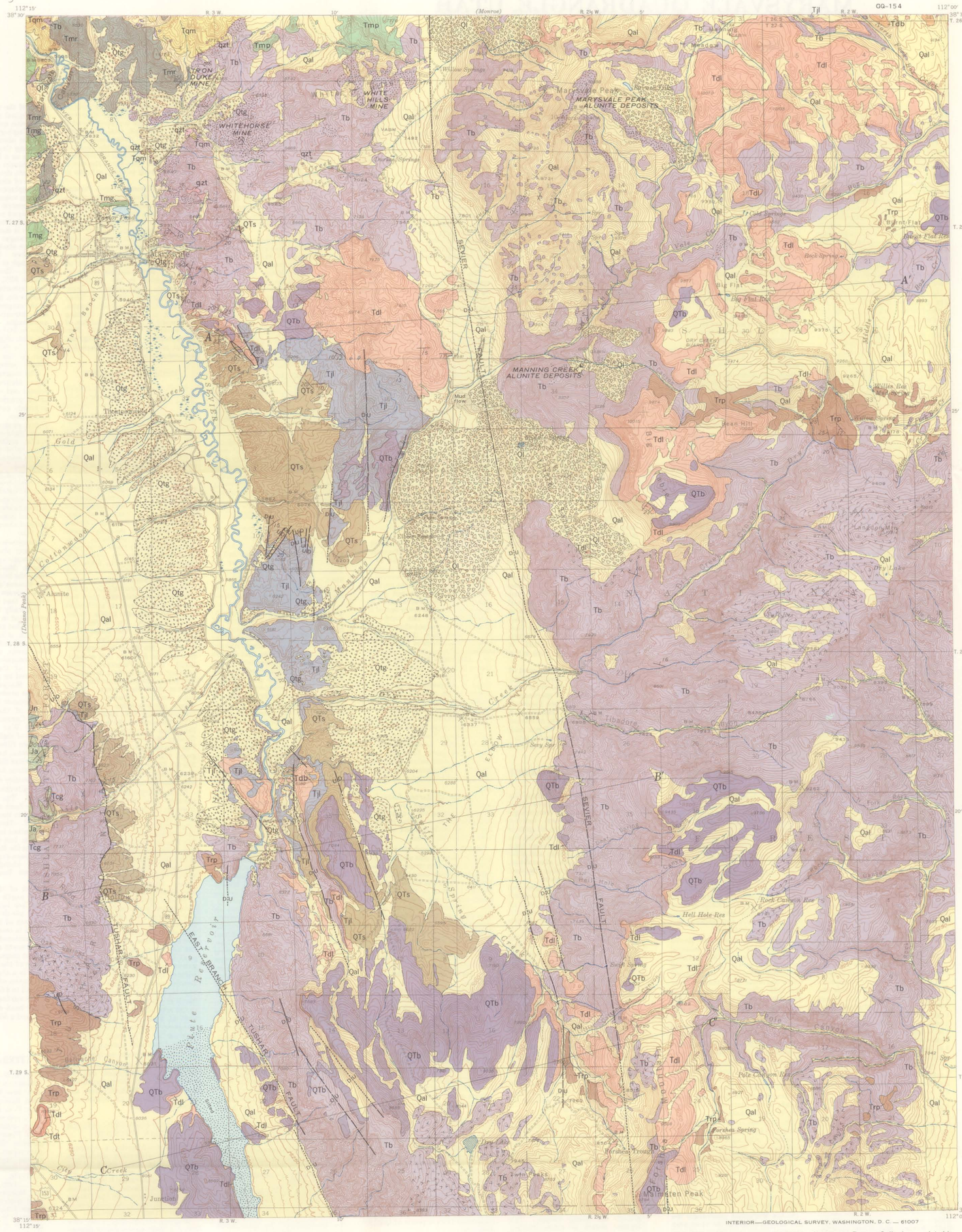
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGY OF THE MARYSVALE QUADRANGLE

UTAH

GQ-154



EXPLANATION

Pleistocene and Recent

Qal — **Alluvium**
Talus, alluvial-fan, mudflow, flood-plain, and stream-channel deposits

Ql — **Landslide debris**

Qtg — **Terrace gravel**
Alluvial-fan deposits distinguished by the discordance between their surface profiles and the profiles of similar deposits now accumulating

UNCONFORMITY

Upper Pliocene or lower Pleistocene

QTb — **Basalt**
Flows interlayered with or closely associated with the Sevier River formation

QTs — **Sevier River formation**
Fanglomerate, sand, and silt, mainly of local origin

UNCONFORMITY

Pliocene(?)

Tjl — **Joe Lott tuff**
White stony tuff with included small fragments of latite

Tmp, Tmg, Tmr — **Mount Belknap rhyolite**
Tmp, porphyritic flow-banded rhyolite with abundant phenocrysts of quartz and feldspar.
Tmg, light-gray rhyolite with marked flowage laminations.
Tmr, reddish-brown tuffaceous rhyolite or welded tuff

Tdt, Tdb, Tdl — **Dry Hollow formation**
Tdb, dark-gray to dark brownish gray basaltic andesite.
Tdl, reddish-brown and gray porphyritic quartz latite and porphyritic latite.
Tdt, white to brownish-gray crystal and ashy tuff mostly of quartz latite composition

Trp — **Roger Park basaltic breccia**
Brownish-black to olive-black vesicular breccias of basaltic andesite composition

UNCONFORMITY

Miocene(?)

Tqm, qzt — **Quartz monzonite and associated intrusive rocks**
Quartzite blocks, probably Navajo sandstone, included in quartz monzonite, qzt

Tb, qzt — **Bullion Canyon volcanics**
Chiefly latite tuffs and breccias with minor flows; calcic latite shown by chevrons; silicified, alunitized and kaolinized rocks stippled; quartzite inclusions in the Bullion Canyon volcanics or exposures of underlying bedrock, probably Navajo sandstone, qzt

Tcg — **Conglomerate**
Conglomerate and sandstone beneath the Bullion Canyon volcanics, composed of fragments of underlying formations

UNCONFORMITY

Upper Jurassic

Ja — **Arapien shale**
Red sandstone and red and gray shale in a small area on Tenmile Creek

Jn — **Navajo sandstone**
Mainly light brownish gray quartzite

QUATERNARY

TERTIARY

JURASSIC

JURASSIC AND JURASSIC(?)

Contact
Dashed where approximately located

Fault
Dashed where approximately located; dotted where concealed or inferred. U, *upthrown side;* D, *downthrown side*

Strike and dip of beds

Strike of vertical beds

Outline of terraces and stream trenches

Prospect

Tunnel

Base map by Topographic Division
U. S. Geological Survey, 1945

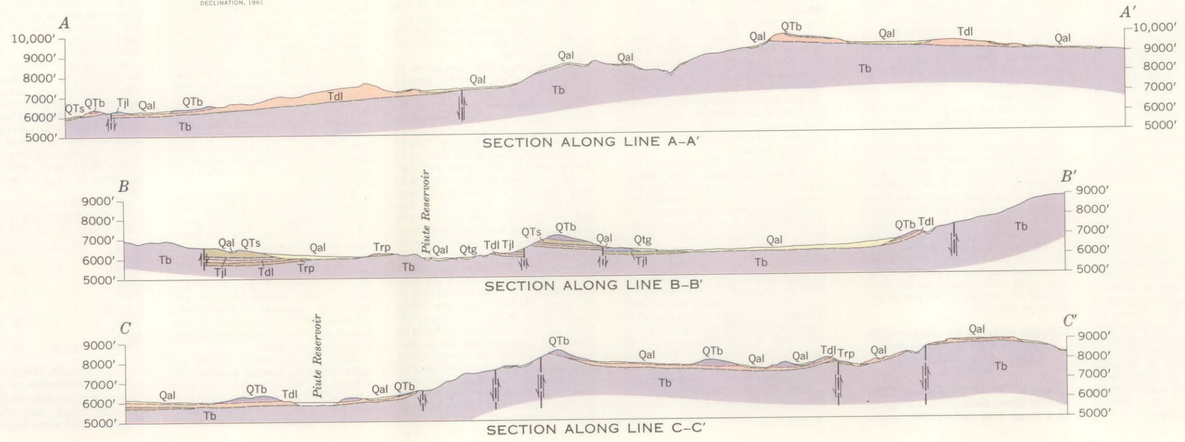
APPROXIMATE MEAN DECLINATION, 1961

SCALE 1:62 500

1 ½ 0 1 2 3 MILES

CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

Geology by Eugene Callaghan assisted by V. C. Kelley, 1938, and by Max E. Willard assisted by P. D. Proctor and J. V. Barnes, 1944–45



GEOLOGIC MAP
OF THE
MARYSVALE QUADRANGLE, UTAH

By
Max E. Willard and Eugene Callaghan
1962

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C. — 61007

GEOLOGY
OF THE
MARYSVALE QUADRANGLE, UTAH

By
Max E. Willard and Eugene Callaghan

INTRODUCTION

A program of topographic and geologic mapping in the Marysvale region was started by the U. S. Geological Survey in 1936. This program included areal geologic mapping of four 15-minute quadrangles and part of another. The Marysvale quadrangle is one of those four.

Approximately 50 square miles of the northwest corner of the Marysvale quadrangle was mapped by Eugene Callaghan in 1938 on the then available contour map of Marysvale and vicinity. Aerial photographs of the rest of the Marysvale quadrangle were made in 1943 at a scale of 1:24,000 and the geology was mapped on these photographs by Max E. Willard in 1944-45.

The authors acknowledge the helpful cooperation of the people of Marysvale and in particular the aid given by John Henry, Lafe King, Irv Mellor, and George Kennedy. The authors were assisted in the geologic mapping by P. D. Proctor, James Barnes, and V. C. Kelley.

Dutton's (1880) classic report on the geology of the High Plateaus of Utah is the first and only comprehensive report on the general geology of the Marysvale area. Subsequent reports by Butler and Gale (1912), Loughlin (1915), Butler and others (1920), and Callaghan (1938, 1939) deal with specific aspects of geology. The first four publications mentioned deal primarily with the general geology as related to mineral deposits with special emphasis on the features associated with alunite. The last-mentioned publication by Callaghan includes an areal geologic map of the northwest corner of the Marysvale quadrangle and a detailed description of the petrography and petrology of the volcanic rocks.

Uranium mineralization in the Marysvale region has not been described in this report. For a treatment of the subject the reader is referred to Walker and Osterwald (1957) for a summary of mineralization and to Kerr and others (1957) for a description of uranium deposits and wall-rock alteration.

The Marysvale quadrangle, which comprises an area of about 235 square miles, is centrally located in the High Plateaus of Utah. It includes along its western edge the lower slope of the Tushar Mountains and a segment of the Sevier Valley, locally known as the Marysvale Valley. In its eastern half the quadrangle includes approximately 100 square miles of the west-central part of the Sevier Plateau. The altitude of this surface of the Sevier Plateau ranges between 9,000 and 10,000 feet above sea level, and it is 2,000 to 5,000 feet above the Sevier Valley. The surface is gently rolling and in general gradually sloping to the east-southeast. This surface is for the most part an area of grassland with scattered aspen and spruce groves.

A major fault-line scarp forms most of the western front of the plateau, and its slopes to the Sevier Valley are steep, commonly descending 2,000 feet in a horizontal distance of 1 mile. Several streams in the central part of the plateau have V-shaped gorges 1,000 feet or more deep; of these Tibadore, Dry Creek, and Manning Creek canyons are the most spectacular.

The western front of the Sevier Plateau is poorly defined near the southern boundary of the Marysvale quadrangle. South of the valley of Swift Spring Creek the plateau appears to include the northward-sloping highland east of Piute Reservoir.

The Sevier Valley in the Marysvale quadrangle is 5 to 6 miles wide and includes at the north the White Hills upland, at the south the Piute Reservoir highland, and between these the relatively low gently sloping areas of The Elbow, The Bench, and their continuations north and south. In the less rugged areas gravel terraces and alluvial fans are prominent features. Through the central part of the valley the north-south-trending flood plain of the Sevier River is, at its widest part, approximately a mile across. There the Sevier River has sharp meanders and numerous oxbow lakes. The flood plain is bounded by the gorge north of Piute Reservoir at the south and by Marysvale Canyon at the north. The winding Marysvale Canyon, which is labeled Sevier Canyon on the Marysvale quadrangle map, and the gorge just north of Piute Reservoir appear to be in part a series of incised meanders.

Marysvale, the only town in the quadrangle, had a population of 626 in 1947. It is the terminus of a branch of the Denver and Rio Grande Western Railroad, 198 miles south of Salt Lake City. One hard-surfaced road, U. S. Highway 89, passes north-south through Marysvale. Much of the Sevier Valley is crossed by usable dirt roads but most of the valley highlands and the Plateau are accessible only on foot or horseback.

The Marysvale quadrangle is largely underlain by Tertiary volcanic rocks. These rocks range from basalt to rhyolite with latite the dominant group. Pyroclastics of latitic composition make up the greater volume of the material. The volcanic sequence includes three larger stratigraphic units: a Miocene(?) unit of latitic pyroclastics and flows, a Pliocene(?) unit of rhyolite, rhyolite tuffs, latite, and latite tuffs, and a unit of late Pliocene or early Pleistocene basalt flows. Between each of the above units are conspicuous erosional unconformities.

Underlying most of the alluvium of the Sevier Valley and containing intercalated basalt flows are the fanglomerates of the late Pliocene or early Pleistocene Sevier River formation. The only other exposures of sedimentary rocks in the Marysvale quadrangle are at the west border in Gold Gulch and the valley of Tenmile Creek. In this area the Miocene(?) volcanic rocks rest on a thin conglomerate, probably of Tertiary age, that lies with angular unconformity on quartzite, sandstone, shale, and limestone beds; the rocks below the unconformity correlate with the Navajo sandstone and Arapien shale.

JURASSIC AND JURASSIC(?) SEDIMENTARY ROCKS

Sedimentary rocks crop out in a small area along the west edge of the quadrangle from Tenmile Creek northward to a point about half a mile north of Gold Gulch. The rocks in this area are continuous with those exposed on Deer Trail Mountain in the adjacent Delano Peak quadrangle. The section on Deer Trail Mountain was described by Butler and others (1920, p. 538).

Navajo sandstone.—Limited exposures of the Navajo sandstone of Jurassic and Jurassic(?) age in Gold Gulch dip south-southeast under the Arapien shale of Late Jurassic age. The Navajo sandstone in the Marysvale and Delano Peak quadrangles is similar in most respects to the formation in other parts of the Southwest, except that in these quadrangles it is sufficiently indurated to be termed quartzite. The rock is light brownish gray and has strongly developed aeolian-type crossbedding. At least 1,000 feet of the formation is exposed in the Delano Peak quadrangle.

Arapien shale.—The strata above the Navajo sandstone and below the angular unconformity at the base of the Tertiary system have been assigned to the Arapien shale (Spieker, 1946). Two members are recognizable, but they have not been mapped separately. The lower unit, the Twelvemile Canyon member, consists of 1,000 feet of medium- to thin-bedded gray limestone with buff-weathering shaly beds, and 1,140 feet of gray shale that weathers buff and contains two 150-foot thicknesses of reddish-brown sandstone. The overlying Twist Gulch member, largely confined to Tenmile Canyon, consists of reddish-brown siltstone, sandstone, and shale. The maximum thickness exposed is about 700 feet.

Fossils from the limestone in the lower part of the formation were identified by J. B. Reeside Jr., of the U. S. Geological Survey as belonging to the Carmel fauna. This identification suggests that this part of the Arapien and the Carmel formation are correlatives.

TERTIARY CONGLOMERATE AND SANDSTONE

Resting unconformably on the shales and sandstones of the Arapien shale in Gold Gulch and Tenmile Creek is a thin conglomerate, generally not more than 50 feet thick, that is made exclusively of debris from the underlying rocks. Conformably above the conglomerate and apparently grading into it is a water-laid tuffaceous sandstone which also contains some detrital material from the older rocks. These relations suggest that the conglomerate and sandstone accumulated just prior to and in part contemporaneous with the first of the Miocene(?) volcanism.

MIOCENE(?) IGNEOUS ROCKS

Bullion Canyon volcanics.—The latitic breccias, tuffs, crystal tuffs, and flows that make up the lowest division of the Tertiary volcanic rock in the Marysvale and adjacent quadrangles were named the Bullion Canyon volcanics by Callaghan (1939, p. 441-442). He named the sequence for the occurrence along Bullion Canyon west of Marysvale in the Delano Peak quadrangle.

The rocks of the Bullion Canyon volcanics form a large part of the Marysvale quadrangle. They are well exposed along the west front of the Sevier Plateau, on the intravalley highlands, and in the Tushar Mountains.

These earlier Tertiary rocks consist of a thick series of latitic breccias, tuffs and thin flows at the base, a succession of latite and quartz latite flows with thin intervening beds of volcanic breccia, and more calcic flows and breccias at the top. The total thickness of these volcanic rocks in the Marysvale quadrangle cannot be accurately determined but it probably exceeds 3,000 feet.

The latitic pyroclastics and thin flows at the base of the Bullion Canyon volcanics make up the bulk of the exposures in Marysvale Canyon and in the highland east of Piute Reservoir. Between 500 and 600 feet of these latitic pyroclastics is also exposed along the lower slopes of the west front of the Sevier Plateau. The latite and quartz latite flows of the middle part of the Bullion Canyon volcanics are well exposed in the southern part of the White Hills, and a thickness of approximately 600 feet is also exposed above the pyroclastics on the west front of the Sevier Plateau. The more calcic upper group of interbedded pyroclastics and flows is exposed in the higher parts of the southern half of the quadrangle. Excellent exposures of the more calcic latites occur on Langdon Mountain in the east-central part of the quadrangle, on Forshea Mountain in the southeast corner of the quadrangle, and near the head of Dry Creek. On the map these occurrences are separated from the rest of the Bullion Canyon volcanics.

The latite flows of the lower and middle parts of the Bullion Canyon volcanics are typically grayish red but at places may be grayish, reddish purple or dark reddish brown. Most of the flows contain closely spaced phenocrysts of andesine and biotite set in a stony groundmass. The andesine and biotite phenocrysts in a specimen believed to be typical of the upper middle part of the Bullion Canyon volcanics from the White Horse mine northeast of Marysvale are 1 to 5 mm across, the average being 3 mm. These andesine phenocrysts are in part euhedral and at places contain blebs of albite. Due to the subparallel arrangement of the platy and prismatic phenocrysts and a concentration of dark particles in parallel layers in the groundmass the rock has a distinct primary foliation or flow structure. A similar structure is typical of many of the other latite flows; it is especially well developed in those exposed on the north side of Dry Creek Canyon three-quarters of a mile above the mouth. A chemical analysis of the latite from the White Horse mine and the norm for this rock are shown in column 1 of tables 1 and 2.

Table 1
Chemical Analyses (in percent)

	1	2	3
SiO_2	60.47	64.72	56.84
Al_2O_3	19.29	15.47	15.81
Fe_2O_3	1.27	2.13	4.97
FeO	3.93	2.18	4.45
MgO	1.54	1.39	3.10
CaO	2.28	4.02	6.19
Na_2O	3.24	3.73	3.28
K_2O	5.11	3.32	2.30
H_2O-	.44	.06	.17
H_2O+	.61	2.26	1.33
TiO_2	.56	.60	1.11
CO_2	.49	none	none
P_2O_5	.02	.22	.21
S	none	.02	none
MnO	.38	.15	.16
BaO	not determined	.13	.08
Total	99.63	100.40	100.00

(1) Fresh latite from White Horse alunite mine (analyst: Cyrus Feldman, U. S. Geological Survey)
(2) Calcic latite from north of Dry Lake west of Forshea Mountain (analyst: Charles Milton, U. S. Geological Survey)
(3) Roger Park basaltic breccia near the head of Dry Creek Canyon (analyst: Charles Milton, U. S. Geological Survey)

Table 2
Norms (in percent)

	1	2	3
Quartz	12.30	20.04	11.34
Orthoclase	30.02	19.46	13.34
Albite	27.25	31.44	27.77
Anorthite	11.40	15.85	21.68
Corundum	4.18	-----	-----
Hypersthene	10.00	6.55	13.68
Magnetite	-----	3.02	7.18
Hematite	1.28	-----	-----
Limonite	1.06	1.22	2.13
Apatite	-----	.34	.34
Subtotal	97.49	97.92	97.46
Water	1.05	2.32	1.50
S	-----	.02	-----
BaO	-----	.13	.08
Total	98.54	100.39	99.04

(1) Fresh latite from White Horse alunite mine
(2) Calcic latite from north of Dry Lake west of Forshea Mountain
(3) Roger Park basaltic breccia near head of Dry Creek Canyon

The pyroclastics of the lower and middle parts of the Bullion Canyon volcanics range in size from dust to coarse fragments several feet across. In general the fragments are of porphyritic latite, or quartz latite, similar in composition, color, and texture to the associated flows. Rude stratification locally evident in these pyroclastics appears to be the result of changes in the size of the fragments ejected during successive eruptions. In general the attitudes of the stratification planes within a larger pyroclastic unit do not parallel the contact of that unit with the overlying and underlying flows. Each of the larger pyroclastic units is a composite of small lenticular layers some of which are very long compared to their width. A cross section of this composite structure in the pyroclastics is well exposed in Marysvale Canyon.

The 500 to 600 feet of calcic latites and pyroclastics near the top of the Bullion Canyon volcanics is typically medium light gray to medium gray. Most of the latite is porphyritic; phenocrysts of euhedral biotite 2 to 5 mm across are common and hornblende needles up to 5 mm long are everywhere present. A specimen typical of this part of the Bullion Canyon volcanics collected from Forshea Mountain contained in addition to biotite and hornblende large-zoned euhedra ranging from sodic andesine to calcic oligoclase many of which in their central parts are intergrown with an isotropic material, possibly glass. The fine-grained groundmass contains many crystallites, probably plagioclase, and grains of ilmenite and magnetite. A chemical analysis and the norm of this specimen are shown in column 2, tables 1 and 2.

The Miocene(?) rocks including the later quartz monzonite are commonly altered and this characteristic can be used in distinguishing the group. The most widespread alteration resulted in the formation of carbonate, chlorite, sericite, and some quartz. Another alteration superimposed on that described above has formed alunite, kaolinite, quartz, and minor amounts of pyrite at the expense of the earlier primary minerals. In the Marysvale quadrangle this later alteration is of limited extent and for the most part concentrated about the intrusive quartz monzonite bodies. This alteration could have been largely accomplished by the interaction of a sulfate-bearing solution and the primary minerals of the rock (Willard and Proctor, 1946). Replacement bodies of alunite resulting from this alteration were mined for potash during World War I and for alumina during World War II.

In an elongate area extending from a point northeast of Marysvale to the northern boundary of the quadrangle, many large bodies of quartzite are exposed; several of these are more than 500 feet long and two are as long as 1,000 feet. Most of the quartzite is in the Bullion Canyon volcanics, but some is in the quartz monzonite. All of it seems to be Navajo sandstone. Some of the quartzite apparently was rafted into the present position by the Miocene(?) volcanic flows and the intrusive quartz monzonite; however some of it may represent hills of underlying bedrock that were covered by the volcanics and subsequently exposed by erosion.

Quartz monzonite.—Intrusive bodies of Miocene(?) quartz monzonite occur along a line trending east-northeast just north of Marysvale (Callaghan, 1939). In the Marysvale quadrangle this intrusive quartz monzonite is exposed in two small areas: one near the head of Marysvale Canyon, the other approximately 1 mile east of Marysvale Canyon at the north boundary of the quadrangle. The quartz monzonite occurs chiefly as small stocks intruded into the Bullion Canyon volcanics. The Mount Belknap rhyolite of the Pliocene(?) volcanic rocks lies on the eroded surface of this quartz monzonite.

The appearance of the quartz monzonite is markedly different from place to place, even within the same body. The mineralogy of the rock, however, is very similar throughout. The quartz monzonite ranges from almost black through medium gray to greenish gray. In the smaller bodies it is fine grained and at places even porphyritic; but typically, as at the south end of Marysvale Canyon, it is equigranular and granitoid in appearance. The rock consists of calcic oligoclase, orthoclase, quartz, augite, and biotite; accessory magnetite, apatite, and titanite; and later tourmaline, epidote, chlorite, and sericite.

In the contact zone surrounding the intrusive quartz monzonite, the altered latite of the Bullion Canyon volcanics is commonly pink, but at places it is black or green. In the pink rock the groundmass is an aggregate of orthoclase and quartz, and the plagioclase phenocrysts of the latite are partly replaced by orthoclase. At places much magnetite and some biotite have been introduced. Locally, epidote and chlorite are in sufficient amounts to give the rock a greenish cast.

PLIOCENE(?) VOLCANIC ROCKS

Roger Park basaltic breccia.—Only the thin northern edge of the Roger Park basaltic breccia, named from an area at the south margin of the adjoining Delano Peak quadrangle, is preserved in downfaulted blocks in Marysvale Valley west of the Piute Reservoir and at points on the summit of the Sevier Plateau. Outside the Marysvale quadrangle this formation is widely distributed and makes up most of the Sevier Plateau south of Kingston Canyon, the Awapa Plateau to the east, the southern part of the Tushar Mountains, and much of the Markagunt Plateau to the south. It likewise extends far out into the Great Basin. The center, or centers, of eruption is not known.

The formation consists of flows and breccias that resemble basalt. The breccias are made of angular fragments mainly less than 6 inches in diameter though some are several feet in diameter. Thin black flows occur in many places in the formation and in places flow material grades into or cements the boulders. The matrix consists of smaller fragments and ashy material which tend to weather more rapidly than the boulders so that steep slopes are extremely rugged, whereas gentle slopes, such as those on the Roger Park basaltic breccia in the Marysvale quadrangle, are soil covered but boulder strewn.

The flows and the breccia fragments range in color from brownish black to olive black; at many places they are vesicular. Examined under the microscope, a specimen of this rock from the head of Dry Creek Canyon was found to contain large phenocrysts of sodic andesine and augite in part altered to hornblende. The andesine phenocrysts are zoned and in their central parts show a micrographic texture similar to that in the calcic latite from Forshea Mountain. Magnetite and ilmenite are abundant, constituting 5 to 10 percent of the rock. The magnetite occurs in grains that are in part megascopic size. Small apatite crystals were observed throughout the section. As can be seen from column 3 of tables 1 and 2 this basaltic-appearing rock is intermediate in composition between the typical calcic latite and basalt.

In the Marysvale quadrangle the Roger Park basaltic breccia is overlain by the Dry Hollow formation. From evidence mainly outside the Marysvale quadrangle, the Roger Park is placed as definitely later than the Bullion Canyon volcanics. South of Circleville Canyon, outside the mapped area, it lies upon the eroded surface of an intrusion that has moved upward through sedimentary rocks similar in appearance to the Upper Cretaceous(?) and lower Tertiary rocks of the Sevier and Monroe quadrangles. The breccia is believed to be more closely related to the younger or Dry Hollow formation than to the Bullion Canyon volcanics, even though in Kingston Canyon south of the Marysvale quadrangle, there is some resemblance between them.

Dry Hollow formation.—Flows in the Dry Hollow formation are largely latite but quartz latite is locally present. The flows appear to have once covered most of the Marysvale quadrangle, but now exist only as erosion remnants. They occur on the Sevier Plateau in the northeast corner of the quadrangle and along the higher parts of the western edge of the plateau from Deer Spring Canyon to the southern boundary. A large remnant of the latite occurs on the intravalley highland 2 to 3 miles east of Marysvale. Separate small patches also occur in the area adjacent to Piute Reservoir.

For the most part the latite of the Dry Hollow formation rests on the eroded surface of the Miocene(?) Bullion Canyon volcanics; however, on a small hill between Bellyache Canyon and City Creek it lies upon light-gray to pinkish-gray latite tuff and breccia. In large areas in adjacent quadrangles to the north and west a similar tuffaceous rock underlies the latite flows. These rocks have been grouped with the Dry Hollow formation because of their close association with the latite and because they are similar to it in composition.

In most places in the Marysvale quadrangle the latite of the Dry Hollow formation is the youngest rock exposed at the surface. Locally, however, it may be overlain by younger rocks, including the Joe Lott tuff, Sevier River formation, and late Tertiary or Recent basalt flows. At three localities a mile north of the Elbow Ranch on Manning Creek, a mile northeast of the Piute Reservoir dam, latite of the Dry Hollow formation is overlain by basalt, which is in turn overlain by the Joe Lott tuff. Similar basalt at the same stratigraphic position is widely exposed in the Monroe quadrangle.

A flow typical of the latite in the Dry Hollow formation that is exposed on Big Table north of Dry Creek Canyon ranges in color from reddish brown through brownish gray to light brownish gray. It contains numerous phenocrysts, whose proportions to the groundmass differ from place to place. Plagioclase phenocrysts as much as 5 mm long, hornblende needles 2 mm long, and biotite euhedra as much as 3 mm across are common. Megascopic grains of magnetite surrounded by coatings of red iron oxide are abundant. The groundmass in general is stony in appearance and, although in part fine grained, contains much glass; locally it is vesicular.

At a few places, as for example between Bean Hill and the Dry Creek guard station, the flows of the Dry Hollow have a vitrophyric texture. Phenocrysts of calcic plagioclase, biotite, hornblende, and magnetite in amounts similar to those of the typical latite are set in a vitreous black groundmass.

The thickness of the Dry Hollow formation in the Marysvale quadrangle exceeds 300 feet at a few places, but more commonly it is 50 to 100 feet thick. In adjacent quadrangles the Dry Hollow formation is much thicker.

The Dry Hollow formation contains no known mineral deposits of importance. Local bleaching of the rock, possibly by hot springs, has produced an alteration similar to that noted in the Mount Belknap rhyolite. Many joints and fractures in the Dry Hollow rocks, particularly in the southern half of the quadrangle, have been filled with manganese oxide, chalcedony, and kaolin.

Mount Belknap rhyolite.—In the area north of Marysvale three distinct varieties of the Mount Belknap rhyolite were recognized and separately mapped: a red rhyolitic tuff, a gray rhyolite, and a porphyritic rhyolite. Though these varieties of the Mount Belknap rhyolite differ widely in appearance, their composition is remarkably similar.

The typical red rhyolitic tuff is reddish brown to pinkish gray and, though not glassy, is not coarsely granular. Fragments in the tuff, commonly 5 to 10 mm in diameter, are either light or dark gray and of the same composition as the rhyolite. Both these fragments and the mass of the rhyolite are devitrification aggregates. Large orthoclase phenocrysts and scarce quartz phenocrysts are enclosed by a mass of minute feldspar grains with some biotite flakes. Magnetite occurs in the fragments but little is present in the groundmass. The red color is due to minute flecks of hematite. Minute spherulites occur in groups and crystallized streaks, and lenses contain orthoclase. The bulk of this rock unit is probably welded tuff.

The gray rhyolite is conspicuously flow-banded and the bands are intricately contorted. The darker bands include material that is only slightly devitrified, and the lighter ones are more obviously crystalline. As a whole the gray variety of the Mount Belknap rhyolite is light gray, has no phenocrysts, and has thin bands of obviously crystalline quartz and orthoclase alternating with devitrified material.

One variety of the Mount Belknap rhyolite exposed west of the Sevier fault along the northern boundary of the quadrangle differs from either the red or gray facies in being distinctly porphyritic with phenocrysts of quartz and feldspar in a devitrified groundmass.

None of the varieties of Mount Belknap rhyolite contain mineral deposits; neither are they intruded by granular rocks. A widespread bleaching, however, of many square miles has occurred in the red rhyolitic tuff. This alteration, which is probably of the hot spring type, has only slightly modified the rhyolite composition.

A maximum thickness of between 700 and 800 feet of Mount Belknap rhyolite is exposed in the Marysvale quadrangle. It is underlain unconformably by the Miocene(?) Bullion Canyon volcanics and quartz monzonite. No later rocks overlie the Mount Belknap rhyolite in this quadrangle, but in the Sevier quadrangle to the northwest it is overlain by the Joe Lott tuff.

Joe Lott tuff.—The Joe Lott tuff is exposed in the Sevier Valley from a point 1 mile east of the Piute Reservoir dam northward to a point 2 miles southeast of Marysvale. The thickness of the formation in this area ranges from approximately 350 feet at a point southeast of Marysvale to not more than 50 feet on the intravalley highland east of Piute Reservoir.

In the Marysvale quadrangle the Joe Lott tuff is for the most part massive, white, and stony, and contains fragments of white rhyolite and scattered small fragments of latite. Locally the tuff is stained pink or reddish brown. At places it is friable and weathers to low rounded hills with gentle slopes. Elsewhere it is well lithified so that its disintegration produces a talus of angular flintlike fragments.

In the Marysvale quadrangle the Joe Lott tuff rests on latite or basalt of the Dry Hollow formation. At places it is overlain by the Sevier River formation, elsewhere by Recent basalt.

Inasmuch as the Joe Lott tuff occurs over large areas in adjacent quadrangles to the west and northwest, it seems likely that it also once covered a much larger part of the Marysvale quadrangle than it does at present. Locally, as for example west of Piute Reservoir, the Joe Lott tuff wedges out so that the younger Sevier River formation rests directly on latite of the Dry Hollow formation. This together with the fact that the younger Sevier River formation includes fragments of the Joe Lott tuff clearly points to a period of erosion after the deposition of the tuff.

UPPER PLIOCENE OR LOWER PLEISTOCENE SEDIMENTARY AND VOLCANIC ROCKS

Sevier River formation.—The Sevier River formation is exposed in a large area east of Thompsonville, along the west edge of The Elbow, and on the lower slopes of the Tushar Mountains between Gold Gulch and Rudd Hollow. The formation consists of partly consolidated fanglomerate, conglomerate, and sand and silt that was derived chiefly from tuff and latite of the Pliocene(?) volcanic rocks. Pinkish beds near Marysvale contain quartzite fragments and in places contain fragments of basalt and Bullion Canyon volcanic rocks also. None of the sediments of the Sevier River formation are very far removed from their source, and they are typical valley-fill sediments. Hence, the differences in composition from place to place result from difference in the source rock.

No fossils were collected from the Sevier River formation in the Marysvale quadrangle, but in the Sevier quadrangle, the formation contained, in addition to fresh-water gastropods, diatoms that are regarded as late Pliocene or early Pleistocene age (Callaghan, 1938, p. 101).

In composition and texture the Sevier River formation in the Marysvale quadrangle does not differ appreciably from the Quaternary alluvium and terrace gravel and at places it is difficult to distinguish between them. Typically, however, the crude bedding in the Sevier River formation is faulted and tilted. Often the sediments dip toward their apparent source or at angles greater or less than the expectable initial dips for sediments of this type. Typically the formation is eroded to smoothly rounded hills and terraces that are covered with residual cobbles and boulders; these characteristics can be used with caution to distinguish the formation.

The Sevier River formation has been much eroded and partly buried in recent sediments. No measure of the original thickness is available in the Marysvale quadrangle, but a maximum thickness of between 300 and 400 feet is now exposed.

Basalt.—Flows of olivine basalt 50 to 250 feet thick occur in the Sevier Valley and on the Sevier Plateau. On the highland east of Piute Reservoir the basalt rests on the Sevier River formation. Elsewhere it lies upon the Bullion Canyon volcanics, the Dry Hollow formation, or the Joe Lott tuff. It is the youngest volcanic rock in the quadrangle.

At places, as for example west of Piute Reservoir, the basalt is vesicular and in part cinderlike with much flow breccia. A specimen of basalt from west of Piute Reservoir is black, fine-grained, vesicular rock with small phenocrysts of olivine that are mostly 0.2 to 0.7 mm long in a groundmass of andesine laths, blebs of augite, and granules of magnetite.

PLEISTOCENE AND RECENT DEPOSITS

Within the Sevier Valley the Quaternary deposits have been divided on the basis of morphology and apparent origin into: terrace gravel, which includes all gravel deposits whose surface profiles are not in accordance with present base levels; landslide debris; and alluvium, including talus, alluvial-fan, stream-trench, flood-plain, fan-terrace, and mudflow deposits.

Terrace gravels.—The largest and best developed deposits of terrace gravel occur along the west bank of the Sevier River from approximately 1 mile south of Marysvale to a point a little south of Alunite and on the east side of the river in the lower parts of The Elbow. Smaller deposits occur in the Sevier Valley north of Marysvale.

These terrace gravels are composed of poorly sorted boulders, cobbles, pebbles, and sand made of rock fragments similar to the rocks that make up the adjacent mountains. Lenticularly interbedded gravel and sand are typical of the deposits. The terrace gravels are not different in texture or structure from alluvial-fan sediments now being deposited. They are recognized largely on the basis of morphology and the discordance in attitude between their surface profiles and the surface profiles of currently deposited gravels.

East-west profiles on the terrace gravels, both east and west of the Sevier River, slope toward the river at much lower angles than similar profiles on adjacent presently forming alluvial fans. The gradients of the recent streams that have dissected the terrace gravels are steeper than equivalent surface profiles on the terrace gravel. Parallel to the mountain fronts the surface profiles of the terrace gravels are gently convex. The highest points on these profiles occur opposite the mouths of large mountain streams: Cottonwood Creek and Tenmile Creek west of the Sevier River and Dry Creek east of the Sevier River.

The terrace gravels south of Marysvale have been eroded by the meandering Sevier River so that they now form a steep bank 50 to 75 feet high along the flood plain of the river. This bank is being dissected by intermittent streams most of which head on the terrace gravel, but a few have completely cut across the terrace gravel and have adjusted their gradients to that of the adjacent alluvial fan. At places the lower slopes of the gravel terraces are covered by fan-terrace deposits.

Both south of Marysvale and in The Elbow the height of the terrace gravels above the surrounding alluvium becomes less toward the mountain front. The parts of the terrace gravel nearest the mountains are being regraded or buried in the debris of more recent alluvial fans.

Landslide debris.—Landslides occurred north of Willow Springs at the northern boundary of the quadrangle, in Straight Canyon east of its junction with Manning Creek, on the west slope of Marysvale Peak, and at the north end of The Elbow between the Little Table on the east and Manning Creek on the west.

The Elbow landslide is by far the largest in the quadrangle. It covers an area of between 4 and 5 square miles, is roughly fan shaped with a surface slope of 800 feet per mile. This landslide heads at the cliff between Little Table and Big Table. The cliff is approximately 1,200 feet high and forms two amphitheater-like reentrants in the plateau. The largest reentrant is at the north end of the cliff and is the location from which most of the landslide debris came. The surface of The Elbow slide in its upper parts is hummocky with no systematic arrangement of the hills and depressions. Below this hummocky area are regularly arranged crescentic ridges and depressions that are concave toward the apex of the slide and roughly parallel to its outer limit.

The Elbow landslide is largely a rockfall. There are no evident structures in the bedrock that would facilitate rock sliding. It appears that a mass of rock broke away from the Sevier fault scarp and after falling to the base flowed over the gently sloping surface of the valley. The course of Manning Creek above the Elbow Ranch was deflected westward around the outer edge of this flowing mass of debris.

The rock fragments in The Elbow landslide are largely derived from the Bullion Canyon volcanics and the Dry Hollow formation but include also late Tertiary or early Quaternary basalt which, as already noted, at places rests on the late Pliocene or early Pleistocene Sevier River formation. The outer edges of the landslide are now being buried in Recent alluvium. The landslide and the terrace gravels are not in contact at the surface and their relative ages could not be established. The greater erosion of the terrace gravels suggests that they are somewhat older, but this difference in degree of erosion may be due only to differences in the nature of the sediments involved.

The Straight Canyon landslide is much smaller than the Elbow landslide. Most of the surface of the Straight Canyon landslide is irregularly hummocky and covered by large blocks of volcanic rock. A feature of landslides not present elsewhere in the quadrangle is well developed near the lower end of this landslide where the surface is broken by a crescent-shaped declivity 40 feet high that is convex toward the source of the landslide. This declivity marks the upper limit of a small subsidiary slide block in the main mass of landslide debris.

On the east slope of Marysvale Peak a cirquelike amphitheater occurs at an altitude of between 10,000 and 10,200 feet. A large mass of landslide debris occupies the valley between two narrow ridges of volcanic rocks, which extend east and southeast from the ends of the amphitheater. Landslides from the two ridges partly filled the valley forming a dam below the amphitheater. This damming resulted in the basin now occupied by Barney Lake.

Drainage of Barney Lake is at present by seepage through the landslide debris, but a tributary of Manning Creek is eroding headward across the landslides and will eventually drain the basin.

Whether the amphitheater occupied by Barney Lake and the valley below it are a true cirque and glacial trough was not established. Conclusive evidence of glaciation on the Sevier Plateau in the Marysvale quadrangle is not available. Gregory (1944, p. 584) reported glacial scouring on the surface of the Aquarius Plateau southeast of the Marysvale quadrangle. Glaciation occurred at and below the altitude of the Sevier Plateau and it, therefore, seems likely that glaciers may also have been present for a time in the higher parts of the Sevier Plateau.

Alluvium.—Alluvium on the upper rolling surface of the Sevier Plateau is locally thick; as much as 100 feet is exposed near the head of Dry Creek and an equal thickness may be present above the heads of Deer Spring and Hell Hole Canyons.

Locally alluvium on the plateau surface has been and is being incised by the many canyons that are encroaching on the plateau from both the east and west. This is best shown in the area of Pole Canyon in the southeast corner of the quadrangle where remnants of the plateau surface between canyons are capped by a relatively thick mantle of alluvium. Certainly the thicker parts of this mantle on the rolling surface of the plateau and on the divides between canyons is the oldest alluvium on the plateau and it is related to an earlier cycle of erosion and deposition; it may be as old as or even older than the Sevier River formation. On the map this older alluvium was not separated from deposits of Quaternary age.

It seems that the alluvium of this earlier cycle accumulated on a broad surface of moderate relief that was developed prior to the structural disturbance responsible for the present relief of the region. Gregory (1944, p. 579) postulated a similar prefaulting surface of low relief to explain the present ungraded, unsystematic streamways of the South Fork and East Fork of the Sevier River.

Alluvial fans are numerous in the Sevier Valley. The fan formed by Dry Creek in The Elbow and the fan along the western border of the quadrangle that heads in Cottonwood Canyon in the Delano Peak quadrangle are the largest. Many of the alluvial fans in the Marysvale quadrangle, including the two just mentioned, have been entrenched at their heads by the streams responsible for their formation. The stream trench at the apex of the Dry Creek fan is approximately 50 feet deep and becomes shallower as the middle of the fan area is approached. A similar trench that cut the Cottonwood Creek fan ends east of Alunite. The aprons of both of these alluvial fans are being truncated by the downcutting of the Sevier River. The slopes resulting from this downcutting are in turn being dissected by intermittent streams that have the flood plain of the Sevier River as their base level. Several of these dissecting streams have extended their valleys by headward erosion to the mid-fan areas and a few now connect with the lower parts of the apex trenches. In its lower parts the valley of Dry Creek appears to be of this origin.

The dissection of the truncated outer parts of the Dry Creek and Cottonwood Creek fans resulted from the rejuvenation of the Sevier River which created a new base level for the streams from the lower slopes of the fans. Dissection of the heads of the alluvial fans is probably part of the normal cycle of erosion and deposition and unrelated to changes in the level of the Sevier River.

Two distinct terraces below the level of the terrace gravels extend approximately 3 miles south of Thompsonville along the west edge of the Sevier River flood plain. These terraces are separated from each other and the flood plain by steep slopes 10 to 20 feet high that are roughly parallel to the axis of the Sevier River flood plain.

The surfaces of each of these terraces slope gently toward the river. Parallel to the long axis of the flood plain the surfaces of the terraces are gently rolling. The highest points on the terraces are opposite small streams that enter the flood plain from the west. Stream trenches in the terrace gravels also continue through the small terraces. These fan-terraces were formed of a group of small coalescing alluvial fans. A swing of the river to the east side of its flood plain allowed the fans to be built and when the river swung back the fans were truncated. The shortened fan-building streams cut trenches along the course they followed when the truncation occurred. Another swing of the river to the east permitted the process to be repeated.

STRUCTURAL GEOLOGY

The great structural features of the Marysvale quadrangle are faults and monoclinal flexures. Parts of two of the great faults described by Dutton (1880, p. 25), the Sevier and Tushar faults, are in the Marysvale quadrangle. Minor faults are numerous in the Sevier Valley, but none was recognized on the plateau.

The Sevier fault in the Marysvale quadrangle follows a north-northwest course along the west edge of the Sevier Plateau. Within the quadrangle this fault shows the close relationship between actual rupture and monoclinal flexure that Dutton recognized as characteristic of the structural development of the High Plateaus. Eardley and Beutner (1934, p. 152) concluded that the displacement on the Sevier fault, on the basis of physiographic data east of Alunite, in the central part of the quadrangle was not much in excess of 500 feet. The measured displacement on the Sevier fault ranges from zero at a point a little south of Little Cottonwood Canyon to between 2,000 and 2,500 feet in the central part of the quadrangle. These figures are based on observed offsets of the Dry Hollow formation.

A west-dipping monoclinal flexure starting in the area of Little Cottonwood Canyon and terminating along the East Branch of the Tushar fault has lowered part of the Dry Hollow formation approximately 500 feet. Minor normal faults that strike approximately northwest cut this monoclinal flexure just east of the East Branch of the Tushar fault and in the upper valley of Spring Creek. The displacements on the minor faults in Spring Creek increase markedly from south to north. This differential movement along the minor faults, as well as along the Sevier fault, combined with the west-dipping monocline, has resulted in a northward-sloping monocline whose crest plunges gently west. The resulting structural high coincides with the Piute Reservoir highland. South of the Marysvale quadrangle the details of this structural high are not available, but Dutton (1880, p. 31) reports 3,000 feet of displacement on the Sevier fault at the East Fork Canyon a short distance farther south, and the displacement on the Sevier fault at the south boundary of the Marysvale quadrangle is approximately 600 feet. These data suggest that displacement along the fault increases southward from the zero point at Little Cottonwood Canyon much as it does north of that point; hence, a southward-dipping monocline may also exist. These combined differential movements north and south of the zero point would produce an east-west-trending anticlinal structure. A similar structural development may account for other intravalley highlands and transverse ridges.

The Tushar fault lies along the east base of the Tushar Mountains and for most of its length, as described by Dutton (1880, p. 29), the displacement is distributed through a wide zone containing many discontinuous and branching faults and monoclinal flexures. In the Marysvale quadrangle, from a point approximately 1 mile south of Alunite to a little south of Rudd Hollow, the Tushar fault is a single fracture along which the east side has moved down relative to the west side. In the Delano Peak quadrangle a displacement of 1,500 feet was estimated by Eardley and Beutner (1934, p. 153). South of Gold Gulch the main Tushar fault dies out and a second, the East Branch of the Tushar fault, begins; and from here it continues to the southern boundary of the quadrangle. Along the East Branch of the Tushar fault, opposite Piute Reservoir, the west side has moved down at least 1,000 feet relative to the east side.

The Tushar and East Branch faults converge toward the north and probably join near the mouth of Tenmile Creek. The continuation of the Tushar fault south of the point of junction is doubtful. It may be that the Tushar fault and the East Branch of the Tushar fault are in fact a single fracture and that the opposite displacements noted above are the result of rotational movement about the inferred junction as a center.

Most of the small faults are approximately parallel to either the Sevier or Tushar faults. On most small faults the displacement is relatively downward to the west. A conspicuous exception to this generalization occurs on the east side of the ridge east of Piute Reservoir dam. This ridge is a horst bounded on the east and west by nearly parallel faults. Where section line B-B′ crosses the ridge the displacement on these faults is not less than 400 feet and from there the throw decreases both to the north and to the south.

The late Pliocene or early Pleistocene Sevier River formation in the Marysvale quadrangle is a typical fanglomerate which could have formed only as the result of considerable topographic relief. The distribution of the formation and the textural changes within it suggest that the relief necessary for its deposition was the result of faulting. If this suggestion is correct, faulting in the Marysvale quadrangle began at least as early as late Pliocene. The Sevier River formation is at places cut by faults, hence it is evident that faulting continued after the deposition of the Sevier River formation. Perhaps faulting is still in progress, for at present minor earthquakes are common in the area.

GEOLOGIC HISTORY

Little of the pre-Tertiary history of the Marysvale quadrangle can be told. Exposures of the Navajo sandstone and Arapien shale reveal that during Jurassic time continental and marine sediments were being deposited. No record of Cretaceous time is present.

Sedimentary rocks of Late Cretaceous(?) and early Tertiary age, which occur in the quadrangles to the north and northwest, are not present here. The absence of these rocks is due either to nondeposition or to deposition and subsequent erosion. This interval of nondeposition or erosion was followed by the eruption of the great masses of Miocene(?) volcanic rocks. Later in the Miocene(?) these rocks were intruded by quartz monzonite magma, followed by the formation of metallic mineral deposits and the alunitic alteration of volcanic rocks.

Before the accumulation of the Pliocene(?) volcanic rocks there was a period of erosion of sufficient length to expose the quartz monzonite intrusives. On the resulting erosion surface, the Roger Park basaltic breccia, the Dry Hollow formation, the Mount Belknap rhyolite, and the Joe Lott tuff accumulated. On the Pliocene(?) rocks another erosion surface developed, and remnants of this surface still exist on the Sevier Plateau. Large-scale faulting followed, and the larger physiographic features of the quadrangle were established.

The presence of the Sevier River formation near the crest of the Tushar Mountains in the Delano Peak quadrangle to the west suggests that the sediments of the Sevier River formation began to accumulate prior to the major tectonic movements in the area.

In the Marysvale quadrangle it appears that differential movement on the large faults, which is probably not later than late Pliocene, created a structural basin in the central part of the quadrangle. The alluvial fans of the Sevier River formation accumulated at the base of the fault scarps and finally filled the basin. The north-south drainage of the basin was then established. As the outlet of the basin was lowered by erosion the river cut a trench through the basin fill. Subsequent movements on the great faults tilted the sediments of the Sevier River formation. This renewed movement on the faults started another cycle of alluvial-fan formation, now represented in part by the Quaternary terrace gravels, and glaciers possibly formed in the highest mountains. Contemporaneous with the above events, faulting within the valley block produced a small local basin in the area of The Elbow that for a time at least may not have been integrated with the drainage developed earlier. This small basin was in part filled with terrace gravels. Renewed movement on the great faults tilted the sediments of the Sevier River formation and the terrace gravels; large landslides occurred along the fault scarps, and the present cycle of erosion and deposition began.

MINERAL DEPOSITS OTHER THAN URANIUM

Alunite.—Alunite, a hydrous potassium aluminum silicate, is abundant in many parts of the Marysvale region. Within the Marysvale quadrangle it occurs only as replacement bodies in the Bullion Canyon volcanics. In the Delano Peak quadrangle to the west, alunite is present mostly in large veins.

During World War I the vein deposits were an important domestic source of potash. Many of the replacement deposits were discovered during this period, but before they could be explored to any great extent the war ended. With the start of World War II interest in the alunite deposits was revived; this time they were considered a potential source of aluminum, and the emphasis was on exploration and development of the replacement deposits.

As a result of the revived interest in alunite, an experimental plant for the recovery of potash and aluminum was constructed at Salt Lake City by the Defense Plant Corporation. This plant was operated by Kalunite, Inc. At least 12,000 tons of ore, most of which came from the White Horse mine in the Marysvale quadrangle, was shipped to the plant.

The location of the most important alunite deposits in the Marysvale quadrangle are listed below:

	Section	Township	Range
White Horse	10	27 S.	3 W.
White Hills	11-12	27 S.	3 W.
Marysvale Peak	10	27 S.	2½ W.
Manning Creek	34-35	27 S.	2½ W.

These deposits, like all the replacement alunite bodies of the Marysvale region, are extremely irregular in size, shape, and composition. They are the most highly altered parts of the volcanic rocks in which the original minerals were replaced by alunite, quartz, and clay minerals.

The high-grade alunite ore (90-94 percent alunite) near the shaft at Manning Creek is unique in that it occurs as a local concentration of large blocks of alunite in a mass of landslide debris. The other occurrences of alunite at Manning Creek are replacements of the Bullion Canyon volcanics in place.

In general the appearance of the alunitized volcanic rock changes markedly from place to place. Typically it is massive and fine grained, and ranges from chalky white through shades of gray to pink, red, or yellow. The ore may be dense and tough or soft and friable.

Iron.—The Iron Duke magnetite mine in SE¼ sec. 4, T. 27 S., R. 3 W., approximately 3 miles north of Marysvale, is on the south contact of the largest of the quartz monzonite intrusives in the Marysvale quadrangle. The mine was opened prior to 1911 and several carloads of ore were shipped to the smelter for flux. In 1911 and 1912 the greater part of the known reserves was mined—between 2,000 to 3,000 tons.

The magnetite at the Iron Duke mine occurs in irregular-shaped masses and veinlets and as disseminated grains in a fine- to coarse-grained, contact-metamorphosed latite flow. The contact metamorphism produced magnetite, orthoclase, light-colored biotite, quartz, augite, apatite, and titanite. All these minerals also occur in the quartz monzonite but are much less abundant.

The principal ore body was nearly vertical, roughly lens shaped, and approximately 95 feet long. In the glory hole the lens was 10 feet wide; 40 feet below the glory hole the mineralized zone was 40 feet wide, but pinched sharply toward the ends of the lens.

Manganese.—Manganese is known at many places in the Marysvale quadrangle and in the Monroe quadrangle. Most of the occurrences are along the Sevier fault; at Monroe in the Monroe quadrangle the manganese appears to be related to the hot springs that rise along the fault.

Typically the manganese is disseminated in chalcedony, producing a rock that ranges from bluish gray to black, is brittle, and breaks with a characteristic conchoidal fracture. The areas of mineralization are very irregular and commonly small. Many of the deposits have been explored by pits and trenches, but in the Marysvale quadrangle only one has produced ore.

A deposit of pyrolusite and wad south of the mouth of Manning Creek Canyon was developed during World War II and several shipments of high-grade ore were made. The ore filled spaces in a roughly horizontal bed of volcanic breccia 5 to 10 feet thick. At this deposit the crystalline and amorphous manganese oxides either were present in thin alternating layers or were mixed. The deposit is close to the Sevier fault and may be genetically related to the fault.

Gold.—There are no producing gold mines in the Marysvale quadrangle, but several gold-bearing veins in the Bullion Canyon volcanics have been explored. Most of them occur along the Tushar fault between Tenmile Creek and Gold Gulch.

Most of the veins in this area trend north and dip steeply east. They are largely milky quartz, at places are drusy, and contain small amounts of lamellar calcite. The quartz is commonly copper stained and scattered grains of tetrahedrite are present at places. No gold is evident megascopically.

One of the largest of the quartz veins is a short distance north of the canyon of Tenmile Creek. This vein is 3 to 4 feet wide and is exposed at the surface for about 500 feet. It has been explored by 90 feet of drift and a 30-foot shaft.

LITERATURE CITED

Butler, B. S., and Gale, H. S., 1912, Alunite—a newly discovered deposit near Marysvale, Utah: U. S. Geol. Survey Bull. 511, 64 p.

Butler, B. S., Loughlin, G. F., Heikes, V. C., and others, 1920, Ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672 p.

Callaghan, Eugene, 1938, Preliminary report on the alunite deposits of the Marysvale region, Utah: U. S. Geol. Survey Bull. 886-D, p. 91-134.

________1939, Volcanic sequence in the Marysvale region in southwest-central Utah: Am. Geophys. Union Trans., pt. III, p. 438-452.

Dutton, C. E., 1880, Report on the geology of the high plateaus of Utah: U. S. Geog. and Geol. Survey Rocky Mountain Region, 307 p.

Eardley, A. J., and Beutner, E. L., 1934, Geomorphology of Marysvale Canyon and vicinity, Utah: Utah Acad. Sci. Proc., v. 11, p. 149-159.

Gregory, H. E., 1944, Geologic observations in the upper Sevier River valley, Utah: Am. Jour. Sci., v. 242, no. 11, p. 577-606.

Kerr, P. F., Brophy, G. P., Dahl, H. M., Green, Jack, and Woolard, L. E., 1957, Marysvale, Utah, uranium area: Geol. Soc. America Spec. Paper 64, 212 p.

Loughlin, G. F., 1915, Recent alunite developments near Marysvale and Beaver, Utah: U. S. Geol. Survey Bull. 620-K, p. 237-270.

Spieker, E. M., 1946, Late Mesozoic and early Cenozoic history of central Utah: U. S. Geol. Survey Prof. Paper 205-D, p. 117-161.

Walker, G. W., and Osterwald, F. W., 1956, Relation of secondary uranium minerals to pitchblende-bearing veins at Marysvale, Piute County, Utah, *in* Page, L. R., Stocking, H. E., and Smith, H. B., Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, 1955: U. S. Geol. Survey Prof. Paper 300, p. 123-129.

Willard, M. E., and Proctor, P. D., 1946, White Horse alunite deposit, Marysvale, Utah: Econ. Geology, v. 41, no. 6, p. 619-643.