Meridian, Arizona, scale 40 chains to an inch.

Farmer, R. A., 1910, Resurvey of fract. Township No. 1 North, Range No. 5 East of the Gila and Salt River Meridian, Ariz., scale 40 chains to an inch.

Lee, W. T., 1902, Map of Salt River valley, Arizona: U. S. Geological Survey Water Supply Paper No. 136 (1905), scale 1:42,000 (approx.).

Pierce, Wm. H., and Ingalls, W. F., Survey of 1867-68, G.L.O. survey plats. Nos. 00004; 00005; 00009; 00015; 00018; 00021; 00091; 00095; and 00098, scale 1:31680.

U. S. Geol. Survey quad. Buckhorn, Ariz., 1956, base from aerial photographs taken 1955, scale 1:24000.

U. S. Geol. Survey quad. Granite Reef Dam, Ariz., 1964, base from aerial photographs taken 1962, scale 1:24000.

U. S. Geol. Survey quad. Mesa, Ariz., 1952, base from aerial photographs taken 1951, scale 1:24000.

U. S. Geol. Survey quad. Stewart Mtn., Ariz., 1964, base from aerial photographs taken 1962, scale 1:24000.

U. S. Geol. Survey quad. Tempe, Ariz., 1952, base from aerial photographs taken 1951, scale 1:24000.

AERIAL PHOTOGRAPHS USED

Aerial photographs, 1936 and 1938, for Soil Conservation Ser., Dept. of Agriculture, by Fairchild Aerial Surveys, Inc., Los Angeles, Calif., March 10, 1936: L 1729-30, 1734-35, 1811-13, 1820-22; March 19, 1936: L 1870-72, 1939-41, 1951-53, 2013-15, 2028-30; March 27, 1936: L 2110-12, 2125-26; Nov. 25, 1938: BPO 3207-3209, scale 1:16000.

Aerial photographs, December 31, 1965, for Highway Dept., state of Ariz., 10-1 to 3, scale 1:800; 12-1 to 2, 13-1 to 8, 14-1 to 8, 15-1 to 11, 16-1 to 6, 17-1 to 10, 18-1 to 11, 19-1 to 9, scale 1:1000.

Aerial photographs, 1954, for U. S. Geol. Survey, January 11, 1954: DHP-2N-33 and 53; January 26, 1954: DHP-6N-17 and 19, scale 1:16900.