# GEOLOGY AND AQUIFER CHARACTERISTICS OF THE INNER-VALLEY ALLUVIUM IN THE SAFFORD VALLEY, ARIZONA

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Water-bearing characteristics of sediments composing the Recent inner-valley alluvium and older subjacent fluviatile and lacustrine deposits are of utmost importance to the economy of the Safford Valley. Proper interpretation of the availability, mode of occurrence, and movement of ground-water can be made only if the geologic environment and boundary conditions are known. Complete information on the stratigraphy, structural characteristics, and contact relations of these sediments is therefore necessary to delineate the water-bearing zones, differences in permeability, sources of recharge, and areas of discharge.

The area studied in Safford Valley is along a stretch of the Gila River in Graham County. The eastern, northern, and southwestern boundaries are formed by the Peloncillo, Gila, and the Graham (Pinaleno) and Santa Teresa Mountains, respectively. The northwestern boundary is somewhat arbitrarily drawn along the eastern edge of the San Carlos Indian Reservation a few miles downstream from the town of Geronimo. The southern boundary is placed between Townships 10 and 11 South, including the Cactus Flats-Artesia area south of Safford.

The Safford Valley lies in a northwest-trending structural trough that has been depressed with respect to the mountains bordering it to the northeast and southwest. Drillers' logs of wells in the area indicate that the bordering mountainous areas were probably the source of much of the materials deposited in the inner-valley alluvium. However, most of the valley is filled with sediments which include fine-grained lacustrine as well as fluviatile materials, and from the surface of Safford Valley.

Following a change in the climatic and structural conditions which prevailed during aggradation of the trough, the Gila River developed its present course on the fine-grained sediments and initiated a period of downcutting which produced the present inner valley.

The structural character of the basement and margins of the Safford basin are obscured by the materials filling the trough. Only a small percentage of the wells drilled in the area of study penetrate into the underlying older fill or "lake beds", as most have been drilled for water in the inner-valley alluvium. A few deep holes, exploratory tests for oil, did not reach bedrock, although one of these was drilled to a depth of 3767 feet. The logs of these test wells and other wells in the basin indicate that the older fill is only in part of lacustrine or playa origin. The older alluvium apparently also includes considerable fluviatile materials. The use of "lake beds" as a blanket term to denote the older alluvium is therefore improper.

The Recent fill in the inner valleys is of fluviatile origin and ranges from about 20 to 110 feet in most wells. The logs of these wells also indicate that the materials composing the inner-valley alluvium are mainly unconsolidated silt, sand, gravel, cobbles, and boulders.

Gound-water in the Recent alluvium of the inner valley occurs at shallow depths in most wells. Many of the well-records indicate that water in the alluvium is at depths of about 25 feet below the land surface. Apparently water in many wells is also encountered in more than one zone at depth. Water-bearing sediments in the Recent alluvium are sand and gravel underlain by lacustrine-type clay. The water in these coarse materials is predominantly unconfined. The gound-water in the inner-valley fill is the main source of water to wells pumped to

supply water for irrigation in Safford Valley. It is used to supplement available supplies of surface water, so that the amount pumped in any given year is therefore variable.

Recharge to ground-water in the inner-valley fill is by both natural and artificial means. Natural sources include the Gila River and precipitation over the floor of the inner valley, as well as seepage from the older alluvium; artificial sources are seepage from irrigation canals and cultivated lands over which irrigation water has been spread.

Natural discharge of ground-water from the basin is due to evaporation, transpiration, and seepage losses to the Gila River. Artificial discharge by pumping accounts for large amounts of withdrawal from the subsurface reservoir.

Consideration of the factors affecting recharge and discharge presents a number of problems. One of these problems is the nature of the movement of ground-water from the Recent fill and the underlying older alluvium, and between the older alluvium and the materials with which they are intercalated along the margins of the basin. Study of the logs indicates that although the basal contact of the inner-valley fill with the subjacent clays of the older alluvium is irregular owing probably to scour and fill activity, it has a gradient which is inclined in the same direction as the gradient of the present Gila River. Analysis of the logs also suggests that at least locally the marginal contact of the inner fill with the older alluvium is probably abrupt and steeply inclined. Undoubtedly any recharge to the inner fill from confined water in the older alluvium by seepage across the contact is greatest along the marginal boundaries. This is so because of the more or less impervious fine materials underlying the basal contact, greater permeability of strata in a horizontal direction, and the greater area of contact surface along the inner-valley side walls than at the base of the inner fill.

Another facet of the study is the water-bearing character of sand-gravel aquifers in the inner-valley alluvium and the extent of their continuity and discontinuity. According to the general conception of alluvium-filled valleys in arid and semi-arid lands, as expressed by Knechtel (1938), the sand and gravel beds in such areas are lenticular, numerous, and discontinuous, and the individual beds occur at varying depth and pinch out laterally. A study of water-well logs in the Recent alluvium suggests this may not be the correct analysis of sediment distribution within the inner valley. The available logs of wells and test holes drilled in the area into the older alluvium suggest greater regularity in bedding as well as marked absence of coarse clastics even along the outer margins of the basin. The general absence of coarse clastic materials along the basin margins suggests that recharge of the older alluvium from the bordering upland areas may be insignificant.

Drillers' logs of water-wells and records of wells compiled by the Ground Water Branch of the United States Geological Survey are being analyzed to determine the geologic geometry of the basin. Essentially all available logs have been examined and posted on a fence diagram covering the area investigated. The adequacy and reliability varies in different parts of the area as a function of the number and distribution of the well-logs, their accuracy, and interpretations of the well-drillers' terminology.

From information on the fence diagram it is apparent that most wells show the following generalized sequence from top to bottom: top soil or "fill", sand or sand and gravel, gravel (with or without boulders), and clay. Many logs of wells also show clay at intermediate depths and in varying thicknesses. In most cases the holes were terminated when clay was encountered, probably on the assumption that impermeable lake clay had been penetrated.

The generalized sequence outlined above leads to speculation on the magnitude of lithologic continuity. Possibly the conventional interpretation of valley fills in the semi-arid southwest does not apply in this area. This sequence also suggests that the source of at least a part of the fill in the inner valley in the area is from local terrace gravel and conglomerate and the underlying

older alluvium. The coarse materials of the terrace deposits were "peeled-off" first to form the basal part of the fill in the inner valley; the fine materials, sand, silt, and clay, eroded later, form the upper part of the valley fill. Although it is likely that all or most of the coarse materials in the inner fill were supplied by local sources, it is not now possible to estimate how much of the fine materials are of local origin and what percentage has been brought downstream from outside the area. However, it is likely that the fraction supplied locally is not insignificant. In any event, the stratigraphic relationships so far revealed are of utmost importance in terms of permeability and hydraulic continuity.

Upon the determination of the geologic framework and boundary conditions the existing hydrologic and hydraulic data can be utilized in formulating a rational quantitative description of the distribution and mode of occurrence of ground-water in the Safford Valley. Possible analytic approaches include specific capacities, empirical formulae for estimating permeabilities, pumping tests of aquifer performance, and particularly flow-net analysis using analog equipment and electrical models for translating the geologic parameters into permeability parameters.

## REFERENCES

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