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GEOHYDROLOGY OF THE SAFFORD INNER VALLEY

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INTRODUCTION

The following report describes a 25-mile interval of the Gila River between Section 1, T. 7 S., R. 27 E., and Section 1, T. 6 S., R. 24 E. as shown on the index map (Fig. 2). The town of Safford lies approximately in the center of the area.

The term "Inner Valley" denotes the alluvium filled trough beneath the present Gila River flood plain. It is a distinct feature within the large Safford structural basin. The Inner Valley is the single most important source of ground water in the Safford basin.

The information presented herein was compiled as a part of an investigation of the geology and ground-water resources of the Safford basin, conducted by the University of Arizona and the U. S. Geological Survey and sponsored by the Rockefeller Foundation. Records of approximately 500 wells in the files of the U. S. Geological Survey Ground Water office in Tucson provided the bulk of the data used. Appreciation is expressed for the use of this material, and also for numerous discussions with U. S. Geological Survey personnel, in particular Messrs. E. S. Davidson, M. B. Booher, W. F. Hardt, and S. G. Brown. Thanks for stimulating ideas and guidance also go to Dr. J. W. Harshbarger and Dr. M. A. Melton, Department of Geology, University of Arizona.

LITHOLOGY OF THE ALLUVIUM

The alluvium is composed almost entirely of sand, gravel, cobbles, and boulders which are much coarser than the underlying silt and clay forming the older basin fill. For this reason the bottom of the alluvium can be determined with a high degree of certainty from drillers' logs.

Clay is present within the alluvium as lenticular beds which occur in two zones, one near the bottom of the alluvium between Safford and Solomon, the other near the top of the alluvium between Pima and Safford. The upper zone is most widespread and is up to 30 feet thick locally, which may indicate an overall decrease in grain size in the upper part of the alluvium, although drillers' logs are not sufficiently detailed to confirm this conclusion.

SHAPE AND CONFIGURATION OF THE INNER VALLEY

The alluvium is deposited in an elongate trough about 2-1/2 miles wide. The shape of this trough is depicted by contours on Figure 1. It is roughly U-shaped having steep sides and an irregular lower surface. The alluvial material is wedge-shape in cross section with the thickest part usually lying on the south side of the trough. This is also shown on Figure 1. In longitudinal section the alluvium gradually thins downstream. Near Solomon it has a average thickness of 80 feet and a maximum of 110 feet. In the vicinity of Pima the average thickness is only 50 feet.

In a downstream direction from Solomon the bottom of the trough is divided into two channels by a discontinuous ridge, 10 to 40 feet high. These channels may represent former positions of the river when it was in a downcutting stage.

GROUND-WATER OCCURRENCE

Figure 2 shows ground-water conditions within the Inner Valley during July 1960. The dotted lines are water-table contours. These show a more or less uniform hydrologic gradient in a downstream direction. Some recharge occurs along the southern edge of the trough. The solid lines are flow lines constructed from the water-table contours. They provide a better visual picture of the actual movement of the ground water. Deflections in the flow lines seem to be controlled by a number of factors. Near Solomon, deflections apparently are related to variation in thickness of alluvium. The flow lines diverge and go around areas which are thin (less than 30 feet) or thick (greater than 60 feet). In other areas, deflections are probably due to changes in permeability, the amount of pumpage, and to recharge conditions.

The pattern of flow suggests that the ground water moves through the alluvial trough in a manner similar to laminar flow in a huge conduit. Recharge enters the Inner Valley alluvium from tributaries or from irrigation canals. Discharge of water occurs as effluent seepage, transpiration, and well pumpage.

Data on permeability of the alluvium is not obtainable directly from drillers' logs. As mentioned previously, the grain size probably decreases in the upper part of the alluvium where clay is more abundant. This fact accounts for the decrease in permeability reported by Feth (1952, p. 64) from work done by Turner, et al. (1941). Feth states: "The tabulations demonstrate a distinct zonation of permeability within the Recent alluvium. The low figures (15-664) were all determined for samples. . . . to a depth of 7 feet. . . . The high permeabilities (1100-12,000) were for samples taken at depths between 29 and 82 feet. . . ." If the decrease in permeability is mostly above 29 feet it will not exert a very great influence on ground-water movement, as the water table is usually lower. The upper clay zone is also mostly above the water table.

The water-table contour map shown in Figure 2 differs from another water-table map which was prepared incorporating water levels from the older basin fill. This difference, together with the pattern of the flow lines and the significant difference in grain size between alluvium and underlying beds, strongly suggests that separate geohydrologic systems exist for the alluvial trough and the major part of the valley fill.

GEOMORPHIC DEVELOPMENT

The profiles of the bottom of the Inner Valley shown in Figure 1 could

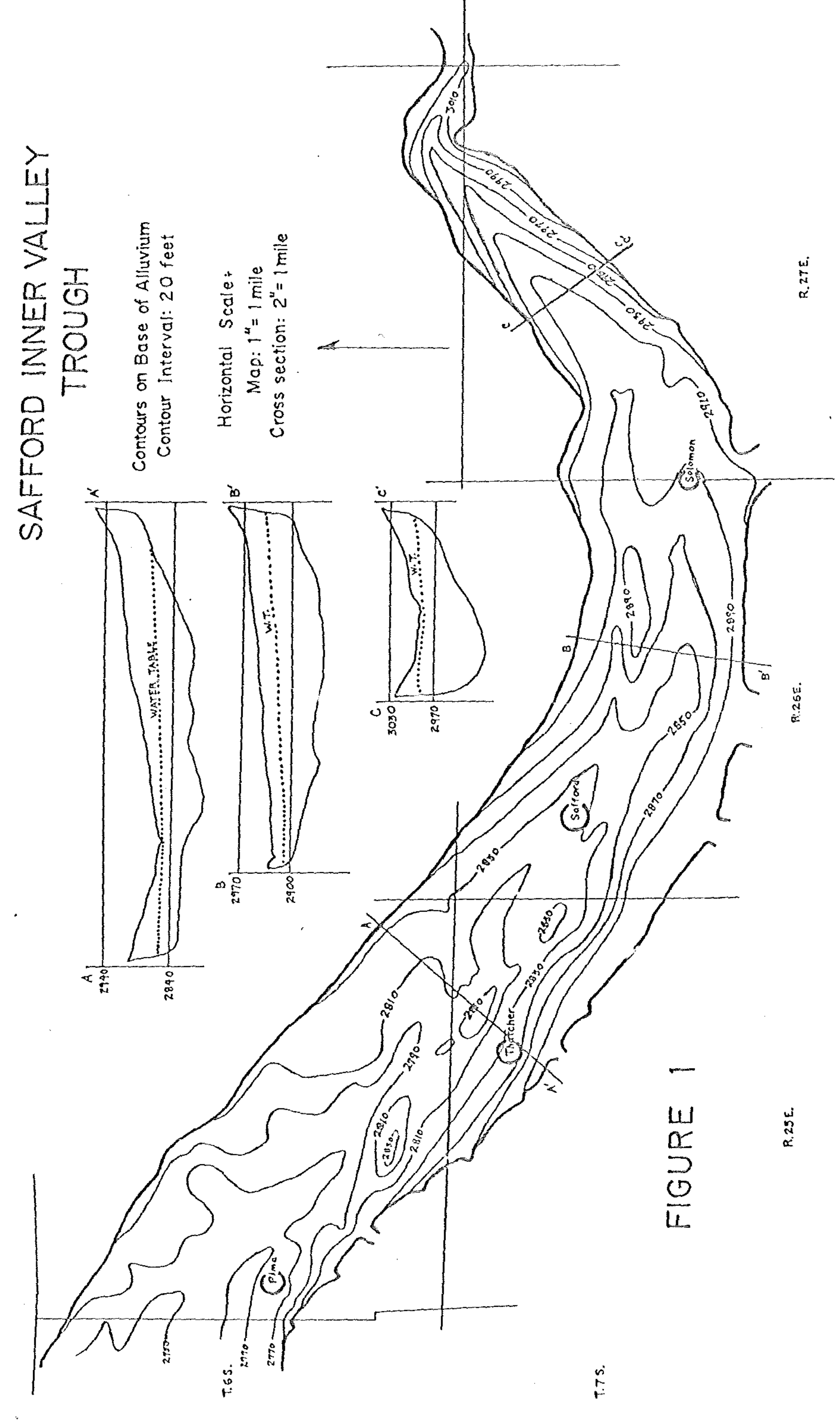

FIGURE 1

have developed as a result of early episodes of vigorous downcutting and partial filling, followed by later meandering or braiding. During the later stage the river bed was widened by side trimming and the channel was filled by both blanket river deposits and fan material from tributaries. This stage has continued into the present time.

The two most obvious reasons for such a change from one form of river activity to another are (a) decrease in volume of flow, or (b) increase in amount of sediment being transported. On the basis of the corroborating evidence listed below, it is suggested that the cause was decrease in volume of flow.

(1) Change in meander size. Within the Inner Valley are abundant traces of a meander belt older than the present one. Loops of this older belt which can be measured on aerial photographs have an average radius of one mile. The radius of loops in the present meander belt is about one-third of a mile.

Dury (1954) and others have reported that the size of loops in a meander belt is closely related to discharge of the river. Thus the decrease in the size of meander loops of the Gila River indicates a loss in volume of flow.

(2) Increase in gradient. In Figure 1, the gradient of the bottom of the alluvial trough below the mouth of the San Simon is about 9 feet per mile. The present gradient of the Gila River is about 12 feet per mile. Melton (1960, personal communication) has suggested that this increase in gradient may have been an adjustment of the stream to maintain its load during progressive loss of volume of flow.

(3) Change in grain size. The probable upward decrease in grain size in the alluvium could have been caused by a decrease in transporting power of the river. Since the gradient of the Gila has increased, only a sharp decrease in flow could account for such a change to deposition of finer material.

The most likely cause for decrease in flow of the Gila River is climatic change. Another cause could have been a decrease in the size of the drainage area, but the older Gila drainage as shown by Melton (1960, p. 121) does not differ in magnitude from the present drainage area. It is likely, therefore, that the decrease in flow represents a climatic change toward the more arid conditions which are present today. Such a change may have occurred at the time of the world-wide shift toward a drier climate about 11,000 years ago.

REFERENCES

Davidson, E. S., 1960, Geology of the eastern part of the Safford Basin, Graham County, Arizona: Arizona Geol. Soc. Digest, v. 3, p. 123-126.

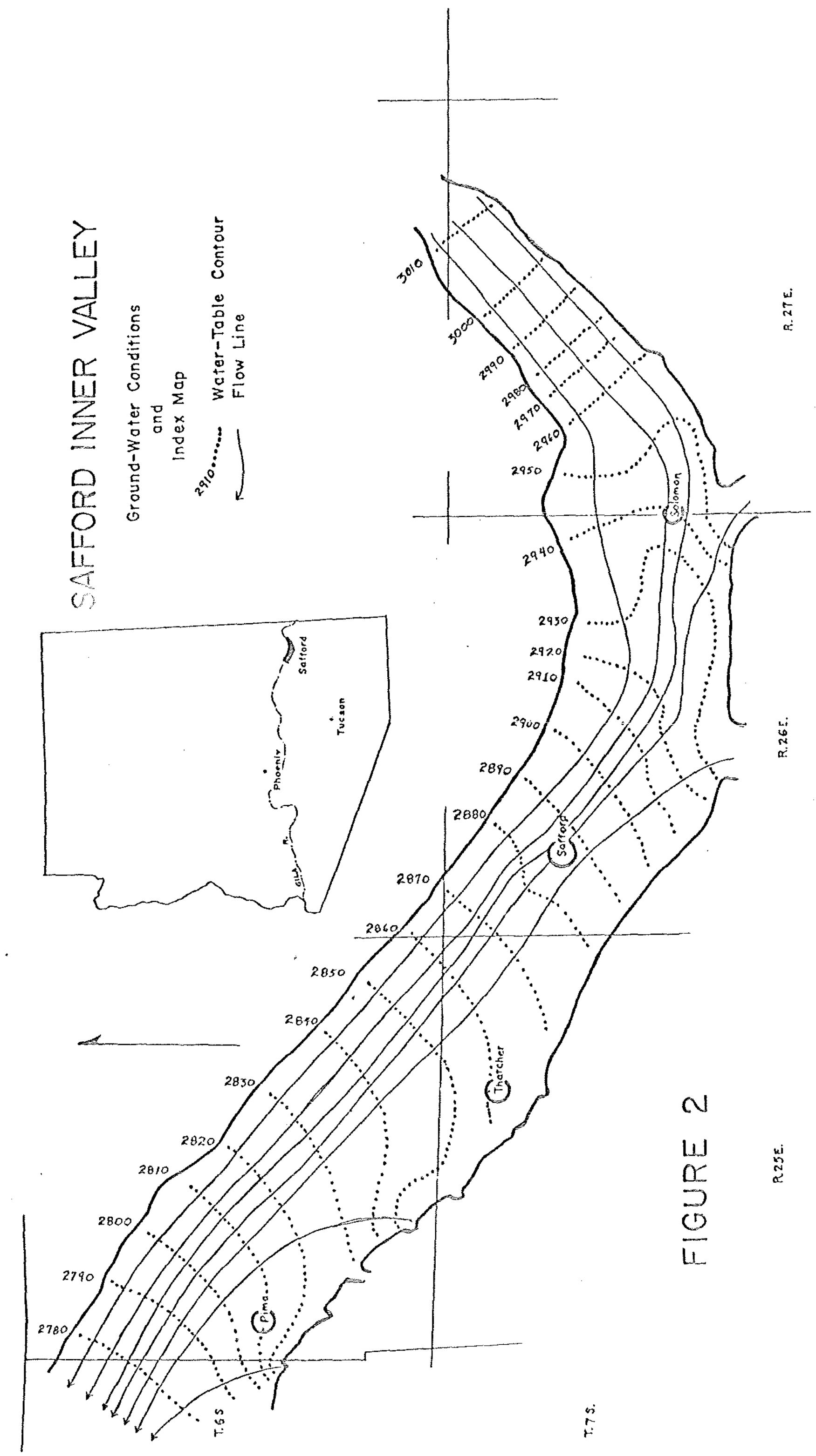

FIGURE 2

Dury, G. H., 1954, Contribution to a general theory of meandering valleys: Am. Jour. Sci., v. 252, p. 193-224.

Feth, J. H., 1952, Safford Basin, Graham County, in Ground water in the Gila River basin and adjacent areas, Arizona: U. S. Geol. Survey open-file report.

Melton, M. A., 1960, Origin of the drainage of southeastern Arizona: Arizona Geol. Soc. Digest, v. 3, p. 113-122.

Turner, S. F., et al., 1941, Water resources of the Safford and Duncan-Virden valleys: U. S. Geol. Survey open-file report.

SANTA CATALINA FOOTHILLS FAULT IN THE PONTATOC AREA

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The Arizona Geological Society field trip of December 1960 was conducted to examine the Pantano beds in the area immediately northeast of Tucson and the boundary fault which separates these beds from older gneissic and granitic rocks. This fault, mapped as a single break along the foot of the Santa Catalina, Tanque Verde, and Rincon Mountain blocks, has been described as a thrust (Moore, et al., 1941; Wilson and Moore, 1959). In the Santa Catalina foothills area, the fault is best exposed near the Pontatoc mine.

The Pontatoc area is shown in Figure 1. North of the end of Pontatoc and Valley View roads, the fault strikes almost east-west, with an average dip of about 50° to the south. Westward, at the north end of Campbell Avenue, a short exposed portion of the fault strikes somewhat north of west, and dips about 45° south. Pantano beds outcrop to the south of the fault and Catalina gneiss outcrops to the north.

The old Pontatoc mine workings and a number of scattered prospect pits occur within the fault zone. In these workings it can be seen that the Catalina gneiss, which forms the footwall, is brecciated, sheared, altered, and mineralized for a number of feet away from the fault, while the sand and silt of the Pantano beds are unaffected except for slight development of gouge on the fault plane. The mineralization commonly fills the interstices between breccia fragments in the gneiss, and must be later than at least some of the brecciation. The Pantano beds were not observed to be mineralized.

These observations suggest to the writers that the present fault is the expression of a zone of structural weakness older than the Pantano beds, and that this zone was subject to recurrent stress and movement prior to the deposition of the Pantano beds. This seems to be the best explanation for the wide zone of brecciation and shearing in the competent gneiss, with little disturbance of the weak Pantano beds, and the fact that the mineralization occurs only in the gneiss. The following general sequence of events is suggested: (1) original faulting in the gneiss which caused brecciation, (2) mineralization and alteration along the fault zone which may have been accompanied by further brecciation, and (3) final faulting by which the Pantano beds were moved down to their present position in contact with the Catalina gneiss. The age of mineralization may or may not be older than the Pantano beds, since these beds could have been already deposited, but at a stratigraphic position which was not reached by the mineralizing solutions.

No direct structural evidence of relative movement along the fault was seen in the Pontatoc area, but the foregoing data suggest that the fault is not thrust, but normal, at least in its final phase. Most important points in favor of this view are: (1) the high dip of the fault plane, measured where possible, and indicated generally by the straight trace of the fault, and (2) the indications that this high-angle break is an old line of weakness, subject to recurrent movement. Such a feature may have had lateral, normal, or even reverse movement during the course of its history, but it does not fit the commonly conceived picture of