CHAPTER 4: RECONNAISSANCE GEOLOGY OF BIG SMOKY PLAYA, NEVADA

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ABSTRACT

Big Smoky Playa, in the southern part of Big Smoky Valley, Nevada, is surrounded on the north, southeast, and southwest by mountain ranges and on the northeast by a low alluvial divide. Well-developed shoreline features encircle the playa with remarkable symmetry, suggesting that the location of a Pleistocene lake (Lake Tonopah) influenced the size and shape of the playa. Surface types on Big Smoky Playa in 1965 ranged from a hard, smooth surface to a soft, puffy one, with a transition surface having some characteristics of the former two. The hard, smooth surface occupied 23 percent of the playa area, and was underlain by relatively dry sediments to depths ranging from 5 to 15 feet. The salt-encrusted, puffy surface occupied 30 percent of the playa area, and was underlain by a shallow water table at depths from 3 to 5 feet. The transition surface occupying 47 percent of the playa area had a dry crust underlain by moister and darker sediments. Several holes were augered beneath the transition surface, in one place to a depth of 20 feet; however, a water-bearing zone was not penetrated. From field studies and from laboratory determinations, no significant textural difference was found in the sediments underlying the puffy areas and the smooth hard areas. It was concluded that ground-water discharge from a shallow aquifer controls the formation of puffy ground on Big Smoky Playa. The shallow aquifer consists of complex interfingering of permeable lenses of sand and coarse silt within the less permeable silt and clay. Water under hydrostatic head fills the sand-silt lenses and capillary from these lenses produces the puffy ground. Giant desiccation polygons, measuring about 50 yards on a side, were present in two separate areas of the playa; each covered about 350 acres. Phreatophyte Mounds, capped by pickleweed, were 15 to 20 feet wide in their longest dimension and 5 to 12 feet high. The location of high mounds near the margin of the playa was controlled in part by artesian conditions in shallow-playa aquifers.

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INTRODUCTION

Big Smoky Valley is in west-central Nevada about 15 miles northwest of Tonopah. The valley is elongate in a north-south direction and has an interior drainage area of about 3,375 square miles. Three topographically closed basins occupy Big Smoky Valley, two of which contain playas. This study is concerned with Big Smoky Playa and adjoining areas in the south portion of the valley bounded by lat. 38° 30' N and lat. 37° 50' N, and by long. 117° 00' W and long. 117° 50' W (Fig. 1). Big Smoky Playa covers an area of 16 square miles in a shape similar to a distorted figure eight; the northern area is somewhat circular with a radius of about one mile, and the southern ellipsoidal area is about 7 miles long and 2 miles wide. Between these two areas, the surface narrows to one-quarter mile in width. Well-developed shoreline features encircle the playa with remarkable symmetry, suggesting that the location of a Pleistocene lake (Lake Tonopah) influenced the size and the shape of the playa.

Big Smoky Valley received little attention from geologists before rich ore deposits were discovered in the vicinity of Tonopah in 1900. Shortly after ore was discovered, the region was visited by numerous geologists. Turner (1900) described the Esmeralda Formation of Tertiary age which crops out in the ranges bordering the valley on the south, and Spurr (1905) made an extensive study of the Tonopah district. Later Meinzer (1917) made a ground-water study of the entire valley and mapped the Quaternary deposits. Ferguson, Muller, and Cathcart (1953) mapped the geology of the Coaldale Quadrangle which includes a portion of the area studied in this report. Geologic mapping on a regional scale is incomplete at the time of this writing; however, recently Albers and Stewart (1965) have prepared a

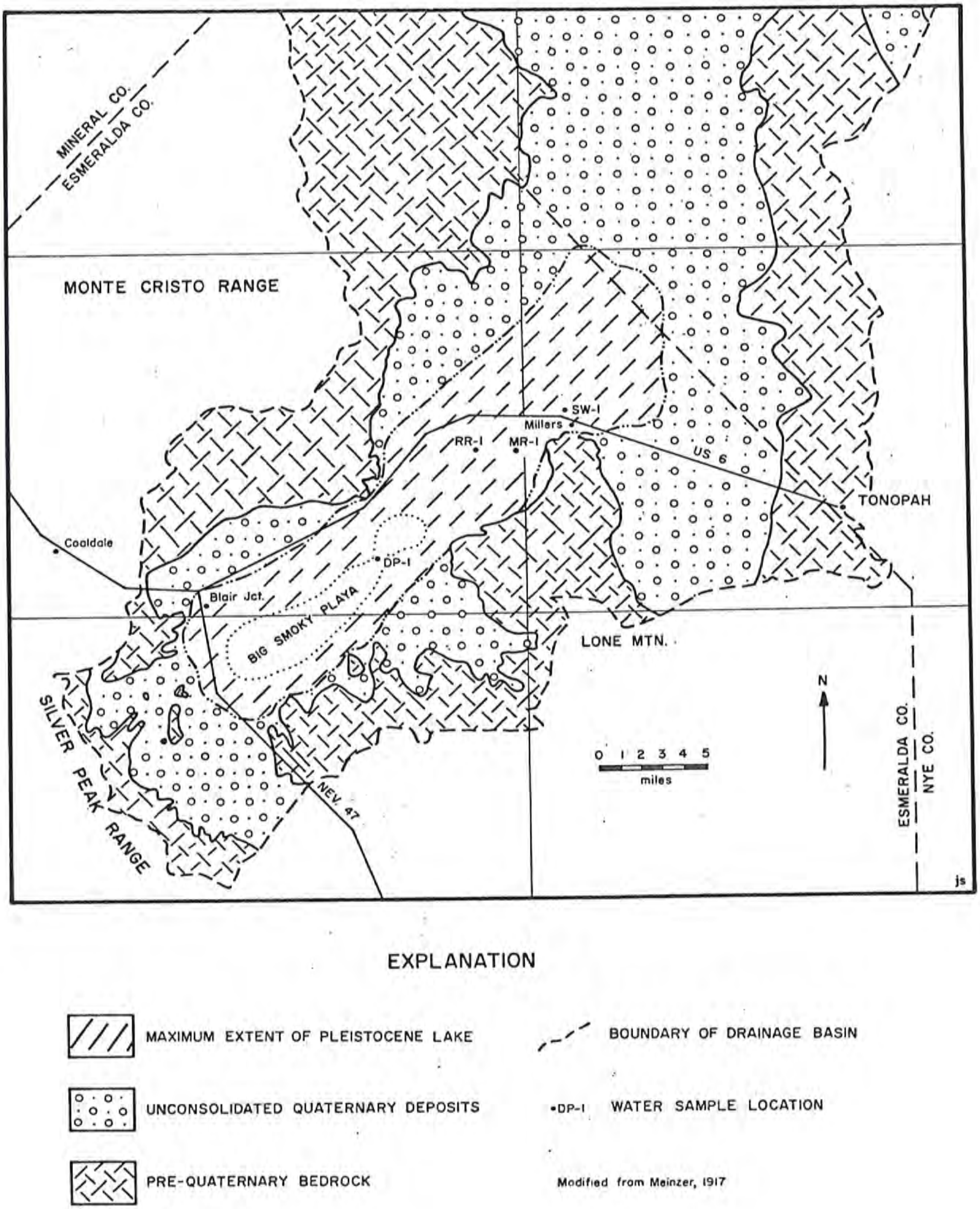

Figure 1. Geological location map of Big Smoky Playa.

preliminary geologic map of Esmeralda County. A general ground-water study including the area of Big Smoky Playa was made by Robinson (1953); Rush (1968, p. 26, 27) calculated the subsurface outflow from Big Smoky Valley into Clayton Valley. This report is based on a Master's thesis by Walker (1966) who engaged in field work during the summer of 1965, and on the observations of Motts who studied the playa for periods of one to two days on five occasions from the summer of 1963 to the winter of 1967-68.

Climate

The amount of precipitation in the area of Nevada around Tonopah is related principally to the topographic elevation. Rush (1968, p. 18) indicates that in general the valley floors and playa surfaces receive an average of about 3 to 5 inches of precipitation per year; the alluvial aprons ranging in altitute from about 4,500 to 5,500 feet receive an average of about 4 to 6 inches; and the highest mountain areas may have an average annual precipitation of 15 inches or more. Walker (1966, p. 22) calculated the average annual precipitation from 1906 to 1965 as 4.67 inches from a composite record based on recordings from the town of Tonopah (elevation 6,090 feet), the Tonopah airport (elevation 5,426 feet), and Coaldale (elevation 4,634 feet). From 1941-64 the average annual precipitation at Coaldale was 3.31 inches. The elevation of Coaldale most nearly approximates the elevation of Big Smoky Playa. Robinson (1953, p. 139) reports a 19-year dry period from 1918 through 1936 intervening between two wet periods, 1906 through 1917 and 1937 through 1949. Walker (1966, p. 22-24) suggests that this latter wet period ended in 1950, a dry period followed until 1962, and another wet cycle began in 1966. The mean monthly precipitation is variable and distributed unevenly through the year. During 1965, for example, almost twice as much precipitation fell in November (1.71 inches) as in any other month.

During the summer of 1965 precipitation throughout the east-central part of Nevada was considerably higher than normal. At Tonopah, U. S. Weather Bureau records indicate the precipitation in 1965 averaged one inch above the 59-year mean calculated by Walker. Local residents claimed that the summer was one of the wettest that they could remember in the last decade. Average rainfall during June, July, and August amounted to .31 inches.

Big Smoky Valley has wide variations of temperature both daily and seasonally. The mean annual temperature at Tonopah is approximately 50° F. (Robinson, 1953, p. 140). Highest temperatures on the playa occur during the summer months, and occasionally reach 100° F. The highest temperature at Tonopah during 1965 was 95° F. (July 5) and the lowest, 3° F. (January 1).

Records of relative humidity are not kept by the present recording stations, but datum from 1930 gives an average value of relative humidity for Tonopah as 45 percent. During the summer months the humidity may drop as low as 5 percent in the late afternoon. At Tohopah the annual evaporation rate from shallow lakes is approximately 65 inches (Visher, 1954, p. 191).

GEOLOGIC AND GEOMORPHIC FRAMEWORK

Big Smoky Playa is surrounded on the north, southeast, and southwest by mountain ranges and on the northeast by a low alluvial divide. The playa is flanked on the north by the Monte Cristo Range, on the southwest by the Silver Peak Range, and on the southeast by Lone Mountain and adjacent hills (Fig. 1). Lone Mountain (elevation 9,103) is the highest point in the drainage basin and is located 15 miles west of Tonopah. The Silver Peak Range forms the drainage divide for Fish Lake Valley on the southeast and for Columbus Marsh on the west.

The bedrock hills surrounding the playa are formed predominantly of plutonic and volcanic rocks with minor amounts of sedimentary rocks. The main mass of Lone Mountain consists of intrusive granite; its southern extension is a low, south-trending ridge of volcanic rocks. The western face of the mountain is a bold fault-line scarp rising over four thousand feet above the valley floor in a horizontal distance of about one mile. The Silver Peak Range primarily consists of volcanic and sedimentary rocks of Tertiary age. The volcanics include basalt, rhyolite, tuff, and welded-ash flows and the sedimentary rocks include conglomerate, limestone, siltstone and shale. The Esmeralda Formation crops out in the shallow washes near the playa and can be traced up-slope to the mountains, where it forms a large part of the Silver Peak Range. The Monte Cristo Range is a crescent-shaped mountain mass which joins the Cedar Mountains on the east and the Pilot Mountains on the west; the range is underlain predominantly by phyllites, andesites, and rhyolite breccias, "welded" rhyolitic ash flows and basalt of Quaternary age. The Monte Cristo Range is exceptionally colorful when viewed from a distance because of the multicolored aspect of the andesites and rhyolites.

Flanking the mountain ranges and sloping gently toward the central portion of the basin are broad desert plains consisting of alluvial fans, bajadas, and pediments. Alluvial fans along the scarp of the western side of Long Mountain are less than one mile across in their distal portion where they merge into the flat valley floor. A prominent lake terrace formed during one of the stages of ancient Pleistocene Lake Tonopah cuts into the steep fans, indicating that the fans probably formed before the lake stage as the result of faulting that took place along the western face of Lone Mountain. The material in the fans consists mostly of large granitic blocks that show well-developed exfoliation and were possibly rafted by ancient mud flows. Desert varnish in the fans is not prominent because of the large proportion of gravels consisting of granite and similar acidic rocks.

A broad slope flanking the Silver Peak Range at the southern terminus of the valley is a pediment surface approximately four miles wide and almost entirely covered with alluvium except for a few bedrock exposures. The profile of this surface is concave upward, with a gradient of 500 feet per mile near the mountains, decreasing to 50 feet per mile in the distal portion near the playa. This pediment surface is cut on the relatively soft shales and sandstones of the Esmeralda Formation and continues in a broad arcuate pattern toward the northeast and the northwest, so that the entire southern portion of the valley is encircled by the erosional surface. Pediments also form the topographic divides that separate Big Smoky Valley from Clayton Valley and Columbus Marsh; therefore, the divides are probably pediment passes (Howard, 1942, p. 3).

The extensive, relatively flat, "desert flat" extends between the broad piedmont slopes and the playa. Whereas the gradient of the alluvial slopes ranges from several hundred feet per mile to about 50 feet per mile, most of the desert flat possesses a gradient that ranges from about 15 feet per mile to about 6 feet per mile. The materials underlying much of the desert flat can probably be classified as bajada because of their thickness. Northwest of Millers a well in the desert flat is reported to have been drilled through 670 feet of alluvial materials before penetrating bedrock (Meinzer, 1917, p. 109). In Big Smoky Valley, the desert flat is nearly 40 miles long and from two to seven miles in width. The vegetation and surface appearance of the desert flat is similar to the higher pediment slopes, with the exception of small playa-like areas where drainage collects due to natural or man-made obstructions such as dunes or roads. These small areas or microplayas, generally a few hundred feet in size, are characterized by fine-grained sediments, and exhibit a hard, dry, mud-cracked surface.

GEOMORPHOLOGY OF BIG SMOKY PLAYA AND ADJACENT AREAS

The lowest elevation of Big Smoky Playa (4,720 feet) is located in the northeastern quarter of the southern part of the playa. About 4 miles east of this area the playa elevation rises to 4,723 feet. The angle formed by the surface and a horizontal plane between these two locations is approximately 30 seconds, a gradient of 0.75 feet per mile.

In most places the playa does not directly border the desert flat but is surrounded by a narrow area herein called a "playa-transition zone" that ranges from a few to several hundred yards in width. The vegetation and sedimentation of this zone are a transition between the desert flat and the playa; vegetation occurs in the zone, but the playa is barren. Sediments of the playa-transition zone are lacustrine silts and clays veneered with a cover of granules and pebbles probably derived from the adjoining desert flat. Large phreatophyte mounds and extensive areas of wind-blown sand occur in the playa-transition zone.

The playa is positioned asymmetrically in the drainage basin, one mile from Lone Mountain on the east and 3 to 10 miles from the Monte Cristo Range on the west. The asymmetric position of the playa can be explained by differential tilting of the basin. Eastward tilting is suggested by the presence of small, steep alluvial fans that terminate abruptly at the base of Lone Mountain. The small fans contrast with the broad, well-defined slopes which border the valley on the western side, a relationship that suggests relatively more tectonic movement along the eastern border of the valley. The position of the playa can also be explained as the result of more rapid deposition from the west which has "pushed" the playa eastward by the encroachment of detrius.

Playa Surface Types

Surface types of Big Smoky in 1965 ranged from a hard, smooth surface to a soft, puffy surface (Fig. 2). These two surface types are end members with a third or transition surface having characteristics of the two. The boundary between surface types was generally gradational and the contacts shown on Figure 2 were approximate.

Hard Surface

In 1965 the typical hard surface was very pale yellow, smooth and dry with almost no microrelief, and covered about 3.5 square miles or 23 percent of the playa area. The surface was characterized by several generations of small desiccation polygons generally less than six inches across. Areas of the hard surface occurred principally in the northern part of the playa, and in limited areas of the desert flat where drainage was locally ponded. Automobiles could easily cross the hard, compact surface at moderate to high speeds and leave no tire impressions (Fig. 3).

Approximately 15 holes were augered at locations throughout the dry surface to depths ranging from 5 to 15 feet. No variation in the moisture content of the subsurface sediments was noted from field inspection. The fine-grained sediments were very dry, and they commonly slipped through the auger head before it could be withdrawn to the surface. The dry nature of the materials at depth indicated that little ground water discharged through the dry surface by capillarity. The surface had no alkali stain, but the sediments reacted vigorously with dilute hydrochloric acid, indicating the presence of carbonates.

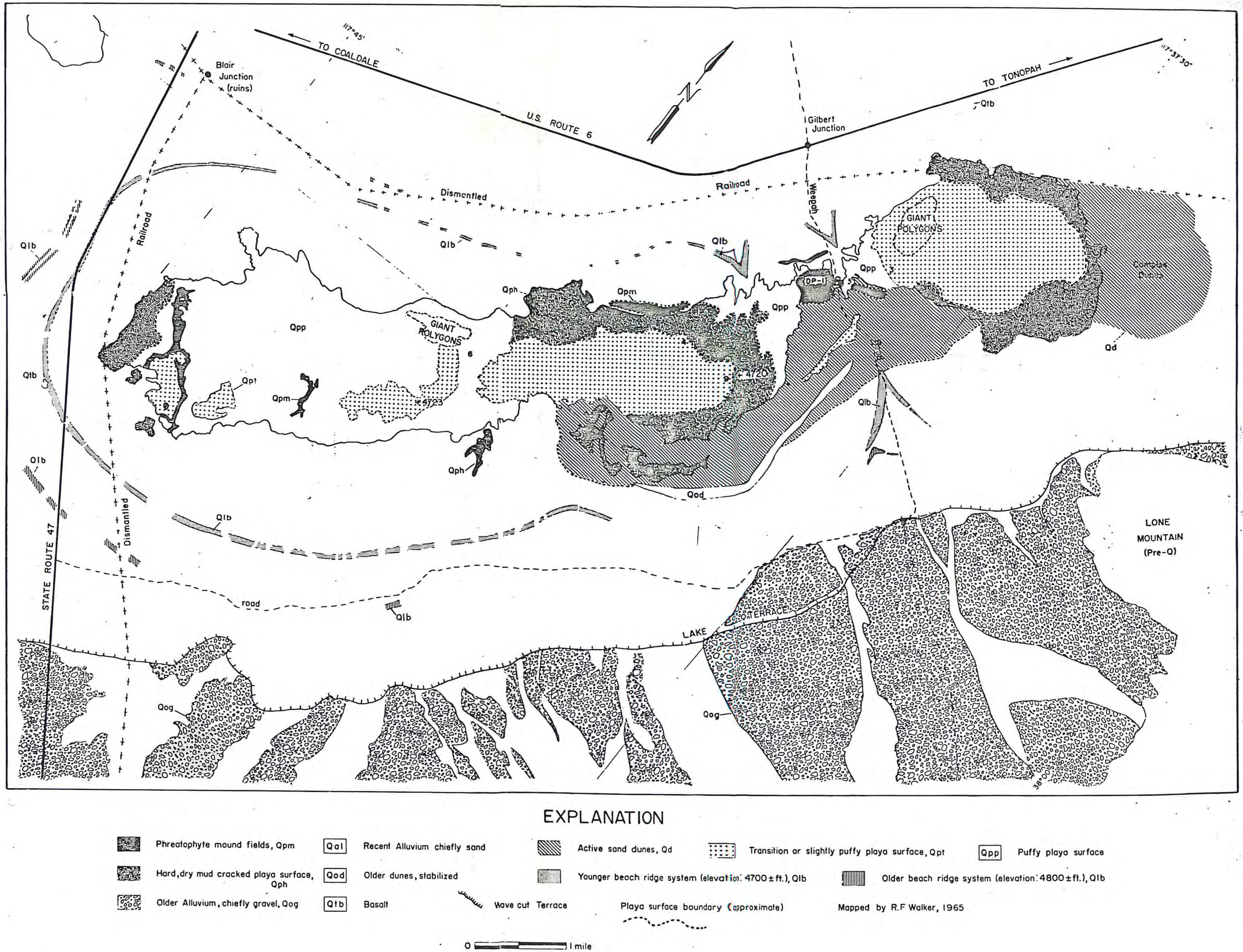

Figure 2. Geologic map of Big Smoky Playa and adjacent areas.

Puffy Surface

A dark, yellowish-brown, puffy surface covered 5 square miles or 30 percent of the playa area in 1965 (Fig. 4). White patches of salt were present throughout the surface whose microrelief ranged up to 6 inches. The crust was dry, but sediments beneath the puffy surface were moist and slightly darker in color. Automobile tires sank from 2 to 4 inches into the crust, and it subsided under the weight of a man.

Approximately 10 holes were augered into the puffy surface at selected places around the playa, and a 3 by 4 foot trench was dug in the narrow southern part of the playa (DP-1, Fig. 2). In all places the water table was penetrated at depths ranging from 3 to 5 feet and the sediments were moist from the surface to the water table. The trench (DP-1) encountered very slow artesian flow at a depth of 40 inches. Ground-water discharge from these near-surface aquifers appears to control the formation of the puffy ground.

Transition Surface

The transition surface was so named because its appearance and characteristics were intermediate between the hard, dry surface and the soft, puffy surface. Automobile tires sank slightly into the surface, but man's walking left no footprints (Fig. 5). The transition surface was the most widespread surface type and covered 7.5 square miles or 47 percent of the playa area. The surface had a yellowish-gray color and microrelief ranged from 1 to 3 inches. The crust was dry, but just beneath the surface sediments were slightly moist and darker in color. Several holes were augered beneath the surface, at one place to a depth of 20 feet; however, a water-bearing zone was not penetrated.

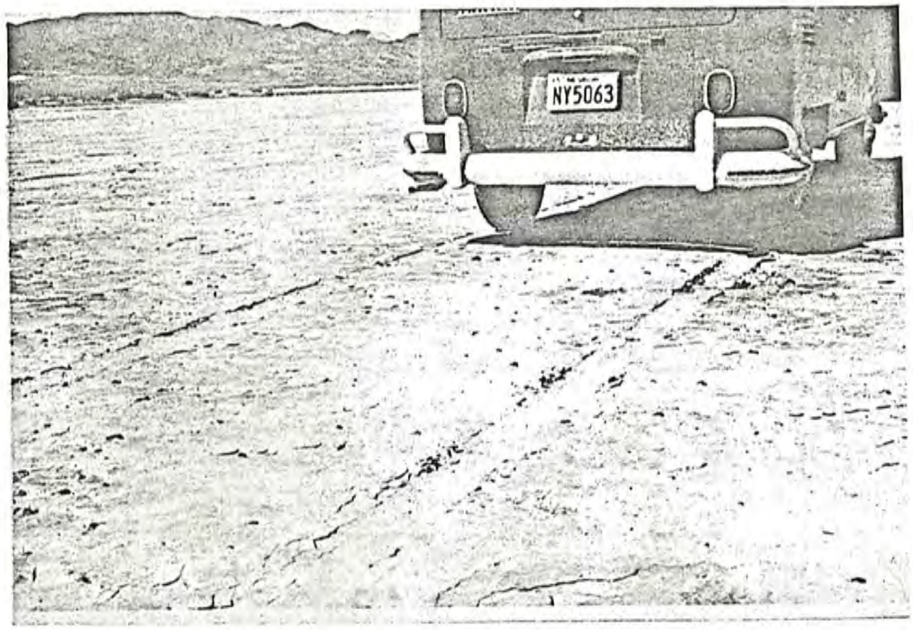

Figure 5. Transition surface, note tire imprints about 1 inch deep made by car.

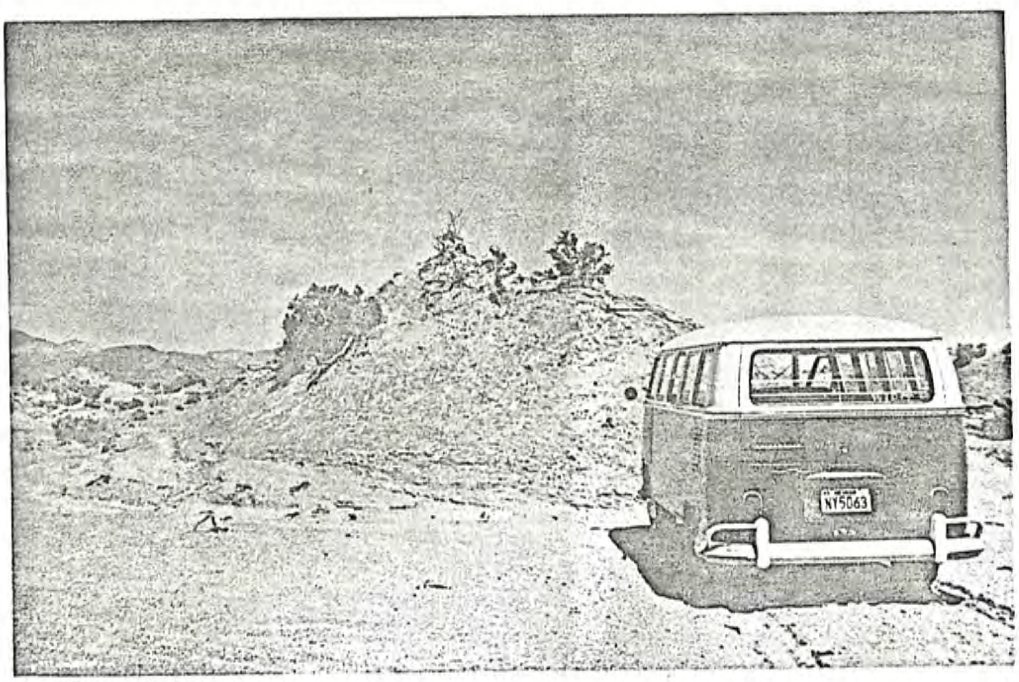

Figure 6. Typical phreatophyte mound in eastern part of Big Smoky Playa.

Pebble Cover

Scattered over parts of the surface of Big Smoky Playa was a sparse cover of granule and pebble-size fragments which generally ranged in diameter from one-half to one inch. The pebbles were angular to subangular, of mafic composition, and similar in size and composition with those in the desert flat, indicating they were probably derived from this latter area. No gravels were found in the subsurface. The density of this pebble cover was greatest at the playa margins and decreased toward the playa center where in places there was a maximum density of three or four pebbles per square foot.

Giant Desiccation Polygons

Giant desiccation polygons, occurring in numerous playas, are formed from deep contraction caused by desiccation of the fine-grained sediments (Neal and Motts, 1967, p. 515-518). On Big Smoky Playa there were no recently-formed giant desiccation polygons, but there were relic fissures filled with coarse sand and silt that supported xerophytic vegetation. These ancient polygons measured about 50 yards on a side and were present in two separate areas--one in the northern and the other in the southern part of the playa (Fig. 2). Each of these areas covered about 350 acres. Both of the polygon areas were near the edge of the playa, and were slightly higher than the main part of the playa. Relic fissures did not occur on or near the lower, central part of the playa. On aerial photographs, the polygons could be recognized easily by their regular, geometric pattern, which was delineated by vegetation.

Phreatophyte Mounds

Plant mounds are small hills, generally a few feet high, of wind-deposited material capped by one or more living or dead desert plants (Fig. 6). Phreatophyte Mounds at Big Smoky Playa differ from those at other playas by their height (5 to 12 feet), by their thick crust (as much as one inch) cemented with calcium carbonate, and by their association with phreatophytes (Motts, 1965, p. 19).

Meinzer (1917, p. 49) first noted the occurrence of large plant mounds at Big Smoky Playa and described their development as follows:

> A mound may have its origin in a single alkali-resistant bush which is able to establish itself on the flat. This bush, by acting as a windbreak, and accumulating a little wind-borne material, produces conditions that are favorable for plant growth in its immediate vicinity. It does this by providing a less dense, less alkaline, and better drained soil than that of the flat, and by providing some immunity from inundation.

Phreatophyte Mounds are roughly circular to elliptical in shape, and sometimes resemble miniature drumlins in plain view. The larger mounds are commonly 15 to 20 feet in longest dimension along their base. Heights of mounds range from 5 to more than 12 feet along the margins of the playa. The mounds commonly are capped by big greasewood (<u>Sarcobatus vermiculatus</u>), which generally have very deep root systems--depths of 20 to 40 feet are not uncommon (Meinzer, 1927, p. 41).

A cross section through a typical mound shows well-developed eolian cross bedding. Texturally, Phreatophyte Mounds contain more sand than the playa sediments, and more silt than clay dunes. Because the mounds consist of thinly interbedded units, it is impossible to sample a single sedimentation unit without contamination from adjoining units. A channel sample of a typical Phreatophyte Mound from Big Smoky has the following textural characteristics: sand 53%, silt 16%, clay 31%.

The hard carbonate crust of Phreatophyte Mounds is formed by capillary and plant water discharging through the mound sediments. This discharge is necessary to maintain the cemented crust, and the height to which the crust can be maintained appears to be related to the potentiometric level of artesian aquifers. Trenching shows that shallow artesian conditions are present in the vicinity of the large mounds at Big Smoky Playa, suggesting that large mounds at other playas may be dependent on similar conditions. When the plant dies and the crust is removed by erosion, the fine-grained materials inside the mound desiccate and are easily removed by rainwater or wind, thereby leading to the total destruction of the mound.

Phreatophyte Mounds tend to occur in groups rather than as single isolated hills. Long, linear groups of mounds joined in places by recent wind-blown sand occur along the western border of the playa (Fig. 2). The longer groups tend to have a sub-parallel alignment with beach ridges that lie up-slope from the playa.

Deflation of Playa Sediments

Wind erosion has apparently been an effective process in removing playa sediments on Big Smoky Playa. When Motts first visited the playa in July, 1962, the central part of the playa surface was covered with mud curls or concave-upward polygons formed from recent flood deposits (Chap. 7, Fig. 26). Two years later when Walker studied the playa all evidence of the mud curls was gone; they had been removed by wind deflation. The actual process of the removal of the mud curls was observed by the authors before and during a heavy thunderstorm in August, 1965. Most of the wind erosion occurred before the storm, during a time of strong upward winds. The wind carried large quantities of the mud curls hundreds of feet into the air (Fig. 7). At the same time abrasion of the curls occurred as the wind carried them by traction along the ground surface.

Two additional lines of evidence indicate that the playa sediments have been removed by wind erosion. First, numerous channels are incised below the desert flat surface surrounding the playa (Fig. 8). These channels have been cut into a surface that formerly was level with and in sedimentary equilibrium with the old playa level. When the playa surface was lowered by erosion, the stream achieved a new base level by incising through the desert-flat surface. Secondly, large areas of the transition playa surface and the adjacent desert flat contain small sand mounds, some of which are capped by xerophytes and some of which contain dead roots (see Fig. 9). These mounds have a common level, and the plants that formed the mounds may have grown on the older, higher surface.

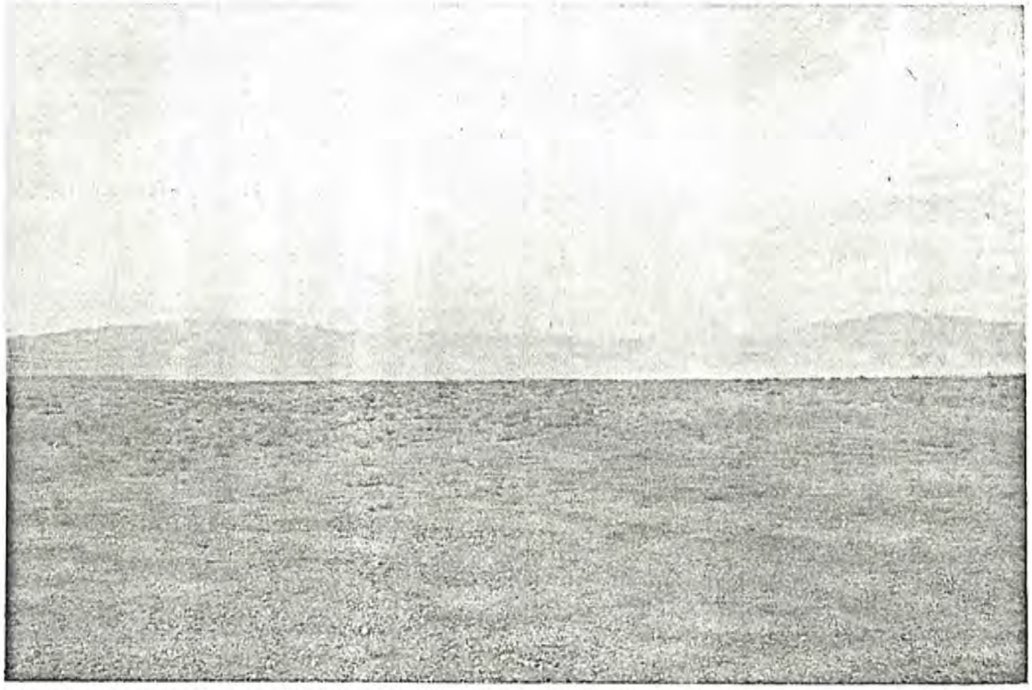

Figure 7. Wind erosion carrying playa sediments high in the air by strong upward winds.

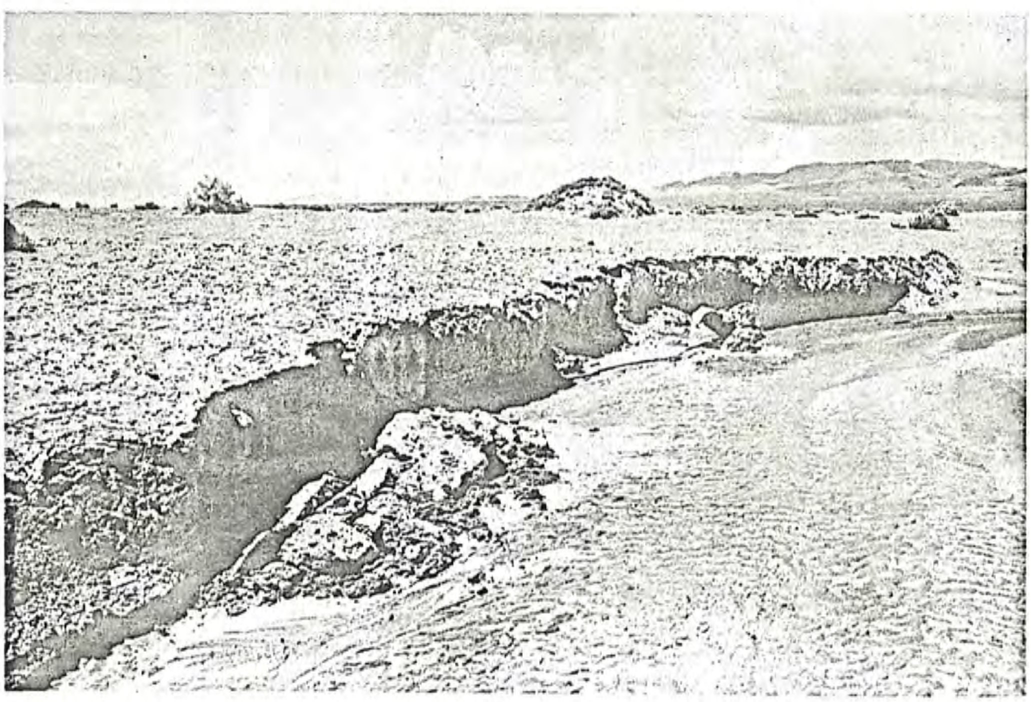

Figure 8. Channel, near playa margin, that has cut into desert flat.

SEDIMENTATION AND HYDROLOGY

Sedimentation

Representative playa samples including the three playa-surface types and playa-sedimentation units were collected and analyzed for textural composition (Table 1 and Figs. 9, 10, 11). Material coarser than 4 Ø (sand fraction) was removed from the samples by wet sieving, and the mud fraction was analyzed using the pipette method described by Folk (1964, p. 36-39). The relative percentages of sand, silt, and clay were calculated for each sample and plotted on a triangular textural diagram (Fig. 10). All playa-surface samples are in the sandy mud and sandy clay range and no significant textural differences in the sediments occur at shallow depths (1 to 4 feet). The sand fraction of each of the samples was examined under the binocular microscope to obtain a visual estimate of the mineral composition. Common constituents are volcanic rock fragments (30-40%), quartz (30-40%), gypsum (15-20%); accessory minerals are mica, carbonates (dolomite and/or calcite), and heavy minerals (mostly amphibole and pyroxene).

Extensive flooding of the playa during August, 1965, (Fig. 12) gave Walker an opportunity to study the relation of flooding to playa sedimentation processes. Following flooding early in the day, a sheet of water was relatively still and undisturbed. However, by late afternoon the wind shifted the sheet and placed much of the finer material in suspension, as shown by the turbid appearance of the water. The flooding also provided additional evidence of the low permeability of the playa surface and of the small quantities of water infiltrating the subsurface. When the lake had receded, the top few inches of the hard (Qph) crust were turned over with a shovel revealing completely dry, shallow sediments.

TABLE 1

LOCATION AND DESCRIPTION OF PLAYA SAMPLES

Sample	Location*	Map Symbol	Description
1	surface crust	Qph	hard surface
2	surface crust	Qph	hard surface
3	surface crust	Qpt	transition surface
4	surface crust	Qpt	transition surface
5	surface crust	Qpp	puffy surface
6	surface crust	Qpp	puffy surface
7	4 ft. beneath surface	Qph	area
8	3 ft. beneath surface	Qpt	area
9	3 ft. beneath surface	Qpp	area

*Locations of samples are shown on Figure 2 and size analyses are shown on Figure 12.

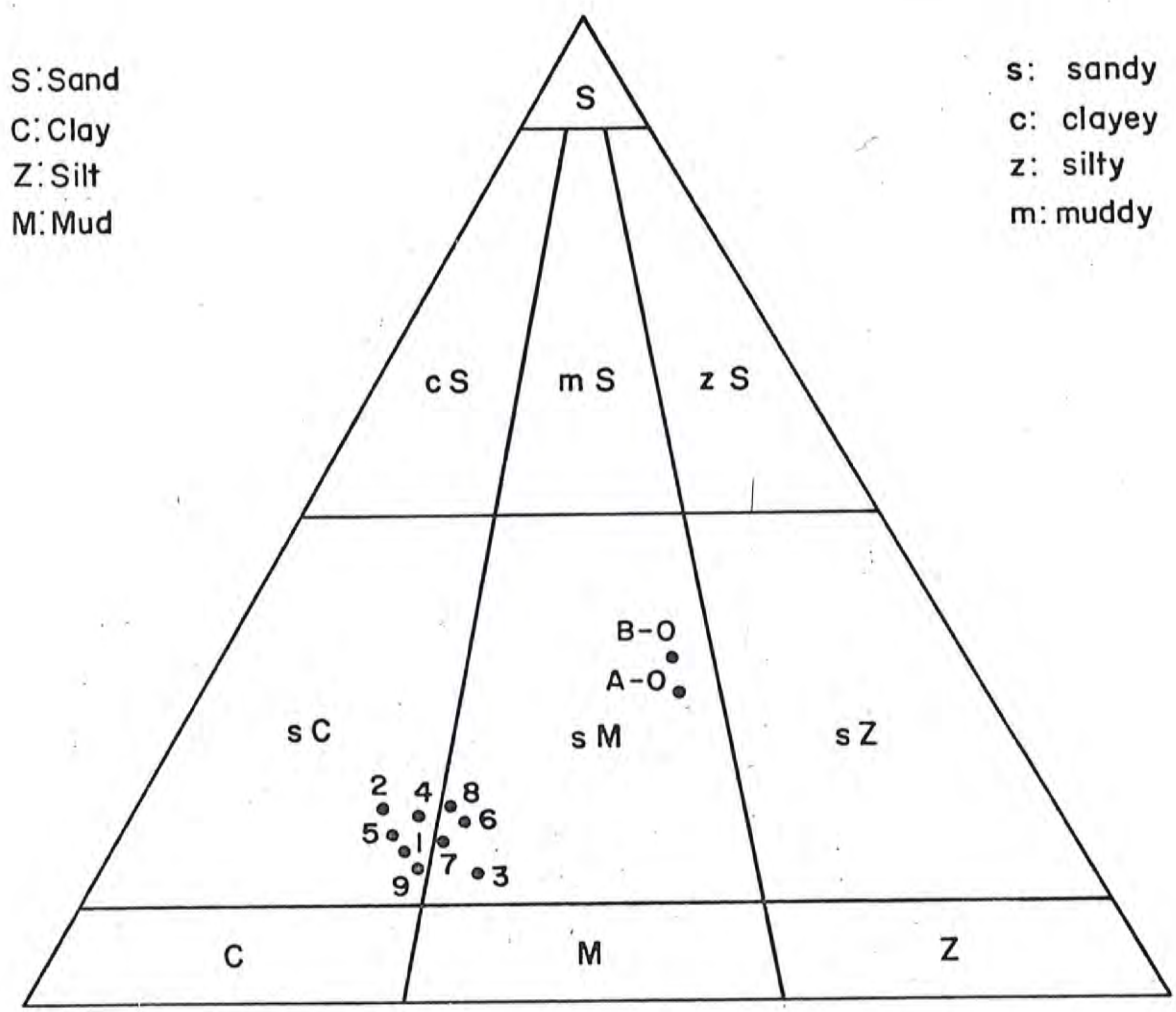

Figure 10. Triangular plot of playa sediments. For location of samples see Figure 2, and for description see Table 1.

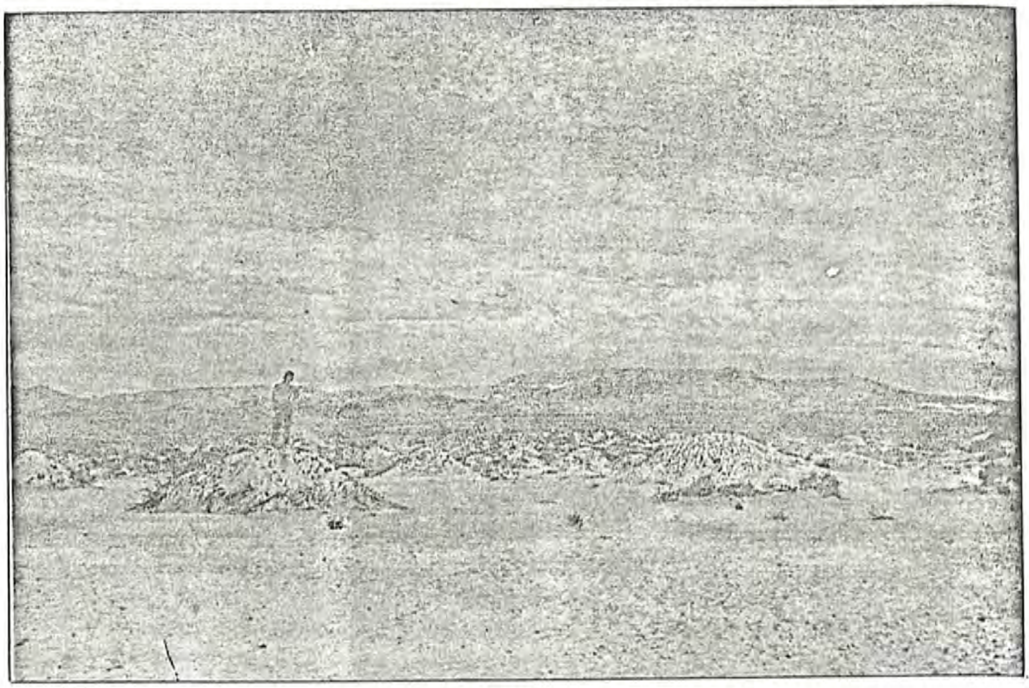

Figure 9. Small mounds in eastern part of playa.

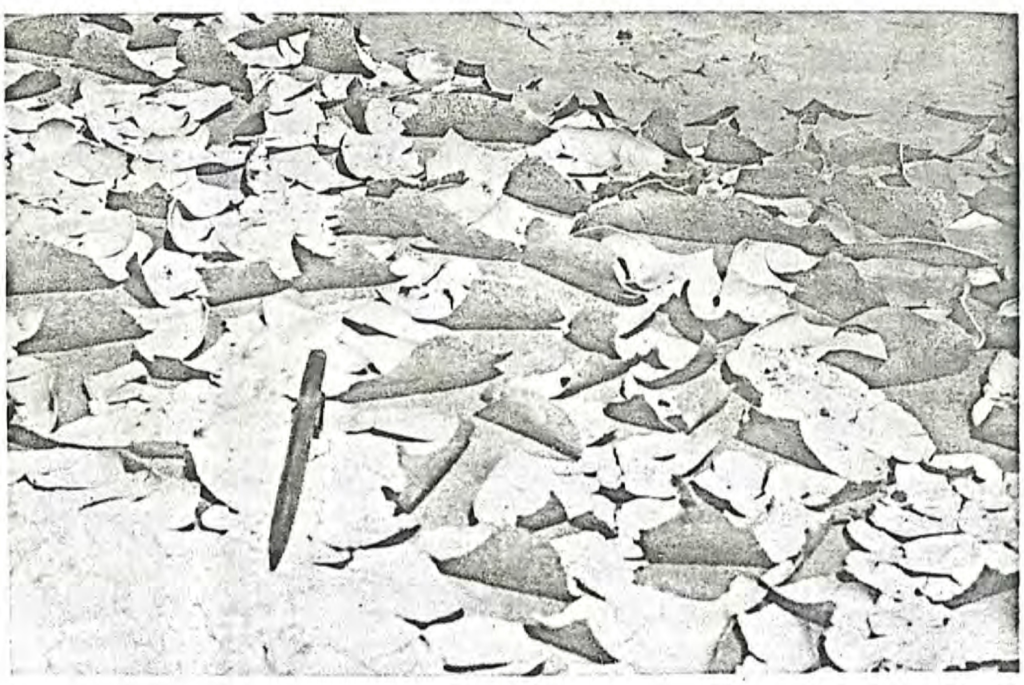

Figure 11. Playa sedimentation unit (mud curl) consisting of basal sand and silt grading upward into finer sized silt and clay. Note curls beginning to form in left part of photograph as sedimentation unit desiccates.

Recession of water from Big Smoky Playa between successive floodings gave Walker an opportunity to study the sediments deposited during these floodings. The term "playa-sedimentation unit" was used to designate the sediments deposited after one ephemeral flood. Each unit was a graded bed consisting of basal sand and silt grading upward into finer-sized silt and clay. The average unit was about 0.05 to 0.10 inches thick. Toward the center of the playa where the sandy basal portion was not deposited, only a very thin unit of silt and clay was laid down. Two samples (A-O and B-O, Fig. 10) of the graded beds from the playa edge were analyzed texturally, and showed a much greater sand content than samples from the fine-grained playa surface. It was not possible to sample the very thin sedimentation units near the center of the playa without mixing and contaminating them with playa-surface sediments.

Hydrology

Big Smoky is a bypass type of hydrologic valley; i.e., some of the water draining from the surrounding mountains discharges through the playa surface, and part of the water travels downgradient where it is discharged in valleys with lower altitudes such as Clayton Valley and Columbus Flat. Rush (1968, p. 15) reached the same conclusion and estimated the average annual recharge to Big Smoky Valley was 16,000 acre-feet and evapotranspiration from the valley was 4,600 acre-feet. Rush believes that the imbalance of 13,000 acre-feet flows through solution openings in carbonate rocks from Big Smoky Valley into Clayton Valley. Ground-water conditions in Big Smoky Valley have been studied by Meinzer (1917) and Robinson (1953). Meinzer's work is based on considerable well data and personal observations in the area during several years in the early 1900's. Most of the wells cited by Meinzer have since been abandoned and are now filled with debris, making it impossible to obtain recent hydrologic data from these wells.

Meinzer (1917, Pl. 2) found that the potentiometric surface at Millers, located about 12 miles northeast of Big Smoky Playa, was about 100 feet below the surface, whereas near the playa the depth to the potentiometric surface was as shallow as two feet. Ground water in the valley fill flows downgradient toward the playa where some is discharged directly through the puffy surface and some is discharged by vegetation. Meinzer (1917, p. 115) also found that the total dissolved solids were higher in water near the playa. Walker sampled water from four wells that lie along an approximate line from Millers to the center of the playa. Partial chemical analyses of these samples were made using a portable water-quality kit. The results are shown in Table 2 and are in agreement with Meinzer's original findings.

TABLE 2

PARTIAL CHEMICAL ANALYSIS OF GROUND-WATER SAMPLES

Sample	Total alkalinity (as ppm $CaCO_3$)	Chlorides (ppm)	Total dissolved solids (ppm)
DP-1	190	77.5	1,085
MR-1	150	50.0	450
RR-1	180	55.0	420
SW-1	135	15.0	224

Location of samples:

DP-1: Trench along Weepah Road crossing narrow portion of playa. Depth: 5 ft.

MR-1: Millers Ranch, 7 miles northeast of playa. Depth: 10 ft.

RR-1: Abandoned railroad well, about 6 miles north of playa. Depth: 4 ft.

SW-1: State drinking well along U. S. Highway 95 at Millers, about 12 miles northeast of playa. Depth: approximately 200 ft.

Note: See Figure 1 for locations of samples.

During the summer of 1965 Walker dug a shallow trench 5 feet deep through clays and silts near the north end of the playa at station DP-1 (Fig. 2). When the trench penetrated a shallow lens of sand and silt, water under the artesian head flowed over the playa surface (Fig. 13). Motts visited the trench in the fall of 1967 and the water was still flowing. This long-continued artesian flow from such a shallow aquifer is an unusual condition in playas of western United States. The following are three possible explanations for the artesian flow. First, the lens of sand and silt containing the artesian water may extend into the dune sand and alluvium of the desert flat, thereby giving the lens a hydrologic connection with the higher recharge area. Second, water from depth could be ascending through a vertical zone of high permeability in the playa sediments. Motts observed areas of higher ground-water discharge along zones of relatively high permeability on South Panamint Playa and Troy Playa in California. Third, deep water may move upward under hydrostatic head, fill the shallow lens, and discharge by capillarity at the surface. The sustained discharge of water for more than two years would indicate a deep source for the water because the large amount of water that has discharged does not appear to be commensurate with the relatively small recharge area.

The playa was flooded from the latter part of July until the middle of August, 1965, when field study by Walker was terminated. Although water never completely covered the playa, at one time about 75 percent of the surface was inundated to a depth of 6 to 18 inches (Fig. 12). At this time the flooded area included the entire southern part of the playa. According to local residents, playa flooding generally occurs only once or twice in the average summer, and water evaporates from the playa "in a matter of days."

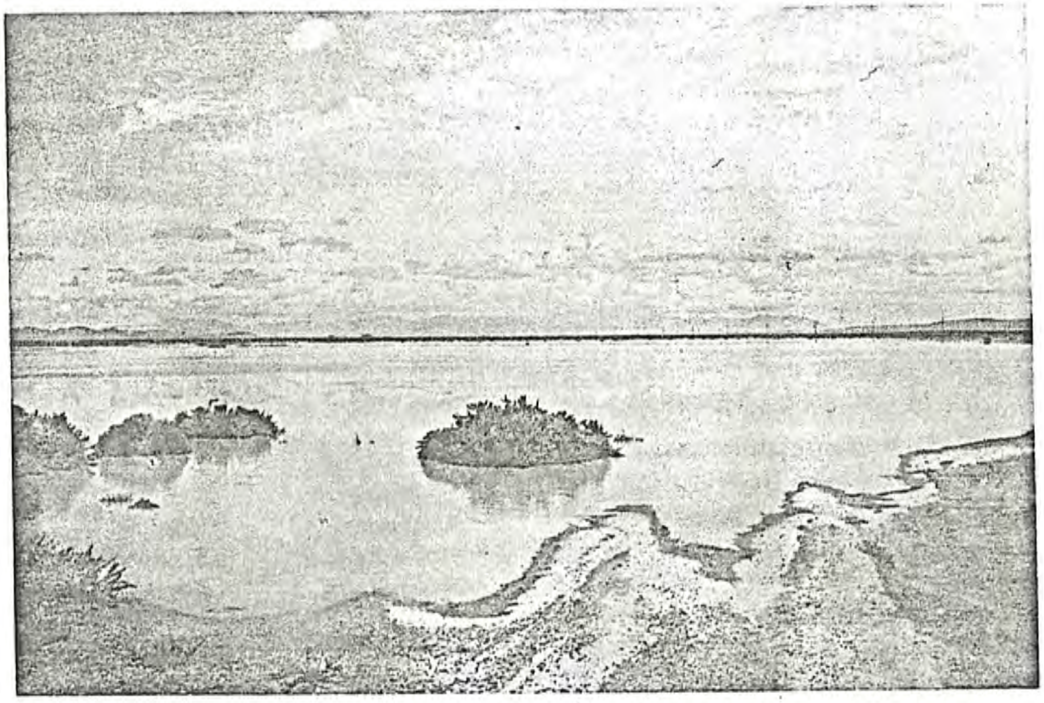

Figure 12. Big Smoky Playa flooded during August, 1965, looking south to Silver Peak Mountains in the background. White zone near water was probably formed by capillary discharge intensified around boundary of standing water.

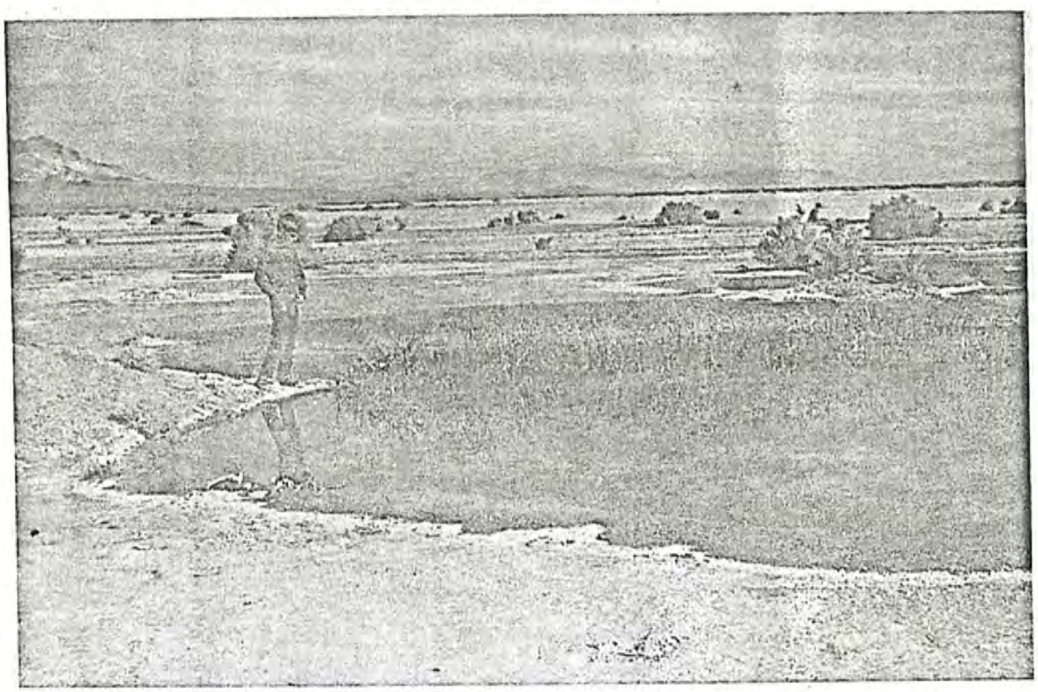

Figure 13. Small pond in 1968 along Weepah Road formed from artesian flowing water. A trench dug by Walker in 1965 penetrated the shallow artesian zone.

Relation of Surface Types to Hydrology

Field evidence at Big Smoky Playa, substantiated by laboratory work, shows a relation between playa-surface types and ground-water depth. As discussed previously, the puffy surfaces are underlain by moist materials, whereas the hard surfaces are not. Laboratory work shows that sediments underlying the different surface types are similar in textural composition; therefore, their relative permeabilities are also similar. In addition, trenching has shown that some of the areas of puffy ground are underlain by sandy lenses. The above evidence suggests that the irregular distribution of puffy, transitional, and smooth-hard surfaces is best explained as complex interfingering of shallow, permeable lenses of sand and coarse silt with less permeable silt and clay. Water under hydrostatic head fills the sandy-silt lenses and capillarity from these lenses produces the puffy-ground conditions. Where sand-silt lenses are not present near the surface or where they occur at great depth, only small amounts of water can escape from the surface, resulting in the hard, smooth surface. The above theory should be substantiated by a more detailed investigation including the drilling of many auger holes in all the surface types.

REFERENCES CITED

Albers, J. P., and Stewart, J. H., 1965, Preliminary geologic map of Esmeralda County, Nevada: U. S. Geol. Survey, Mineral Investigations Field Studies Map MF-298.

Ferguson, J. G., Muller, S. S., and Cathcart, S. H., 1953, Geology of the Coaldale Quadrangle, Nevada: U. S. Geol. Survey Geol. Quad. Map GQ-23.

Folk, R. L., 1964, Petrology of sedimentary rocks: Austin, Texas, Hemphill's Book Stores, 153 p.

Howard, A. D., 1942, Pediment passes and the pediment problem: Jour. Geomorphology, v. 5, p. 21-31.

Meinzer, O. E., 1917, Geology and water resources of Big Smoky, Clayton, and Alkali Spring Valleys, Nevada: U. S. Geol. Survey Water-Supply Paper 423, 167 p.

Motts, Ward S., 1965, Hydrologic types of playas and closed valleys and some relations of hydrology to playa geology: in Geology, Mineralogy and Hydrology of U. S. Playas, Neal, J. T., Editor, Air Force Cambridge Research Lab. Report 65-226, Environmental Research Paper no. 96, p. 31-72.

Neal, James T., and Motts, Ward S., 1967, Recent geomorphic changes in playas of western United States: Jour. of Geol., v. 75, no. 5, p. 511-525.

Robinson, T. W., 1953, Big Smoky Valley, Nevada, in Subsurface Facilities of Water Management and Patterns of Supply-type Area Studies: 83rd Cong. House Comm. Insular and Interior Affairs, the Phys. and Econ. Foundation of Natural Resources, v. 4, p. 130-146.

Rush, F. E., 1968, Water resources appraisal of Clayton Valley-Stonewall Flat area, Nevada and California: Nevada Dept. Conserv. and Nat. Resources, Ground-Water Resources Reconn. Ser. Rept. 45, 64 p.

Spurr, J. E., 1905, Geology of the Tonopah mining district: U. S. Geol. Survey Prof. Paper 42, 265 p.

Turner, W. H., 1900, The Esmeralda formation, a fresh water lake deposit: U. S. Geol. Survey Twenty-first Ann. Rept., Pt. 2, p. 191-208.

Visher, S. S., 1954, Climatic Atlas of the United States: Harvard University Press, 402 p., Map 474, p. 191.

Walker, Robert, 1966, Geomorphology of the southern part of Big Smoky Valley, Esmeralda County, Nevada: M.S. Thesis, University of Massachusetts, Amherst, 101 p.