THE BARSTOW - BRISTOL TROUGH
CENTRAL MOJAVE DESERT, CALIFORNIA

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SUMMARY

The Barstow-Bristol Trough is a depression extending northerly from Barstow and southerly to the Bristol basin near Amboy (fig. 1). A southern extension has been named the Bristol-Cadiz-Danby Trough by Bassett and Kupfer (1964, p. 41). It is believed by the writer to extend northward to the Garlock fault and to be the major structural feature of the Central Mojave (fig. 2).

Broad alluvial valleys of accumulation, debouch from the mountain ranges on both sides, which are outlined by fault zones. In many instances the faults are believed to have down-dropped the lower valleys and shifted them to the southeast from a higher standing plateau. In other cases the former sites of accumulation have been uplifted and folded and or faulted. The Barstow syncline and the Calico Mountain volcanics exemplify this. Volcanism characterizes the flanks and, in at least one instance, has clogged the central portion as shown by the Ludlow volcanic center and the Pisgah and Amboy flows. At the northern end, the Lava Bed Mountains and the Bedrock Springs Formation have been uplifted in the central part of the trough.

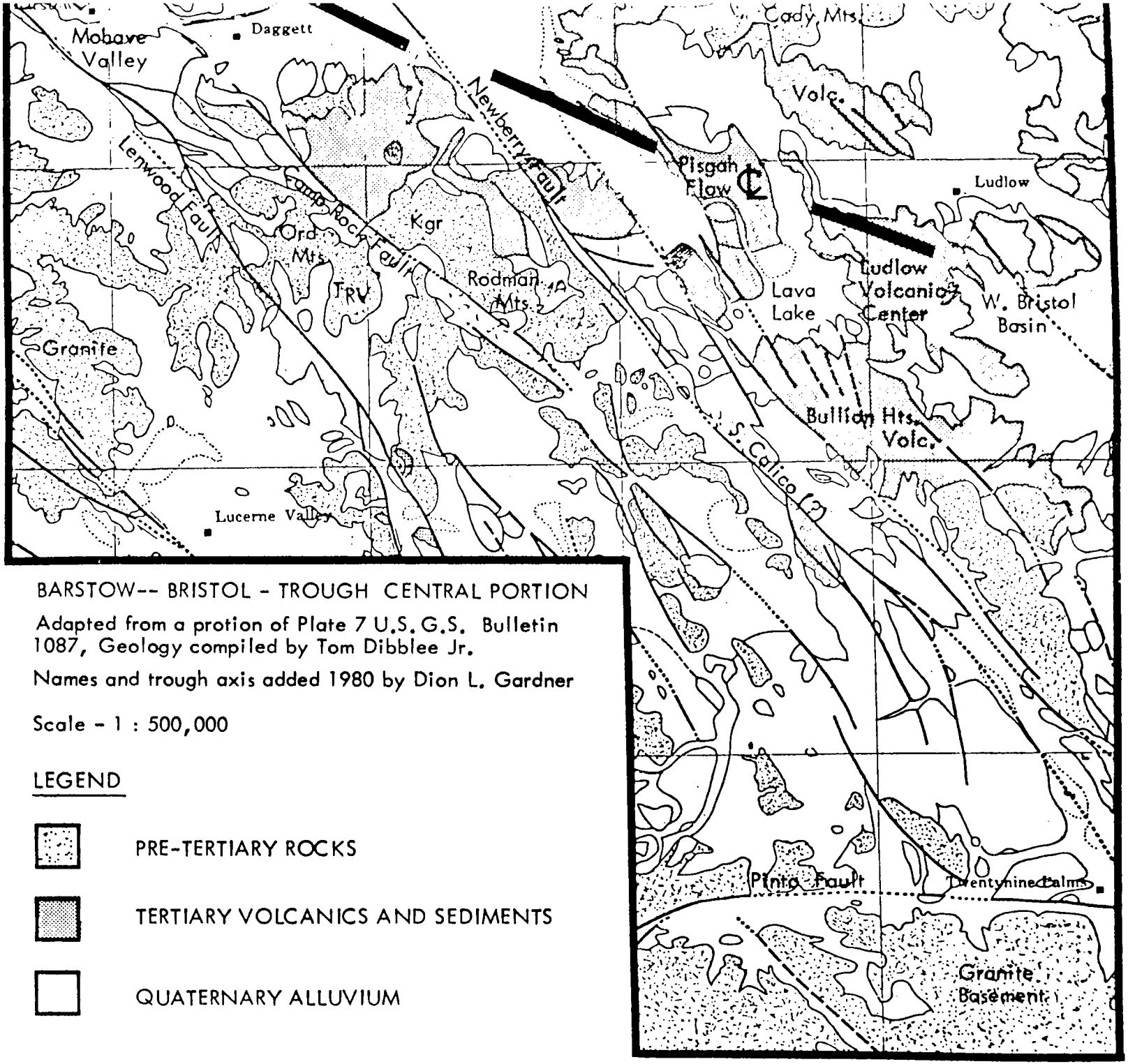
Mineralization of various ages and types occur along the trough and on its flanks. Both metallic and non-metallic deposits have been found.

The name Barstow-Bristol seems to have been first used in the literature by Hill (1920) in a private report to the Metropolitan Water District. Thompson (1929, p. 692) states "the center of the area is dominated by the great trough that extends from Barstow southeastward almost to the Colorado." Bassett and Kupfer (1964, p. 7) postulate "a series of valleys and basins connected either directly or by low passes." The southern extension was named the Bristol-Cadiz-Danby Trough by Bassett and Kupfer (1964, p. 41).

In my thesis (Gardner 1940, p. 292) I described it as follows:

"The Barstow-Bristol Trough parallels the Lucerne Dale Trough on the northeast. It is the larger of the two, extending from an unknown point north of Barstow, southwest to and beyond Bristol Dry Lake for a distance of about 110 miles. The Barstow-Bristol Trough is bounded on the northeast by the Bristol and Cady Mountains which parallel the Cadiz fault zone; and on the southwest by the Newberry and Bullion Mountains which form the boundary along the Newberry fault zone. Between these mountain areas, low standing blocks and basins are found along the entire length of the Barstow-Bristol Trough, bounded on both the northeast and southwest by mountain blocks uplifted and outlined by major fault zones. Within the trough elevations are lowest towards the southern extension."

The Newberry fault zone was renamed the Calico fault (south) (fig. 1) which implies a direct connection to the Calico frontal fault, despite the Mojave Valley and the Manix fault zone which separate the two.



BARSTOW-- BRISTOL - TROUGH CENTRAL PORTION

Adapted from a protion of Plate 7 U.S.G.S. Bulletin 1087, Geology compiled by Tom Dibblee Jr.

Names and trough axis added 1980 by Dion L. Gardner

Scale - 1 : 500,000

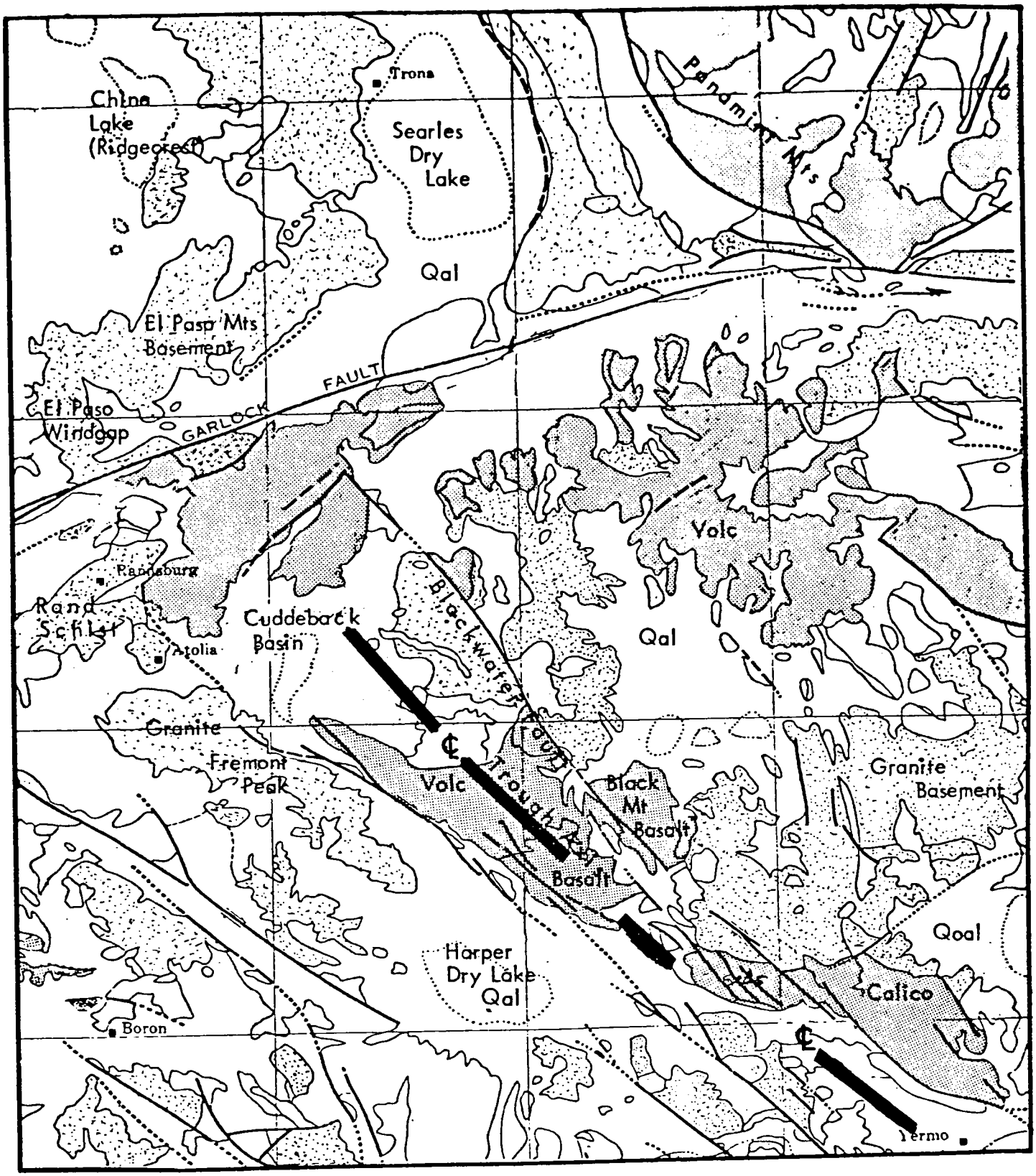
LEGEND

PRE-TERTIARY ROCKS

TERTIARY VOLCANICS AND SEDIMENTS

QUATERNARY ALLUVIUM

Figure 1



BARSTOW - BRISTOL - TROUGH NORTHERN PORTION

Adapted from a protion of Plate 7 U.S. G.S. Bulletin 1087, Geology compiled by Tom Dibblee Jr.

Names and trough axis added 1980 by Dion L. Gardner

Scale - 1 : 500,000

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Figure 2

It has been suggested by Blackwelder (1933, p. 477, [illegible]) and Hewett (1954, p. 377) that the trough was part of the integrated drainage system that transported detritus out of the Mojave during the late Tertiary time or before. Thus, they imply that it is in part an excavated or channel feature. This concept remains unresolved, for some of the deeper gravels may be river transported. They are covered by the recent alluvial fan material.

Hadley and Kanamori (1977, p. 1469) have determined that the crust easterly has a velocity of 6.2 cm/sec and the western ranges are dominated by a 6.7 cm/sec layer. They suggest a "plate boundary at depth in the vicinity of the Helendale-Lenwood-Camp Rock fault." This is the approximate western boundary of the Barstow-Bristol Trough. These suggestions indicate a possible connection to the offshore Murray Fracture Zone with a trench transfer junction and a zone of decoupling (Hadley and Kanamori, 1977, p. 1477).

The foregoing implies that the Trough is a major break in the earth's crust and may extend into the upper mantle. It is of interest to note that the Palmdale Bulge Uplift, as shown on recent maps seems to die out and not cross the main axis of the Trough.

The distinction between the rocks exposed on each side of the Trough appears to be real and of long duration. To the west we find the Ord Mountain Volcanic complex (Triassic ?) which appears to represent the remnant of a high standing plateau which has been offset along the Camp Rock fault. There are also some Paleozoic rocks, but they are neither evident nor continuous. While recent work (Stewart and Poole, 1975) indicates a correlation with sections to the east, a terrific disruption of the once continuous geosyncline is evident. To the east the thick section of Paleozoic rocks occur in prominent high mountains (Marble and Providence). there are also Archean and pre-Cambrian rocks of importance. The granitic intrusions appear to be older, 135 to 159 and 160 to 189 m.y.b.p. (Armstrong and Suppe, 1973, p. 180). To the west these same authors place the granitic intrusive rocks in the 70 to 80 and the 85 to 99 million year age range.

Hewett (1954) states that "westerly from a line drawn through Barstow (or nearby) trending N 45° W.....many closely-spaced faults trend northwest.....and most of these are nearly parallel...dips are steep. The approximate dip displacement of many is known to be several thousand feet...and in only a few instances can lateral movement be inferred." In the area to the northeast fewer proven faults exist with diverse trends.

The trough is readily divisible into three parts as follows:

A. Central portion from Barstow or Daggett southerly to Bristol Dry Lake near Amboy.
B. The extreme southern portion from Bristol to the Colorado River, named the Bristol-Cadiz-Danby Trough (Bassett and Kupfer, 1964, p. 41).
C. The northern portion from Barstow or Yermo northwestward to the Rand and Lava Mountains, terminating at the Garlock fault.

GEOLOGIC FEATURES OF THE CENTRAL PORTION

Barstow-Daggett to Bristol Dry Lake

Although the name indicates Barstow as the northern teminus, Daggett is a more apt starting point. Between Daggett and Barstow a major cross fracture known as the Manix fault zone occurs buried, for the most part, below the alluvial fill of the Mojave Valley. The Mojave River runs down this valley and exists easterly into Soda Lake.

This series of depressions, basin accumulation sites, and topographic lows extends westward for some distance, perhaps to the San Andreas fault. It is of interest to note that three of the major borax occurences (e.g. Calico, Kramer, and Boron), which are known in this part of the Mojave, lie on the northern flank of this east west structural low. No explanation is offered for this alignment.

Southerly from Daggett the broad alluviated Newberry Valley continues to Troy Dry Lake and beyond to the overlying Pisgah basalt flows. Daggett Ridge and the Newberry Mountains lie to the southwest and a tremendous section of volcanic and sedimentary rocks is evident. The sections dips west and appears to be caught between the Newberry (Calico) and Camp Rock fault zones.

Dibblee (1970, p. 4) describes this section as follows:

The assemblages of volcanic and sedimentary rocks, and coarse sedimentary rocks of Daggett Ridge, of Tertiary age, exposed in the Newberry Mountains in this quadrangle and in the adjacent Newberry quadrangle (Dibblee and Bassett, 1966a) form a succession with a maximum combined thickness of as much as 25,000 feet. This entire succession onlaps, with abrubt buttressing out of successively higher units within it, from east to west against a once extremely uneven steep-sloping basement surface eroded deeply into igneous rocks of mesozoic age. Contract with this former basement surface is a buttress unconformity with no evidence of fault movement. This entire succession of volcanic extrusions and coarse alluvial detritus appears to have accumulated very rapidly under subsiding conditions against a mountainous basement terrain of Mesozoic rocks with a topographic relief of some 25,000 feet, with slopes as steep as 70 degrees. This must be the greatest, most abrupt onlap of a Tertiary succession of stratified deposits against the pre-Tertiary basement terrain in the Mojave Desert, if not in California.

Further to the east in the Rodman Mountains a second thick series is found in the area that was termed Box Canyon by Gardner (1940). This unit is southerly from a frontal fault and dips towards the Newberry (Calico) fault. Gardner (1940, p. 278) placed these volcanic rocks in the Rosamond Formation, but now Dibblee has quite properly renamed them, for the term Rosamond is restricted to the western Mojave. Dibblee (1964) shows several thousand feet of continuous section. Even if partially repeated by faulting the section is thick. It is tempting to offset this section and make it equivalent to the Newberry section, but proof is lacking (Garfunkel, 1974).

Silver mineralization has been explored in the Silver Bell and Silver Cliff Mines along vein zones consisting of manganiferous calcite in which silver has been found. No production is known.

In the Ord Mountain section of the Rodman Mountains several occurences of copper-gold mineralization are known and have been explored. The Bessemer iron mine is located on the east side of the Camp Rock fault and has produced a considerable quantity of iron ore. Approximately seven miles on the opposite side of the fault zone, a buried ore body has been found by drilling, but there is no outcrop.

In the central part of the Trough at the eastern end of Troy Dry Lake and in one locality on the northern side near Hector, beds of bentonite (hectorite type) occur (Sweet, 1980, this volume). These are overlain by the Pisgah flow and faulted along the Pisgah fault. Drilling to date has not found the extension on the southern side of the fault, despite a hole that penetrated 1500 feet of alluvial fill.

The Pisgah flows originated from the Pisgah cinder cone and are quite extensive. Other flows are nearby, notably the Sunshine Peak and the Malpais flow of Newberry Mountains. They are believed to be late Quaternary and to have been the last activity of the Ludlow volcanic center. This was developed in the central part of the Trough and is believed to have been the main source area for the volcanic rocks in the southern and eastern Cady Mountains, the Bristol Mountains, and the Bullion Mountains. A wide variety of volcanic rock types occur, both intrusive and extrusive (Bassett and Kupfer, 1964 and Dibblee 1966; 1967).

The date of the activity is uncertain but undoubtly Tertiary-Miocene or earlier.

The Ludlow volcanic center is believed to have been a dominant topographic high and to have been the source of much of the volcanism. The breakup was started or appears to have stated, by the partial to complete collapse of various parts. The most notable depression is Lavic Lake, whose semi-circular outline suggests a subsiding vent area. The high standing Sunshine Peak immediately to the south may have been an intrusive on the flank of the original vent. While this was mapped by Gardner (1940) as monzonite porphry, the rocks are described microscopically as quartze porphry. Dibblee (1966) classifies it as a dacite porphry. Several mineral occurences are known. The Imperial lode, the Mowry, and the Tiptop prospect were worked on in early days. Values were in copper and silver with minor gold and other metallics, along dikes.

The volcanics in the southeast Cady Mountains northwest of Ludlow consist mostly of andesite and basalt which dip south towards the center line of the trough. In several localities manganese oxide minerals with calcite form veins and fracture fillings. The largest of these is at the Logan Mine, where a brecciated zone about 30 feet wide and about 600-feet long is exposed in several open cuts. Another, known as the Black Butte, is smaller. The Lavic Mountain (Lee Yim) Mine is in the same general area. Some production was attained from each of these prospects.

Discrete outcrops of fine-grained Tertiary sedimentary rocks along the front of this volcanic ridge contain strontium. Locally up to 4 feet of gray-white celestite is interbedded with gray clay. The beds strike under the alluvium to the west and dip southerly. Some production was obtained during both WW I and WW II (Durrell, 1953 and Dibblee and Bassett, 1966).

Northerly from Ludlow, the Broadwell Basin formerly was more extensive and spread out to both sides of the mountains. Volcanic sections with sedimentary sequences were deposited and uplifted on the sides of the north-trending valley. The total

sedimentary thickness in the valley itself has not been determined, although it is said that water wells up to 1000 feet were dry and still in sediments.

It is through the Broadwell basin that the overflow from the Soda Lake system is postulated to have reached the Bristol area and spilled southward to the Colorado River. It seems doubtful to me that this took place because Lavic Lake is the low point and would have caught most of the overflow water, while the Ludlow volcanic complex with its intrusive rocks block the exist to the south. Any drainage exiting this way must have been prior to the development of the Ludlow volcanic center, and further back in time. Thus, the earlier suggestion by Darton (1915) that Bristol and Cadiz Valleys resulted from the tilting of an earlier stream valley may be true. Any stream or excavated valley must have predated the volcanics, and could have been early Tertiary age.

GEOLOGIC FEATURES OF THE SOUTHERN PORTION

BRISTOL-CADIZ-DANBY TROUGH

The breakpoint between the central and southern portion is at the Amboy Crater which marks the southern exposure of volcanism along the axis. Thus, the Bristol basin is divided into two parts by the south Amboy Crater flows and also by a central fault zone. The main salt (NaCl) lies adjacent to the highway on the eastern side. The economic value has been reported by Gale (1951) and many others, Bassett and Kupfer (1964) and Var Planck (1954) deal with the mineral occurences.

The accumulated salines are salts such as NaCl, gypsum, and calcium chloride. Celestite occurs as concretions only and is not of economic importance. Recently there has been a demand for calcium chloride as a de-icer for eastern highways. It is confined to seeps along the northern and western portion of the lake.

The U.S. Geological Survey drilled holes in the Bristol, Cadiz, and Danby basins (Bassett, Kupfer, Barstow, 1959) which penetrated salt, clay, and limy beds. The holes did not reach bedrock. In the Bristol Dry Lake no fossils were found about 1007 feet total depth. However in both the Cadiz and Danby Lakes fossils were recovered. Several species of shallow water forams, ostracods, and algae seeds were identified. They indicate a shallow brackish water. The similar assemblage from Danby also contained one barnacle. No conclusion can be made as to the marine or non-marine environment of deposition (Smith, 1960).

The drill cores suggest to Bassett, Kupfer, and Barstow (1959) that "Conditions of deposition have been much the same for many millennia." Salt, silt, and clay of the same brownish color extend to a depth of 1000 feet in Bristol and to 500 feet in both Cadiz and Danby. This is suggestive of ephemerial lakes. In the Danby hole at depths greater than 500 feet sets of calcareous silt and laminated green and blue clays contained fossils. This suggests a permanent and somewhat salty body of water. It is of interest to note that the bottom of the holes was below sea level.

GEOLOGIC FEATURES OF THE NORHTERN PORTION

Southeasterly from Barstow on the northern side of the Manix fault and the Mojave River depression is found the town of Yermo. From here the center line of the Trough appears to extend northward along the axis of the valley west of the Calico

Mountains. The Calico volcanic rocks and associated sediments have been uplifted along the Calico Frontal fault to form the Calico Mountains. Uplift has also taken place northerly along the Blackwater fault to form ranges on the eastern side.

The eastern flank the Camp Rock fault and its extension the Harper Lake fault limit the depressed zone. Granites and gneisses occur to the west. While Harper Lake itself remains as a basin of accumulation it is not nearly as extensive as it was before its eastern half was uplifted. These mid-Miocene beds are fossiliferous. Easterly and northerly the volcanic rocks are capped by the Black Mountain Basalt.

Although the trough has been nearly destroyed by these uplifts, a remnant still exists, extending from Yermo, northwestward past Harper Dry Lake and thence through the narrow gap at the south end of Cuddeback Dry Lake at the base of Fremont Peak. While Cuddeback Dry Lake trends obliquely to the north, the gravity maps show a large circular depression. The present low abuts against the Lava Mountains, but a linear valley extends along the eastern side to terminate against the Garlock fault.

The basin of deposition of the Bed Rock Springs Formation (Smith, 1964) was coextensive with the present Cuddeback Lake. Over an area of 200 square miles 5000 feet of middle Pliocene sediments accumulated. Most of the sediments are partially hidden by the volcanic rocks of the Lava Mountains.

MINERALIZATION

The Randsburg Mining District is found near the extreme terminus of the trough but along its western margin. Starting with Gold (Yellow Aster) which was founded in 1895 the district was intensively prospected and all or nearly all outcrops that panned were located and dug on. The Aster was the most productive although the Butte, Sunshine and many others had production.

An interesting sidelight on the activities of this gold period involves the St. Elmo gold mine. This is an old producer located south of Atolia, along highway 395. The ore contains a heavy white mineral, later identified as scheelite. About 1900 the owners started to search for another vein of this heavy stuff which was hindering their recovery of gold. They found a smallish outcrop far to the north near the Sunshine and walked right over the entire Atolia District which has been very productive of high-grade scheelite. The Papoose was not found until 1914-15 but produced 7,977 tons at 15.29 percent or a total of 122,000 units. The vein is believed to have outcropped but showed mostly Quartz.

The other big producer - the Union, had a minor showing about 3-inches wide and less than 30 feet long as a discovery. This bottomed at less than 50 feet, but additional development opened big ore on seven level and elsewhere. Production amounted to 200,000 tons or 592,152 units. The Atolia District has produced 387,386 tons as a minimum at 2.72 percent, or a total of 1,052,558 units. At 26 dollars per units. This amounts to 26 million dollars. Todays price approaches 50 dollars per unit, which would double this figure. Additional ore mined more recently adds to these figures. No one knows how much ore was high-graded and never included in these figures.

At the close of WW I (1918) tungsten mining collapsed, and remained inactive until WW II. After a drilling campaign in the Union and elsewhere, the property was acquired by Surcease Mining Company (Hoeffling Bros.) who produced considerable tungsten from dumps and placers.

In 1919, the Kelly Silver Mine was discovered. The large black boulder has been passed over many times. It did not pan, and so was considered no good. The outcrop was covered by the Juanita Mining claim whose discovery was a small gold vein. Ultimately the black in the boulder was identified as black metal silver sulphide and a very high assay was obtained. The Uranium Claim group was located and the Juanita bought for $10,000 cash. The glory hole at the outcrop produced over a million without a dump. Everything was shipped.

Further development continued (1925) and a mill was built. With the slump in silver price, a quiet period was followed by lesser activity until the close down during WW II. After the war, in 1946, an extension was found by drilling southerly from the open pit, directly in front of the Staff Houses. Ore was mined up to the base of the alluvium which forms the top of the slope about 30 feet below ground surface.

Scattered showings of mineralization and some production occurred from Randsburg southerly along the Trough (Fremont Peak mine and others), the most productive district was Calico. This was a major silver camp in the last part of the century from about 1881 to 1900. The mine produced perhaps 15 to 20 million dollars in silver plus a small amount of barite, gold, and lead. Most of the silver was secondary chlorides and bromides. Many small veins and veinlets abound only rarely was the silver concentrated in larger ore shoots. All ore was confined to shallow depths.

Many reports have been written on the district but the most interesting is by Weber (1966; 1967). Also see Dibblee (1967); Wright and others, 1953).

The major interest at present is in the landslide frontal material (Weber, 1966; 1967) which may become a large open-cut operation if the environmentalists permit and the silver price remains high.

Two veins or areas produced gold, the Burcham near Calico and the Waterman located westerly from the trough axis in the Waterman Hills.

Three mines or veins produced barite but they are now idle. Many of the silver veins and barium (barite) as a gangue mineral.

DISCUSSION

Hewett (1954) indicates that the Mojave Block was elevated to 15,000 feet or more in comparison with areas to the south and north. Much of this material was eroded and transported outside of the block. Hewett thought that the northwest-striking faults were of early Tertiary age and remained active through the Neogene into late Quaternary and recent times. He considered the movement to have been predominantely dip-slip and that some had "scissor action."

Dibblee (1967) persuasively argues for strike slip and presents valid arguments. It would appear to me that oblique dip-slip with the east side down and to the south,

most nearly fits the displacements. The displacements have been large in some instances, and considerably more detailed work, plus age dating, is needed before volcanic sections can be correlated across fault zones.

All workers have recognized the importance of the Garlock and San Andreas fault zones, and the Transverse Ranges in geologic studies of southern California.

I believe that the Barstow-Bristol Trough is an important structural feature in the Central Mojave Desert, and that other important mining districts will be found by further prospecting and development along this trend.

A final discussion of the origin must await further investigation.

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