UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER SUPPLY FOR PERSIMMON GAP AND SANTA ELENA RANGER STATIONS, BIG BEND NATIONAL PARK, BREWSTER COUNTY, TEXAS

By

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Prepared for the National Park Service
United States Department of the Interior

1958

Open-file report ~~—Not reviewed for conformance with standards and nomenclature of the~~ Geological Survey

58-9

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INTRODUCTION

During the period May 12 to 19, 1958, a reconnaissance survey was made of the water resources in the vicinity of the Persimmon Gap and Santa Elena entrances to the Big Bend National Park, Brewster County, Texas, at the request of the National Park Service. (See figs. ___ and ___.) The work was done to determine potential sources of water for ranger stations to be built at the two park entrances.

The following are the water needs at the proposed ranger stations:

(1). Water will be needed at the Persimmon Gap and Santa Elena entrances to supply ranger stations and other installations to be constructed at the park entrances.

(2). The amount of water desired is 10,000 gpd gallons per day, or about 7 gpm gallons per minute, at each station. The water should be of a quality suitable for domestic use, if possible conforming to the U. S. Public Health Service standards for drinking water as given in table 1.

(3). If possible the water should be obtained within the boundaries of the park to avoid problems of water rights, rights of way for pipeline, etc.

...Persimmon Gap and Santa Elena ...areas, Big Be... National Park,

Brewster County, Tex.

Chemical constituents

(~~Analyses (given)~~ are in parts per million ~~except specific conductance, pH, and percent sodium~~)

Location or owner	Depth of well (ft.)	Date of collection	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	~~Total~~ hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	pH
U. S. Public Health Service drinking-water standards	-	-	-	0.3		-	125	-	-	a250	250	b1.5	c	d500	e	-	-	-
Sump, Nine Point Draw	9	May 12, 1958	17	-	-	61	9.0	73	146	191	19	1.0	0.2	454	189	46	668	7.9
Green Ranch, L. C. Parnell	60	May 18, 1958	24	-	-	125	24	42	222	144	55	.8	111	688	410	18	977	7.8
Persimmon Gap, Ranger Station	-	Dec. 3, 1953	6.0	0.08	-	28	22	1,590	435	2,920	159	2.2	1.0	4,940	160	96	6,350	8.2
"O" well, Persimmon Gap, Ranger Station	123	Aug. 15, 1953	7.2	.02	-	41	22	1,620	274	3,110	172	1.1	1.5	5,110	193	95	6,950	7.9
Rough Run, Crossing Dike	-	May 13, 1958	16	-	-	10	.3	634	f550	742	120	4.4	0	1,800	26	98	2,670	8.8
Terlingua Creek at Old Terlingua Road	-	May 13, 1958	22	-	-	110	29	219	157	690	12	2.0	0	1,160	394	55	1,570	8.1
Tule Spring	-	May 14, 1958	41	-	-	2.8	0	175	269	86	40	7.0	3.0	491	7	98	749	8.3
Burro Spring	-	May 14, 1958	46	-	-	38	1.1	66	172	43	26	4.8	9.2	316	99	59	468	8.1
Christmas Spring	-	May 13, 1958	47	-	-	21	0	44	132	14	9.0	4.8	.5	210	52	65	278	8.0

a Sulfate much in excess of 250 ppm may have a laxative effect.
b Fluoride in excess of 1.5 ppm may cause mottled dental enamel in growing children.
c Nitrate in shallow wells may indicate contamination. Nitrate in excess of about 44 ppm in drinking water may cause methemoglobinemia ("blue babies") in infants.
d 1,000 ppm total solids permitted of bottle water not available.
e Hardness: Under 60 soft, 61-120 moderately hard, 121-200 hard, 201+ very hard.
f Includes equivalent 30 ppm carbonate.

The writer wishes to acknowledge the valuable help of Dr. Ross A. Maxwell, Geologist, Bureau of Economic Geology, University of Texas, in making the survey.

CONCLUSIONS

An adequate supply of water suitable for use at the proposed Persimmon Gap ranger station probably can be obtained from alluvial material near Nine Point Draw. Maravillas Creek, or the alluvium associated with Maravillas Creek, probably would be satisfactory sources of water also, except that they are outside the park area.

Possible sources of water for a proposed ranger station at the Santa Elena entrance are the Aguja formation, the alluvial material associated with Rough Run, Terlingua Creek, or Tule and Burro Springs.

The Aguja formation near the Santa Elena entrance consists largely of loose, fine-grained sand, and wells drilled into the formations would require particularly careful design and development so as to avoid sand troubles in the finished well.

PERSIMMON GAP

SOURCES OF WATER

Alluvial material under Nine Point Draw

Nine Point Draw, an ephemeral stream, drains a large area to the northwest, west, and southwest of Persimmon Gap. The draw is underlain by alluvial material which probably carries a permanent subsurface flow of water.

Water from the alluvial material underlying the draw was used in the construction of highway bridges about 6 miles south of Persimmon Gap shortly before the middle of May 1958. The water was taken from a sump in the bottom of the draw about 130 yards downstream (east) from the highway bridge.

The bottom of the draw is about 8 feet below the general level of the surrounding plain. The sump, which apparently had been bulldozed in the bottom of the draw, was about 9 feet deep. The water level in the sump was about 8 feet below the bottom of the draw. Thus, the water level in the alluvial material was about 16 feet below the level of the surrounding plain.

The material in the sides of the sump consisted largely of sand with some gravel, most of which was less than 2 inches in diameter. The material in the bottom of the draw at a few places consisted, in part, of gravel, some of which was as much as 2 feet in diameter. Alluvial material was observed in the bottom of the sump; however, the full thickness of the alluvium is not known.

Small gullies entering the draw show that the alluvial material underlying the draw extends beyond the draw at some places. Consequently it would not be necessary to dig a well or sump directly in the bottom of the draw. However, test drilling or digging will be necessary to determine where a source of water could be developed.

A sample of water was taken from the sump on May 12, 1958, for chemical analysis. (See table ___.) The water is suitable for domestic purposes, although it is hard. The quality of the water in the alluvium may vary from time to time; however, the sample was taken at a time of no surface flow in the draw and probably is indicative of about the poorest quality to be expected.

Alluvial material associated with Maravillas Creek

The alluvial ~~material~~ associated with Maravillas Creek is a source of water for wells in an area north and east of the Persimmon Gap entrance. The nearest well, at Parnell's ranch, (Green ranch on map, lat. 29°42' N.; long. 103°8' W.) is a dug well about 60 feet deep. The yield is reported to be adequate for domestic use and for watering stock.

The chemical analysis of water from the well is given in table 1. The water is high in total solids and is very hard. It could be used for domestic purposes except for its high nitrate content. The nitrate content of 111 parts per million is probably a local ~~condition, indicating~~ contamination from the nearby stock corral;

The areal extent of the alluvial ~~material~~ associated with Maravillas Creek is not known; however, the alluvium probably does not ~~occur in~~ the park ~~area~~ in the vicinity of Persimmon Gap. Adequate supplies of water could no doubt be obtained from the alluvium; however, the wells would necessarily be outside the park ~~area~~.

OTHER PLACES INVESTIGATED

Two wells in the vicinity of Cooper's store in Persimmon Gap were drilled originally to supply water for the store. Dr. Ross A. Maxwell reports that the well west of the road was used for a short time after the store was converted into a ranger station; however, the water was so highly mineralized that the pipes had to be replaced about every six months. Chemical analyses of two samples of water are given in table 1, presumably from the well west of the road. The water is too highly mineralized to be suitable for domestic use, the sulfate and dissolved solids content being far in excess of the limits suggested by the U. S. Public Health Service.

Bone Spring, shown on maps of the park area at approximate latitude 29°37' N., longitude 103°10.5' W., about 4½ miles south of the proposed Persimmon Gap ranger station, was considered as a possible source of water. The spring could not be located. Apparently the yield of the spring had decreased and a well had been drilled to supply water to a ranch in the area.

Oil tests in the valley of Maravillas Creek reportedly pass through material containing fresh water at depths ranging from 420 to more than 1,000 feet at different places. Definite information about these wells was not available.

SANTA ELENA ENTRANCE

SOURCES OF WATER

Ground water in the vicinity of the Santa Elena entrance

Geologic conditions are favorable for obtaining ground water from the Aguja formation in the vicinity of the Santa Elena entrance. The Aguja formation crops out in a general eastward-trending band about half

a mile wide. The beds in the lower part of the Aguja dip about 18° S. 30° E. and in the upper part ~~of the hills~~ dip about 35° S. 30° E. (See figs. ___ and ___.)

The contact of the Aguja and the overlying Tornillo clay was not definitely located, but it probably passes in a general easterly direction through the proposed site for the ranger station. The contact with the underlying Terlingua formation is about half a mile north of the site.

The outcrop of the lower part of the Aguja formation was examined in detail and a section was measured along or in the vicinity of line A-B shown on figure 3. A geologic cross section along line A-B is shown on figure ___ and a description of the section is given in table 2.

The Terlingua clay formation underlies the Aguja formation and crops out in the area north of "A" on figure 2. At the surface the Terlingua is yellow clay, but it is reported to be gray to bluish-gray where not weathered.

The lower 225 feet of the Aguja formation consists largely of poorly cemented, fine-grained, gray sand with some layers of medium-grained sand or sandstone. Samples ~~no.~~ 2 and ~~no.~~ 3 are fairly representative of the unconsolidated material in the lower part of the Aguja. Sample ~~no.~~ 1 is representative of the sandstone layers.

Table __.- Section of lower part of the Aguja formation near the Santa Elena entrance. This is a composite of several exposures projected into line A-B of figure __.

	Feet
Aguja formation	
Covered	--
Sandstone, gray, thin-bedded, fine-grained	20
Sandstone, gray, fairly well cemented, medium-grained; caps Hogback ridge	7
Sand, gray to yellow, poorly cemented, fine-grained, (sample no. 5)	27
Clay, dark-gray to black, fairly hard, bentonitic; weathers to loose ashy material; contains sharks teeth; (sample no. 4)	76
Sandstone, gray, irregularly bedded, medium-grained; caps small ridge	2
Sand, gray to yellow, poorly cemented, fine-grained, powdery	27
Covered	112
Coal, brown to black, lignitic. Reported to be 15 to 20 feet thick	2
Covered	113
Sand, gray, poorly cemented, very fine-grained, powdery. Has some layers of thin-bedded sandstone, (sample no. 3)	133
Sandstone, gray to tan, some beds $\frac{1}{2}$-inch thick; medium-grained; caps low hills	7
Sand and silt, gray to tan, poorly cemented, upper part medium-grained, lower part fine-grained, (sample no. 2)	55
Sandstone, gray, some beds $\frac{1}{4}$-inch thick, fairly well cemented, medium to fine-grained; (sample no. 1)	30
Total thickness measured	611
Terlingua ~~formation~~ clay	
Clay, yellow	

The overlying material, estimated to have a total stratigraphic thickness of 227 feet, is covered by alluvium except for about 2 feet of coal exposed below the alluvium in the bottom of a draw. Although only 2 feet of coal was observed, the total thickness of the coal is reported to be about 15 to 20 feet at other exposures in the area.

The material in the upper part of the measured section was estimated to be about 160 feet thick. It consists of sand and sandstone similar to the material in the lower part of the section, and a bed of dark-gray to black clay about 76 feet thick. The lower part of the clay is fairly massive, as indicated by sample no. 4; the upper part is more shaly. The clay weathers to a loose, ashy, salt-and-pepper-colored material, indicating that the clay is bentonitic and that it swells when exposed to water at the land surface. The upper part of the Aguja is covered by alluvium and therefore was not included in the measured section.

The dark-colored rock capping the hill ~~to the~~ northwest of the proposed site for the ranger station is an igneous sill (fig. ___). (A sill is a layer of intrusive igneous rock that is approximately parallel to the bedding of the surrounding formation.) The sill ranges from about 10 to 30 feet thick. It dips southeast and underlies the proposed site for the ranger station, where ~~the sill~~ is only a few feet below the land surface.

The low black hills, just across the draw to the south of the proposed site of the ranger station, are igneous dikes (fig. ___). (A dike is a tabular body of igneous rock that cuts across the bedding of the surrounding formation.) The dike stands nearly vertical and ~~it~~ probably extends a great distance below the land surface. A spur of the dike extends along the west side of the site.

The sill to the northwest of the proposed site probably is in the Aguja formation, and the dike to the south of the site is in the Tornillo clay. The area between the sill and the dike is covered with alluvial material which presumably covers the contact between the Aguja formation and the overlying Tornillo clay.

The fine-grained loose sand in the lower part of the Aguja formation is the most likely source of ground water in the area. However, the fine-grained material will offer some problems of well construction and design. The material probably will not stand up in an open hole if the hole is drilled by the percussion method. There will be difficulty in screening the sand out of the well, and the slot size of the screen should be selected with care. It may be necessary to gravel pack the well as an aid in holding back the fine sand. Thorough development of the well will minimize sand troubles.

A well site based on geologic conditions and accessibility was selected where it seems probable that a well approximately 550 feet deep would penetrate the Aguja formation and yield the desired amount of water. The site shown at "C" in figure is inside the park boundary fence a few hundred feet west of the park entrance and about 0.3 mile from the proposed site for the ranger station. The site for test drilling was selected ~~so that the water-bearing material would be some distance below the water table, thereby providing adequate storage capacity in the underground reservoir. Because of the 10 to 30 degree dip of the Aguja formation and the fact that~~ the depth to the water table is not known ~~it is believed that the aquifer where tapped should be at least several hundred feet below the land surface.~~ However, the

aquifer may be too deep and the water may be of poor quality, as the maximum depth should not be too great because the quality of the water probably becomes poorer with greater depth, and it is considered likely that the water from a depth below about 1,000 feet would not be satisfactory for domestic use.

The area in the immediate vicinity of the proposed site for the ranger station did not appear to be satisfactory for three reasons: (1) The depth to the base of the Aguja formation is computed to be more than 1,000 feet below the land surface. (2) The dike which crosses on the west and part of the south side of the area extends for an indeterminate depth below the land surface, and it likely would tend to restrict the movement of water into the area from these directions. (3) It would be necessary to penetrate the bentonitic clay layer which might cause difficulty in drilling and well construction. The clay layer is absent at site "C".

It is emphasized that much of the discussion relative to the availability of ground water in the area is based on a projection of surface information and inferences. Test drilling is the only means of determining whether or not a well is possible and feasible as a satisfactory source of water.

Alluvium of Rough Run

Rough Run, which crosses part of the park a few miles north of the Santa Elena entrance, is an ephemeral stream underlain by alluvium which probably carries an appreciable sustained flow of water. Rough Run cuts across an igneous dike about 3.5 miles northeast of the

Santa Elena entrance at approximately latitude 29°19.5' N., longitude 103°28' W. The dike can be seen from the Santa Elena Canyon-Panther Junction road at a point about 3.4 miles northeast of the present Santa Elena ranger station. Rough Run crosses the dike about three-fourths of a mile northwest of the road.

The bedrock in the area is relatively impermeable clay. The dike is more resistant to erosion than the clay, so that it stands about 50 to 75 feet above the general level of the valley. Rough Run has cut two narrow notches where it crosses the dike. The subsurface flow is funneled through the alluvial material covering the bottom of the notches. A sump or well dug in the alluvium upstream from the dike should produce ~~the amount of~~ enough water ~~needed~~ for the proposed Santa Elena ranger station.

Of the two gaps cut in the dike by Rough Run, it appears that the one on the northwest (farthest from the road) is the main gap. However, an investigation should be made of the material at the bottom of each gap to determine which has the thickest section of saturated material.

Drilling or auguring? Resistivity?

On May 13, 1958, there was no water at the surface in Rough Run in the vicinity of the dikes. However, a tributary of Rough Run that crosses the dike, ~~had~~ a small flow in the bed of ~~the stream~~ below a "pour off" about 30 feet high on the downstream side of the dike. The tributary is not considered to be a source of water for the ranger station, but it shows that there likely is subsurface flow in the alluvial ~~material~~ under Rough Run.

A chemical analysis of the water in the bed of the tributary is given in table 1. The water has too much sulphate, fluoride, and total solids to be considered suitable for drinking water. However, the water in the alluvium under Rough Run may be of considerably different quality,

Terlingua Creek

Terlingua Creek flows in a southerly direction, passing about 2 miles west of the Santa Elena entrance, where it is about ½ mile west of the park boundary. It flows into the park area about 7 miles southwest of the Santa Elena entrance.

Records of the International Boundary and Water Commission for the period 1932-54 show that there was no flow at the gaging station near Terlingua only on September 29-30, 1937. The chemical analysis of a sample of water taken on May 12 at the old Terlingua road crossing (about lat. 29°17.5' N., long. 103°33' N.), is given in table 1. The water is high in sulfate and dissolved solids and is very hard but could be used for drinking. It should be noted that the chemical quality of water in a stream may differ considerably from time to time, particularly at different stages of the stream.

Tule Spring

Tule Spring is on a graded plain near a small draw about 6 miles southeast of the location proposed for the Santa Elena ranger station (lat. 29°14.5' N., long. 103°26.5' W.).

The principal spring outlet had a measured flow of about 2 gallons per minute on May 14, 1958. Much of the water appears in the form of seeps and it was not possible to measure the total flow, which probably was about

4 gallons per minute. The chemical quality of the water is good except that the fluoride content is very high. The flow from the spring is ponded in the draw in which there are numerous goldfish, indicating the permanence of the spring flow at least within recent years. Two seeps near Tule Spring each had barely perceptible surface flows, indicating that there may be some subsurface flow in the area. The chemical analysis of the water from the principal spring is given on table 1.

Burro Spring

Burro Spring is a little more than a mile east of Tule Spring (about lat. 25°14.5' N., long. 103°25.5' W.).

The spring is in the bottom of a draw at the base of a "pour off" about 50 feet high. The flow was estimated to be about 5 gallons per minute on May 14, 1958. Dr. Ross A. Maxwell reported that the volume of flow of Burro Spring varies considerably, as evidenced by the difference in distance downstream from the "pour off" that spring water flows at different times.

The chemical analysis of water from Burro Spring is given in table 1. The water exceeds the Public Health Service standards for fluoride, but is otherwise of good chemical quality.

OTHER PLACES INVESTIGATED

Christmas Spring (lat. 29°23' N., long. 103°25.5' W.) had a measured flow of about 1 gallon in 3 minutes on May 13, 1958. The chemical analysis of the water is given in table 1.

Maverick Spring (lat. 29°19' N., long. 103°31' W.) was dry on May 13, 1958.

Chittie Spring (lat. 29°13.5' N., long. 103°28' W.) was nearly dry on May 14, 1958.

Red Canary Spring (lat. 29°12' N., long. 103°28' W.) on May 14, 1958, consisted of ~~about six~~ seeps along the northern edge of a draw.

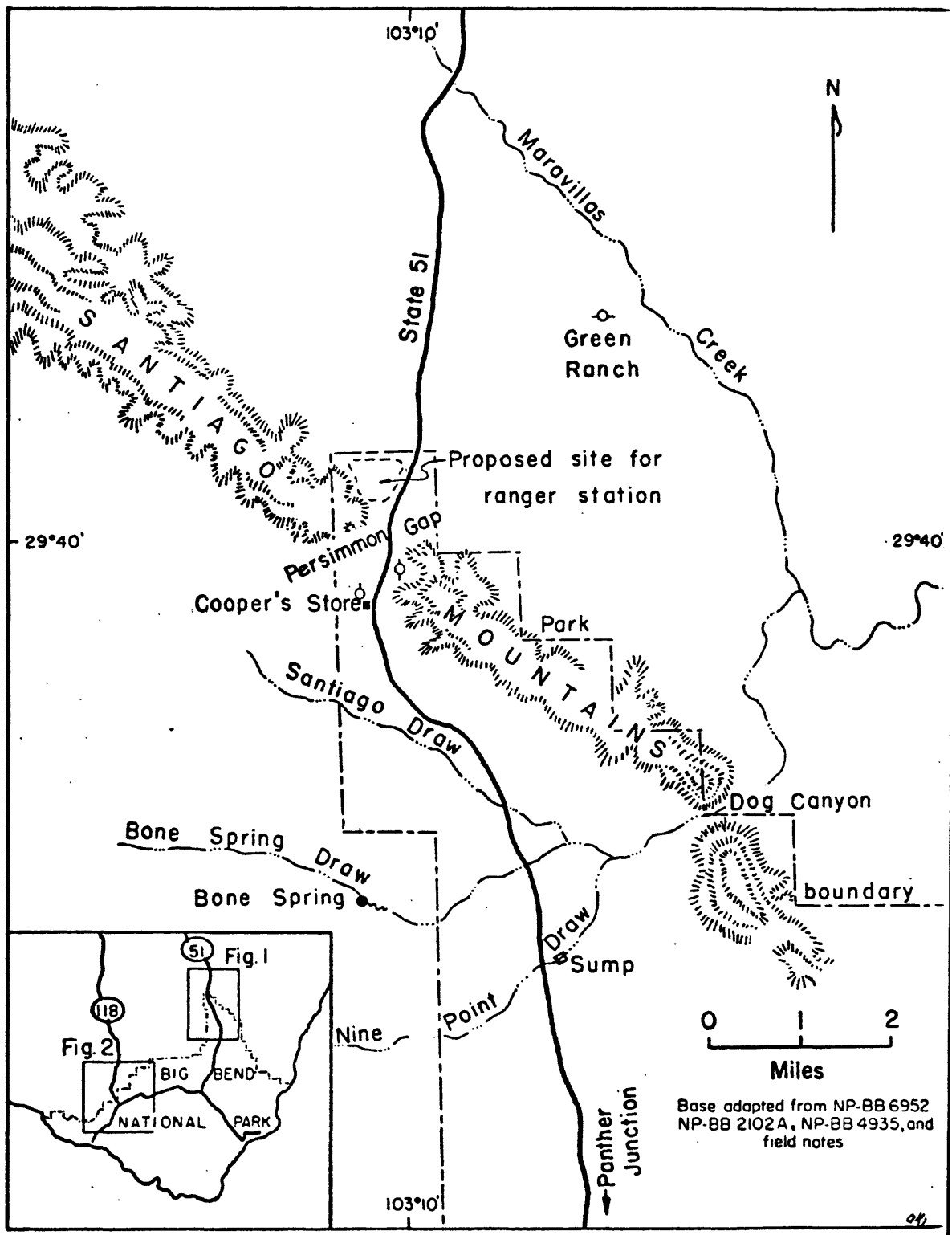

FIGURE 1.- Location map of Persimmon Gap area, Big Bend National Park, Brewster County, Tex.

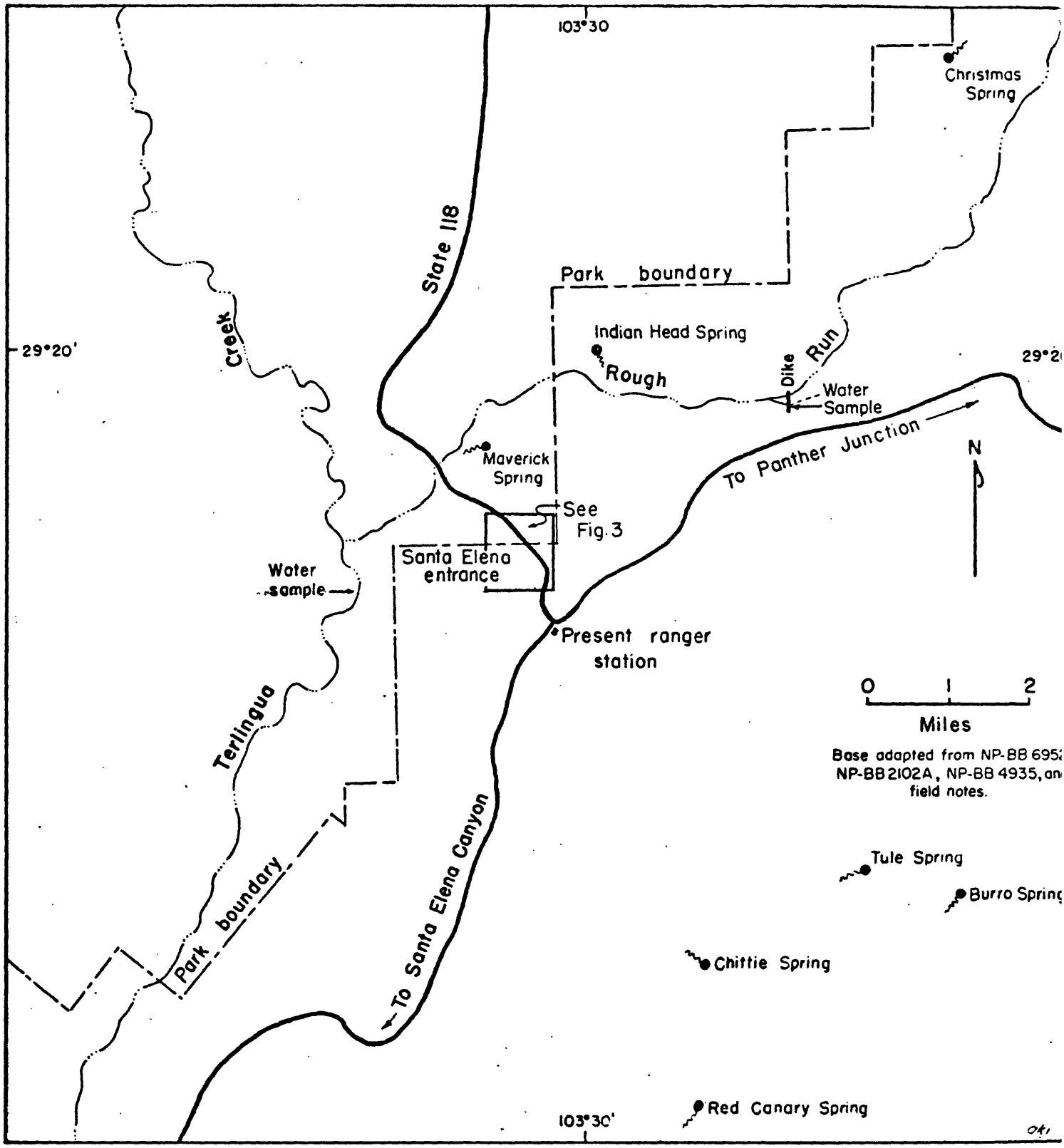

FIGURE 2.- Location map of Santa Elena entrance area, Big Bend National Park, Brewster County, Tex.

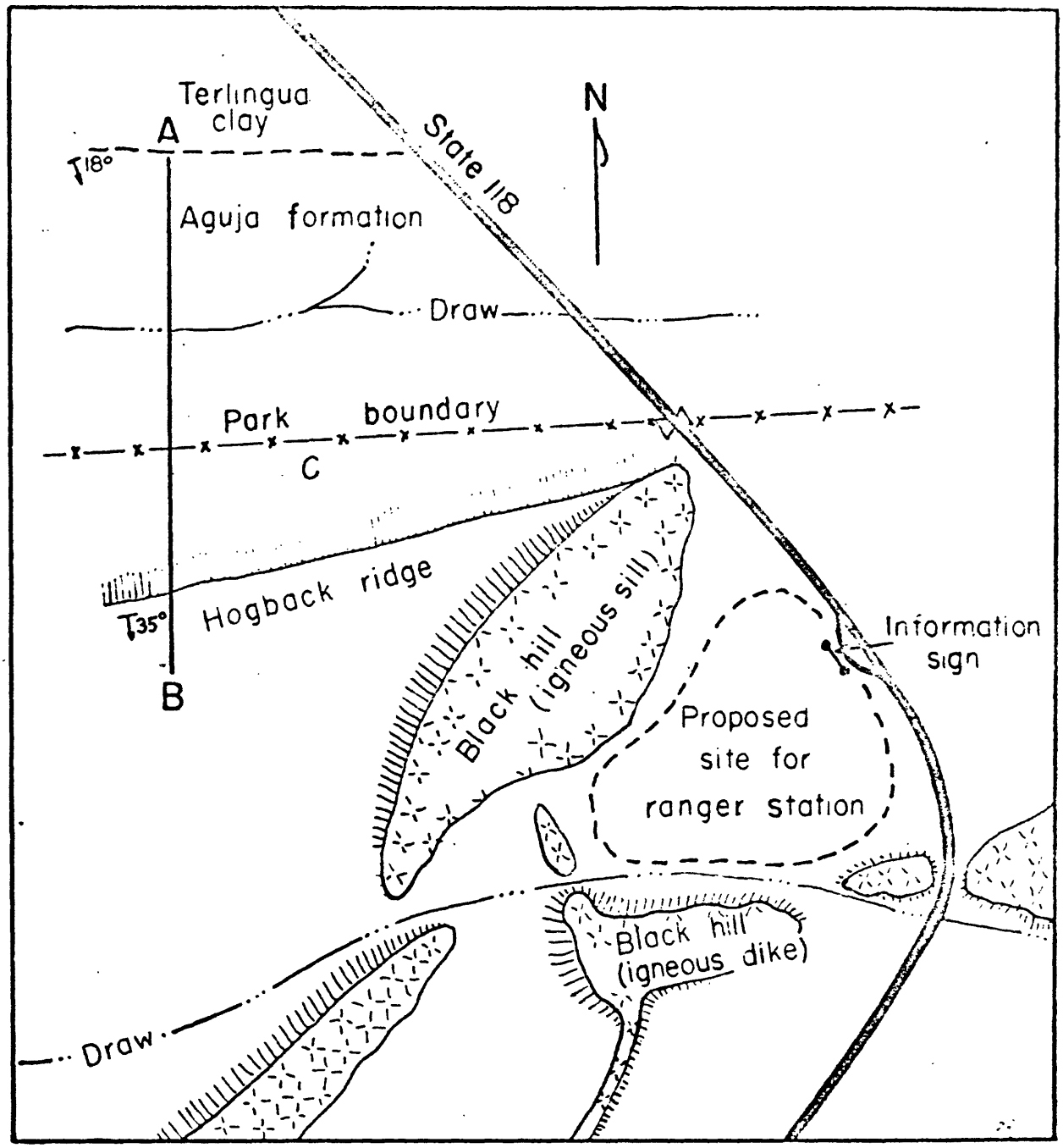

FIGURE 3.- Sketch map of the vicinity of Santa Elena entrance, Big Bend National Park, Brewster County, Tex. (Not to scale.)

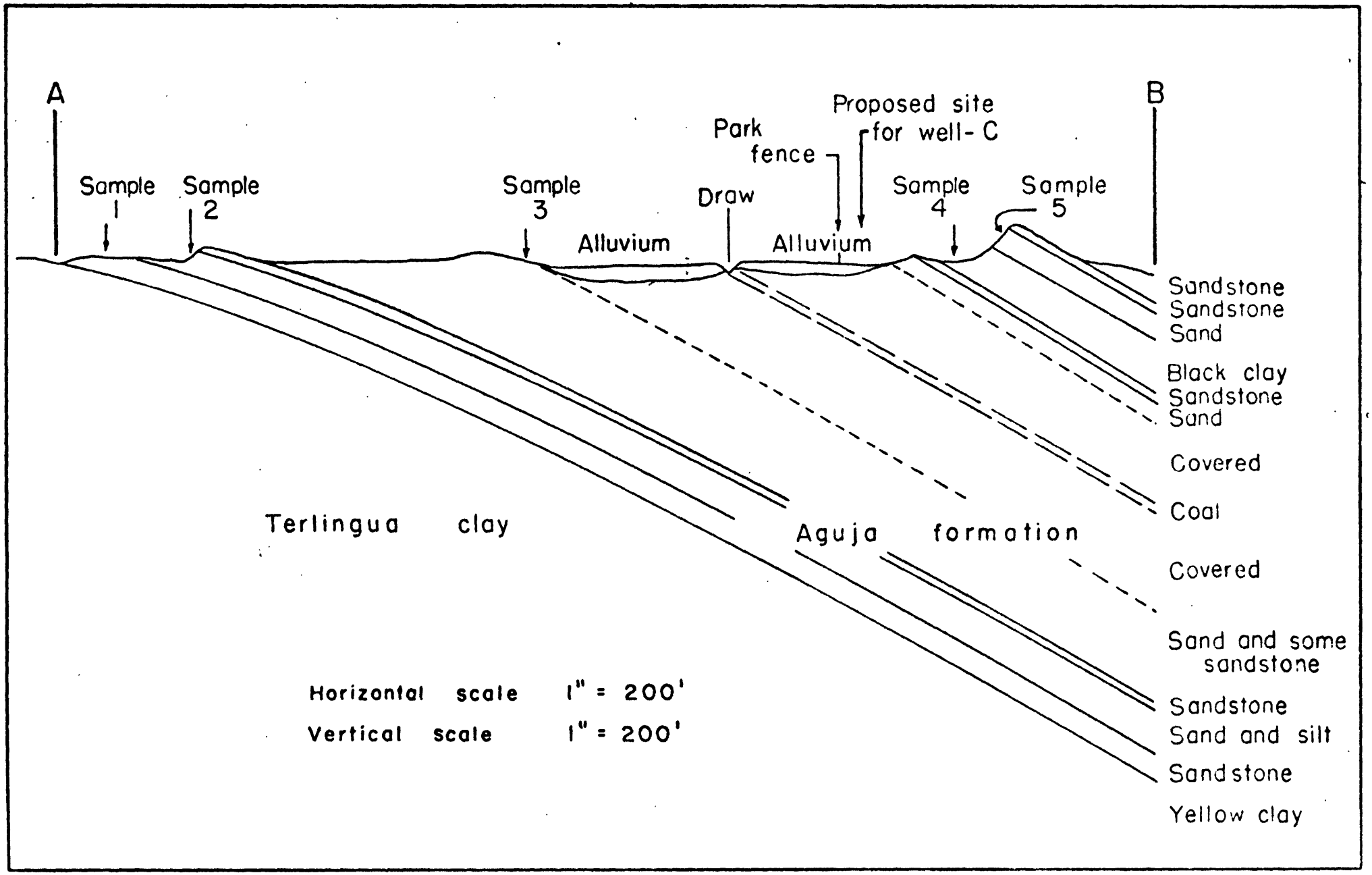

FIGURE 4.- Geologic cross section near Santa Elena entrance, Big Bend National Park, Brewster County, Tex.