

A STUDY OF THE SOURCES OF GROUND WATER

AT

CHACO CANYON NATIONAL MONUMENT

By

Regional Geologist Ross A. Maxwell
National Park Service
Region III

Santa Fe, New Mexico

September, 1940

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INTRODUCTION

Location

Chaco Canyon National Monument is in San Juan and McKinney Counties, northwestern New Mexico. It is reached from the south by leaving U. S. Highway 66 at Thoreau, New Mexico, and traveling northward for 65 miles over an Indian Service road. The Monument may be reached from the north by traveling State Highway 55 southward for 40 miles from Aztec, New Mexico, then State Highway 35 for 24 miles to the Monument Headquarters.

Purpose

The purpose of the field investigation, reported herein, was to make a study of the sources of water that might be obtained and used successfully for the Monument water supply.

Summary and Conclusions

There are two sources of water available for the Monument water supply. One is from shallow wells dug into the alluvium along the Chaco River Valley. The other is from water-bearing zones in the underlying formation. There are perhaps half a dozen of these aquifers ranging from 300 to 3,000 feet in depth.

The former source, that from wells along the Chaco River Valley, is the one now being used by the Custodian, the University of New Mexico Summer School, and the CCC Camp. This source has been dependable in the past and probably will continue to be, unless the run-off is

~~insufficient, during a series of dry years, to recharge the deposits~~
along the stream valley, in which case the wells are likely to fail.

Water from this source may be obtained at a reasonable cost due to the fact that the wells are shallow, usually less than 20 feet, and the stream is near the proposed Headquarters site. The largest item of expense would be for equipment to raise the water from the well to the storage tank on top of the bluff at the proposed Headquarters site behind Pueblo Bonito.

One of the objections to using this source for the water supply is the possibility of pollution. The water from the present Monument well is highly polluted. A nearby corral is believed to be the source of the difficulty. A new well dug upstream from this corral probably would eliminate the present difficulties, but so long as the present human occupation and activity exists along the stream valley there will be a possibility of further pollution.

Water may be obtained from deep wells drilled in the Monument area. In general, the deeper the well, the larger the quantity of water and the more probability that it will be a flowing well. Judging from the depth of existing wells south of the Monument, it is believed that a large quantity of water may be obtained from a well in the vicinity of Pueblo Bonito, drilled to a depth of 1,000 to 1,200 feet. Furthermore, there is a very good reason to believe that such a well would flow. It is also believed that the Dakota sandstone could be reached at a depth of

about 3,000 feet in the vicinity of Pueblo Bonito and it is almost certain that a well from that zone will flow. A flowing well, either in the valley or on top of the bluff behind Pueblo Bonito, would certainly eliminate many of the difficulties that are certain to arise if an attempt is made to obtain water from a shallow well along the Chaco River Valley.

The chief objection to using the water from these bedrock aquifers is that virtually all of the water is slightly mineralized. Sulphur is probably the most noticeable of the minerals. The water from most of the wells has a slight sulphur taste and some of it has a sulphur odor. The taste and odor are not especially objectionable, however, for drinking purposes and the water is much better than the water in many of the municipal water supplies throughout the Southwest. Considering these various problems, the writer feels that a well drilled to one of the subsurface aquifers would be the most satisfactory method of obtaining water for the Chaco Canyon National Monument water supply.

Acknowledgements

Acknowledgement of the friendly assistance and cooperation is due to Lewis T. McKinney, Custodian of Chaco Canyon National Monument, for aid and guidance in the field while obtaining the information on which this report is based.

GEOLOGICAL SETTING

Chaco Canyon National Monument is in the central part of the San Juan Basin, a large structural basin in northwestern New Mexico. The Monument includes an area of about 20,000 acres surrounding Pueblo Bonito, shown on the accompanying map. Since the geological structure of the San Juan Basin has an important control over the subsurface water-bearing zone in the Monument area, a brief description of the general geology of the basin follows.

The San Juan Basin is bounded on the south by the Zuni Mountains, on the east by Brazos Peak northeast of Tierra Amarilla, and the Nacimiento Mountains near Cuba, on the north by the San Juan Mountains in Colorado, and on the west by the Defiance Uplift of eastern Arizona.

The central floor of the basin is underlain by strata of Tertiary age. These are surrounded by strata ranging in age from Cretaceous to Pennsylvanian. An east-west cross section across the basin would show the strata in the center of the basin as relatively flat with beds of Cretaceous strata upturned sharply on both the eastern and western edges. A north-south cross section would be somewhat different. On the south the older formations are upturned rather steeply against the Zuni Mountains, and farther north the Mesa Verde strata dip gently into the basin. On the north the Mesa Verde and older strata dip sharply southward away from the San Juan Mountains. The accompanying map, which is a reproduction of Plate 10, U. S. Geological Survey, Bulletin No. 860,

~~shows the general structural conditions.~~

The surface at Chaco Canyon National Monument is a rolling plain that is underlain by sandstone strata belonging to the Mesa Verde formation. These strata have been trenched by streams that locally have carved rather conspicuous gorges. Chief of these is Chaco Canyon. This valley, perhaps half a mile in width, has been carved by water and other agencies of erosion into a sandstone member of the Mesa Verde group. Near Pueblo Bonito this sandstone member is about 150 feet in thickness. The lower hundred feet is a rather soft, gray to yellowish-gray and brown sandstone that has been cut by a series of joints. Weathering and erosion along the joints has allowed blocks of the sandstone to separate from the main body leaving precipitous bluffs 50 to 100 feet high which line the valley and enclose the level bottom land on each side of the Chaco River.

The Chaco River, or Chaco Wash as it is frequently called, heads about 25 miles southeast of Pueblo Bonito, flows northwestward through the Monument, to enter the San Juan River in the northwestern corner of the State. Although the upper part of the drainage system is now definitely intermittent, it has carved a conspicuous gorge into the underlying sandstone and shales. In addition to cutting the gorge, it has beaded the bottom of the scar by depositing silt, sand, and gravel along the channel. These deposits are of variable thickness and stretch from

canyon wall to wall, a distance of one-fourth to half a mile. When it rains, much of the water rushes down the channel to join the waters of the San Juan, but some of it enters the sand and gravel along the way and as a result these porous alluvial deposits are water-bearing and are one of the important sources of water in that vicinity.

The bedrock strata underlying the surface of the Monument are sandstone and shales that belong to the Mesa Verde group of strata. According to the New Mexico School of Mines Bulletin No. 9, the Mesa Verde in the San Juan Basin has an average thickness of 1980 feet. According to field observations, the strata at the Monument are a portion of the upper Mesa Verde, perhaps rather high in the series. Below the Mesa Verde are 2,000 feet of Mancos strata, and 175 to 200 feet of Dakota sandstone.

The Monument area is near the geographical center of the San Juan Basin, but a short distance south or southwest of the bottom of the structural trough. Thus, the strata dip at a low angle in a northeastern direction. According to the structural contours on the accompanying map, from the latitude of Crown Point to Pueblo Bonito, the average dip is 12 to 15 feet per mile. Measurements taken in the vicinity of the Monument averaged about 20 feet per mile. It appears, therefore, that one might assume the average dip to be 15 to 20 feet per mile.

THE SOURCES OF GROUND WATER

There are two sources of water available for the Chaco Canyon National Monument water supply. These are (1) water from the gravel along the Chaco River, and (2) water from one of the water-bearing sandstone zones in the underlying bedrock.

Water from the Gravel along the Chaco River

Water may be obtained from sump-like wells dug into the sand and gravel along the Chaco River. The depth and size of the excavation is partially controlled by the quantity of water desired. Such wells are usually walled with stone with ample opening to allow the water to seep into the pit. Heavy pumping will lower the water and the wells may be pumped dry, but will fill again when allowed to stand for a few hours.

Depth to Water: These wells vary in depth depending upon the nearness of the well to the stream channel, the character of the alluvial fill, and the amount of reservoir storage desired in the bottom of the well. In most instances, these wells are less than 20 feet in depth.

Quantity of water: The present wells in the Monument area would not be classified as large wells. On the other hand, they furnish considerable water. One of the wells furnishes the water for the CCC Camp, another for Monument Headquarters, and a third for the University of New Mexico Summer School Camp. Other wells dug along this wash

would be expected to yield similar quantities of water. The amount will vary depending upon the porosity and permeability of the gravel in the individual well. It is believed, however, that one well would supply ample water for the Monument Headquarters.

Quality of Water: The water obtained in wells dug into the gravel along the Chaco River is filtered run-off water from the rainfall and melting snow. Therefore, the water has a good taste, and normally is satisfactory for drinking purposes. Near the present Headquarters area certain pollution problems have developed. This pollution is believed to be caused from a nearby corral and the attached copy of a letter shows the seriousness of the problem. It is understood that plans for another well have been proposed. The suggested location is below the same corral that apparently is causing the present trouble.

Location for Digging Another Well

The location for a new well along the Chaco River Valley should be selected with due consideration to the present sources of pollution and to the location of the Monument Headquarters. If the Monument Headquarters is placed on the bluff above and behind Pueblo Bonito, the well should be located reasonably close to the Headquarters development. It is also important that the well be located above the present source of pollution. Therefore, it is believed that the location should be upstream from the Custodian's present office, parking area, and above the

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STATE OF NEW MEXICO
DEPARTMENT OF PUBLIC HEALTH
Santa Fe

July 13, 1940

Mr. Lewis T. McKinney, Custodian
Chaco Canyon National Monument
Chaco Canyon, New Mexico

Dear Sir:

Following is the report of the State Public Health Laboratory
on water sample collected by you June 2nd:

Faucet in Picnic Area. No bacterial count made. B. Coli.
present in 5 out of 5 - 10cc. portions and in 2
out of 2 -1 c.c. portions.

This sample shows heavy pollution.

Sincerely yours,

Paul G. Fox. C.E.
Public Health Engineer

~~drainage that might come from the University of New Mexico Summer School~~
Camp's sewerage disposal field.

Disadvantages in Using this Source of Water for the Permanent Water Supply: The present pollution problem in the Headquarters well has been mentioned and the digging of a new well above the present source of the trouble should, at least, temporarily relieve the problem. It must be remembered, however, that with the continued use of the area by the University and the tourists there will be continuous possibility of pollution of the water in all wells in that vicinity.

The permanency of the water is not all that may be desired. The supply depends entirely upon the precipitation. It is quite evident that the character of the Chaco River Valley has changed even during the lifetime of some of the local people, and we have no way to determine what future changes may take place. During a period of drought, extending through several years, the run-off might fail to recharge the sands along the stream valley and the wells might then fail.

Should this source be selected for the permanent water supply, the cost of a pipe line from the well in the valley to the top of the bluff would be an item of considerable expense and the pumping will be a permanent cost.

Conclusions: Water may be obtained in wells dug in the sand and gravel along the valley of the Chaco River. The location of the well

makes little difference so long as it is within 100 feet of the stream channel, as all of the valley fill deposit appears to be saturated with water. The reservoir is recharged by run-off from precipitation but the supply may fail during periods of drought. The quantity of the water will vary from place to place, depending upon the porosity and permeability of the reservoir. The present well is polluted and other pollution problems may arise in the future, therefore care should be given to locating new wells in respect to sources of contamination. For these reasons, it is believed that it would be more satisfactory to obtain water for the permanent water supply from deep wells drilled to one of the water-bearing sandstones in the underlying bedrock.

Water from One of the Aquifers in the Underlying Bedrock

Deep water wells are common in the area southwest, south, and southeast of Chaco Canyon National Monument. These wells are of various depths ranging from about 300 to 3,100 feet. The approximate location of some of them is shown on the accompanying map. The water is obtained from aquifers in the Mesa Verde group in the more shallow wells and from the Dakota sandstone in the deep wells. A brief description of some of the wells follows:

Chaco Canyon National Monument Well

Located about midway between the Juntodian's present house and Pueblo Bonito. This well is reported to be 465 feet in depth. Two water-bearing zones were encountered, and the water raised to within 45 feet of the surface. Unfortunately, the water was highly mineralized and the well was abandoned.

The writer was told, but could not verify the rumor, that the mineralized water came from the upper water-bearing sands and that for some reason the driller was unable to case off the mineralized water. This may have some bearing on what might be expected in other wells drilled in that area, and it is mentioned here as a matter of record for future guidance.

The Stony Butte Well

12 miles west of Monument Headquarters

Depth - 2800 feet

Yield - 6,000 barrels daily. Flowing well.

Producing aquifer - Dakota sandstone

Surface formation - Mesa Verde

Character of water - Warm, with slight sulphur taste

Surface elevation - about 300 feet less than the
Monument Headquarters

The Sargent Well

About 4 miles south and 3/4 mile east of Headquarters

Depth - 482 feet

Yield - pumping well, but strong yield

Producing aquifer - Mesa Verde

Surface formation - Mesa Verde

Character of water - slight sulphur taste

Surface elevation - about 500 feet above Headquarters

West Westbrook Flowing Well

About 14 miles southwest of Monument Headquarters

Depth - 8007 feet

Yield - flowing well, strong yield

Producing aquifer - Mesa Verde

Surface formation - Mesa Verde

Character of water - sulphur taste

Surface elevation - few hundred feet higher than the
Monument Headquarters

Central Westbrook Flowing Well

About 10 miles southwest of Monument Headquarters

Depth - 920 feet

Yield - flowing well, 25 to 35 gallons per minute

Producing aquifer - Mesa Verde

Surface formation - Mesa Verde

Character of Water - slight sulphur taste

Surface elevation - 300 to 400 feet above Monument
Headquarters

Wade Smith Flowing Well

About 9 miles south of Monument Headquarters

Depth - First artesian flow at 1100 feet

Second artesian flow at 3100 feet

Yield - Flowing well, very strong. Fills 10" casing

Producing aquifers - First aquifer, Mesa Verde

Second aquifer, Dakota

Surface formation - Mesa Verde

Character of water - warm, with slight sulphur taste

Surface elevation - about 500 feet higher than
Monument Headquarters

Well

About 17 to 18 miles southeast of Monument Headquarters

Depth - 300 feet

Yield - strong pumping well

Producing aquifer - Mesa Verde

Surface formation - Mesa Verde

Character of water - Slight sulphur taste

Surface elevation - about 400 feet higher than
Monument Headquarters

Jerry Farris Well

About 16 miles south of Monument Headquarters

Depth - 900 feet

Yield - strong flowing well

Producing aquifer - Mesa Verde

Surface formation - Mesa Verde

Character of water - slight sulphur taste

Surface elevation - about 400 to 500 feet above
Monument Headquarters

The Huspah Well

About 20 miles southeast of Monument Headquarters

Depth - 1800 feet

Yield - very strong pumping well

Producing aquifer - Huspah sand, Mesa Verde

Surface formation - Mesa Verde

Character of water - good, potable water

Surface elevation - about 700 feet higher than the
Monument Headquarters

The Dakota sandstone was reached at 2800 feet in wells nearby.
This sand yields oil, gas, and water.

Depth to Water: Judging from the surface exposures of the sandstone zones in the Mesa Verde, and similar sandstone zones in the underlying formations, there should be several good aquifers that might be reached by drilling a deep well in the vicinity of Pueblo Bonito or at any other point in the Chaco Canyon National Monument area. This suggestion is further supported by the wells described above located to the southwest, south, and southeast of the Monument. In order to obtain reasonable estimates of the depth of these aquifers in the vicinity of Pueblo Bonito, it is necessary to know the approximate dip of the strata, and the difference in elevation between the various wells and the surface at the proposed well site. The average dip in that vicinity appears to be 15 to 20 feet per mile but the difference in elevation is not so easily obtained. A good topographic map of the area is not available, and the topographic map of the State is not of much help, thus the estimated difference in elevation, that appear in the above descriptions of the wells, may not be accurate. The lenticular character of the strata may also have some bearing upon the depth to water at any given site and the degree of permeability and saturation will certainly have an effect upon the yield.

Considering the above factors and assuming that the physical conditions of each aquifer are reasonably uniform, the Sargent Well aquifer should be reached in the vicinity of the Monument Headquarters at a depth of about 300 feet, to which approximately 150 feet should be

added for the depth of a well drilled on top of the bluff behind Pueblo Bonito.

Similar computations would give a depth of 850 feet to the aquifer encountered at the central Westbrook flowing well, or about 1050 feet if the well is drilled on top of the bluff. Speculating still further, the Dakota sandstone should be reached at a depth of about 2800 feet near Pueblo Bonito, or about 2950 on top of the bluff behind the ruin.

This type of estimate may not mean much but the writer believes that a well drilled on top of the bluff behind Pueblo Bonito to a depth of 1000 to 1200 feet will penetrate at least one strong aquifer and that there is a good possibility of obtaining a flowing well. Furthermore, the Dakota sandstone should be tapped at a maximum depth of 3,000 or 3,500 feet.

Quantity of Water: The writer, with Custodian McKinney, visited the wells mentioned above, also several others. Without exception, any one of them will yield ample water for the Monument needs and several of the wells will yield many times the quantity of water necessary.

Quality of Water: The quality of the water from the bedrock aquifers is less encouraging. Invariably the water is mineralized, has a slight sulphur taste, and in some cases a sulphur odor. The taste is not so disagreeable as the water used by many of the municipalities in the Southwest, and the writer purposely drank freely at several of the wells without unpleasant results. Although it is probable that the

water will contain some undesirable mineral, this is not always the case for the water from the Huspah well is excellent. In order that more definite information concerning the mineral content of the water in some of the wells may be made available, a copy of a letter to Custodian McKinney is attached.

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UNITED STATES
DEPARTMENT OF AGRICULTURE
Soil Conservation Service
Box 568
Farmington, New Mexico
August 21, 1930

Mr. L. T. McKinney
Custodian, Chaco Canyon National Monument
Chaco, New Mexico

Dear Mr. McKinney:

The following is a report on your samples of water from our Regional
Soils Section in Albuquerque:

Lab.No.	Location	T.SS	Ca.	Mg.	Na	Cl	SO4	CO3	HCO3	T.S.S. Grav.
W 68	1-Wade Smith Well 350' deep	1853	17	tr	369	64	910	0	293	2088
W 69	2-Chaco Can. NM Well 18' deep	722	46	0	174	13	210	12	288	684
W 70	3-Sargent Well, 5 mi. S. of P. Bonito	1715	17	0	512	58	460	53	615	1700
W 71	4-Wade Smith flowing well 3100' deep	1848	10	4	582	86	920	29	817	1968
W 72	5-Wade Smith, well 700' deep	1178	10	2	340	30	288	0	488	1240

The water sample from the Wade Smith well is high in total dissolved salts which are predominately sodium sulfate (Glauber's salt). This water is considered poor both for domestic use and irrigation.

The Chaco Canyon Monument well contains 684 P.P.M. of total dissolved salts which are mostly sodium sulfate and bicarbonate. This water is not very hard due to the small amount of calcium present. The alkali coefficient shows that it is fair for irrigation purposes and fair for domestic use.

Water from the well at Sargent's place is high in total salts and they are mostly sodium sulfate and bicarbonate. It is classed as poor for domestic and irrigation use. The same is true for the wells of Wade Smith. The flowing well is much less desirable for domestic use than the other one (W 72). Any of the above samples can be used for safety for stock water.

C. S. Fonte,
Junior Range Examiner.

CONCLUSIONS

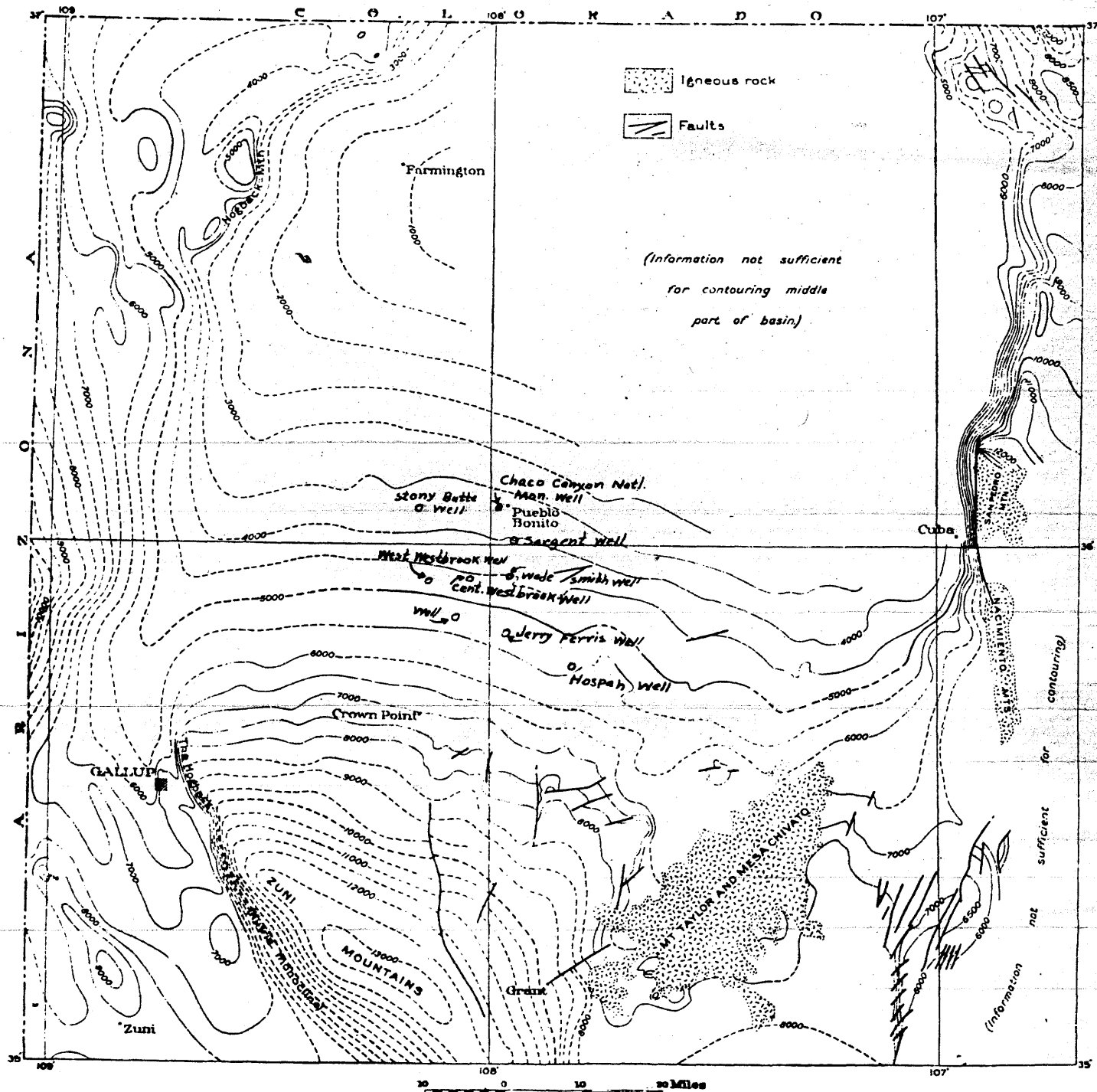
It is the writer's firm belief that water may be obtained for the Chaco Canyon National Monument water supply by drilling a well to one of the subsurface aquifers. Furthermore, it is believed that a very strong well may be obtained at a depth of not greater than 1,000 to 1200 feet and that there is a good chance to obtain a flowing well at that depth. There are deeper aquifers that offer better possibilities of flowing wells and certainly an increase in the quantity of the yield. The Dakota should be encountered at depths of about 3,000 feet.

Virtually all of the water from these aquifers has a slight sulphur taste, but the taste or odor is not sufficient so as to be objectionable for drinking purposes.

It is further believed that it will be far more satisfactory to drill a relatively deep well to one of these aquifers, and perhaps have a flowing well, the water with a slight sulphur taste, than to attempt to develop a permanent water supply from the water accumulation in the alluvium along the Chaco River.

Ross G. Maxwell

Regional Geologist.



MAP SHOWING STRUCTURE OF THE NEW MEXICO PORTION OF THE SAN JUAN BASIN.

Contours adjusted to the top of the Dalton sandstone member of the Mesaverde formation.