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GEOLOGY OF THE SOUTHERN WASATCH MOUNTAINS AND VICINITY, UTAH

CONTENTS

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Geology of the Southern Wasatch Mountains and Vicinity, Utah

a symposium

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Extra copies of map available at $1.00 each.

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Geology of the Southern Wasatch Mountains and Vicinity, Utah

INTRODUCTION

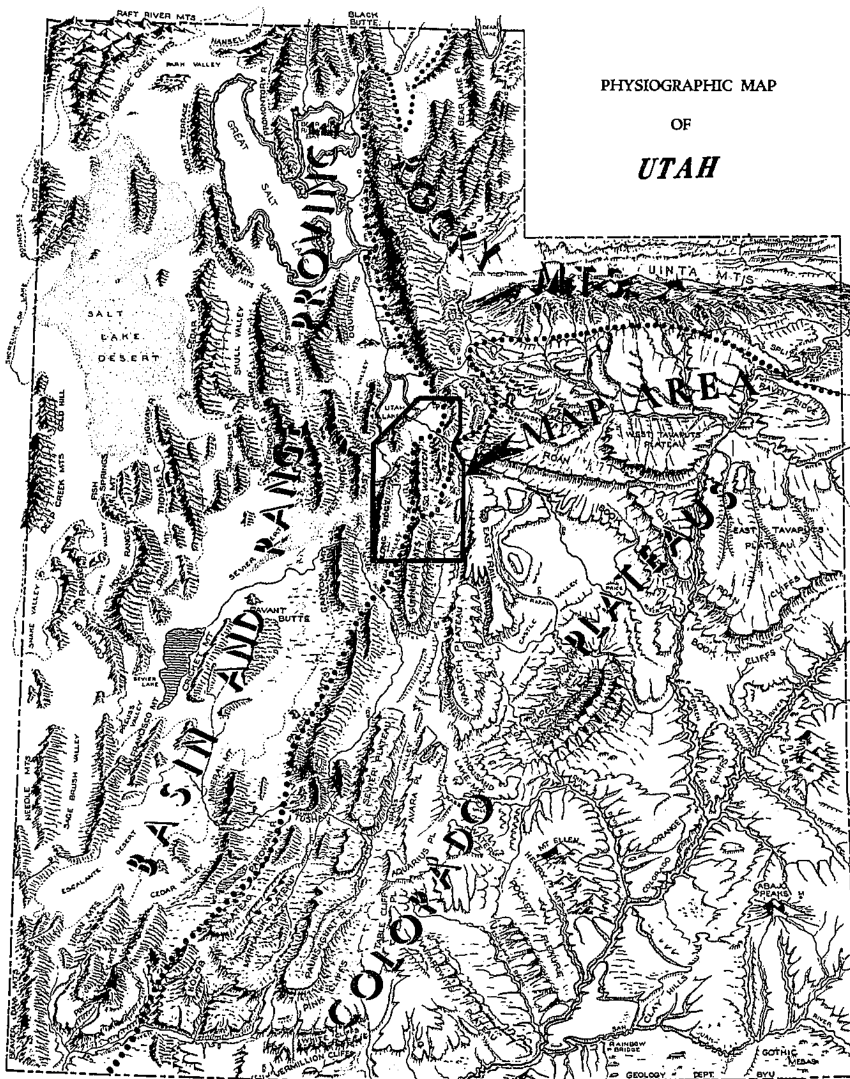
Utah is blessed with geologic features of unusual interest and great variety. The Canyon Lands, the Henry Mountains, the San Rafael Swell, the High Plateaus, the features of Lake Bonneville, the famous mining districts of Tintic, Bingham, and Iron Springs, the magnificent stratigraphic sections exposed in the Book Cliffs and in the Basin Ranges, all have revealed to geologists the tremendous sweep of geologic history and have been made classic through the writings of such pioneer geologists as C. E. Dutton, William M. Davis, C. D. Walcott, and G. K. Gilbert. So complex is Utah's geologic history and so numerous its problems that further detailed work, using improved procedures, continues to increase our understanding of this fascinating area. Each year some aspect is clarified and we wonder why it did not seem more obvious to us before.

In this light we embark on a summary of the current knowledge of the geology of the Southern Wasatch Mountains. The area lies at the junction of three major physiographic divisions: the Middle Rocky Mountains, the Colorado Plateaus, and the Basin and Range Province. It includes sedimentary, igneous, and metamorphic rocks ranging in age from Precambrian to Quaternary, and representing dominantly marine deposits of the Early Paleozoic Cordilleran miogeosyncline, the later Paleozoic Madison and Oquirrh Basins, the Cretaceous Rocky Mountain exogeosyncline, and Cenozoic deposits in freshwater lakes. The area has been involved in major structural deformation in Precambrian time, in folding and thrusting in Late Cretaceous (Laramide) time, and in block faulting in later Cenozoic time. In all, a greater variety of geologic features can scarcely be found in so limited an area.

The area is part of what is sometimes referred to as the "transition zone" in Utah. The transition involves more than the change from Basin and Range landforms to those of the Plateaus, it also involves older transitions from Cretaceous orogenic elements on the west to depositional sites on the east, from Paleozoic cratonic deposition on the east to geosynclinal behavior on the west. Two previous guidebooks have discussed the transition zone in Utah: to the north the Intermountain Association of Petroleum Geologists 10th Annual Field Conference in 1959 considered the Wasatch-Uinta Mountains transition area; to the south the Utah Geological Society 4th Annual Field Conference in 1949 traversed the transition between the Colorado Plateaus and the Great Basin in central Utah.

GEOLOGIC MAP

The geologic map accompanying this report was compiled from a great many sources, most of them published and unpublished theses by graduate students of Ohio State University and Brigham Young University (see "Index to sources of data" printed on the map). The original mapping was done on a variety of base maps, some prepared by plane table, some from air photos, and some on U.S.



INDEX MAP.—Shows Southern Wasatch map area in relation to physiographic provinces.

Geological Survey topographic quadrangles. In transferring the mapping from these diverse bases to the common base used innumerable minor adjustments were made in order to fit the original mapping to the new base as well as possible. Air photos aided in making the transfer for it was sometimes necessary to transfer data from the original map to the photos and thence to the final map in case the original map was too distorted to use directly.

In addition, in cases where adjacent mappers disagreed, the compiler has attempted to resolve their differences as best he could in order to eliminate map boundary faults. Many problems, yet to be solved, became apparent during the compilation and it is hoped that the present map may serve as a means of pointing out these problems in their regional setting for the benefit of future students of this complex and interesting area.

ACKNOWLEDGMENTS

Although many famous pioneer geologists such as William M. Davis and G. K. Gilbert had made reconnaissance observations pertaining to the Southern Wasatch Mountains, the first modern areal mapping in the area was done by Armand J. Eardley in the early 1930's. All later workers are indebted to the perspicacity of his observations.

Impetus for further work in the area came from Professor Edmund M. Spieker who extended his earlier interest in the Mesozoic problems of central Utah by directing Ohio State University graduate students in areas surrounding that of his initial work with the U.S. Geological Survey. Under him, S. L. Schoff's work in the Cedar Hills in 1937 was followed by that of many others of whom the following did work in the area of the present report: Dorothy Taylor, H. D. Zeller, R. E. Hunt, S. J. Muessig, R. E. Metter, A. C. Fograscher, J. E. Cooper, M. A. Khin, R. E. Mase, J. D. Hayes, and G. E. Thomas. Professor George E. Moore, Jr., of Ohio State University acted as graduate thesis advisor for some of these students.

For the past 25 years Professor Harold J. Bissell has been involved in problems relating to Utah Valley and the adjoining ranges. He has inspired a number of students to work in the West Mountain-Long Ridge-Southern Wasatch area and has served as adviser to most of the following Brigham Young University graduate students who have worked in this area: W. O. Abbott, R. S. Brown, R. S. Clark, L. C. Demars, J. H. Elison, D. R. Foutz, P. W. Gaines, R. W. Gates, T. A. Gwynn, H. D. Harris, R. A. Hodgson, K. D. Johnson, J. W. Madsen, D. F. Mecham, C. H. Peacock, H. N. Petersen, D. J. Peterson, D. O. Peterson, R. P. Peterson, J. R. Price, R. R. Rawson, J. A. Rhodes, S. F. Schindler, G. K. Sirrine, C. V. Smith, J. W. Swanson, and B. O. White.

Arthur A. Baker of the U.S. Geological Survey has mapped in the Wasatch Range from Spanish Fork Canyon northward and his work and advice have served as a guide to many of the above listed workers. In addition to the many people whose field work has made the present compilation possible, I wish to acknowledge the efforts of the authors of the papers in the present volume. I also wish to thank Professors Clyde T. Hardy and J. Keith Rigby for help in preparing the road log, and Mr. Colbeth Killip for drafting the geologic map.

The Editor

Some Geomorphic Features of the Southern Wasatch Mountains and Adjacent Areas

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The Southern Wasatch Mountains, part of the Middle Rocky Mountain physiographic province, stand at the eastern margin of the Basin and Range province and adjoin the Colorado Plateau province to the southeast (Woolley, 1946). The area of concern for the present guide has many of the features distinctive of each of these provinces.

FEATURES RELATED OF FAULTING

The dominant physiographic feature of the field trip area is the major western fault line scarp of the Wasatch Mountains, separating the broad valley to the west, at an elevation of approximately 4,500 feet, from the sharply etched peaks of the range to the east, at approximately 12,000 feet.

Recent activity, that is, post-Lake Bonneville, has taken place at several points along the scarp. Near the mouth of Spanish Fork Canyon (Plate 1, fig. 1) a small sag pond is developed in Bonneville sediments. A small branch fault of the Wasatch Fault cuts diagonally across the highway and railroad tracks in Sec. 34, T. 8 S., R. 3 E. The old delta surface shows an offset of approximately 40 feet.

Recent faulting is also evident along the western face of the scarp of Mount Nebo and northward along the eastern margin of Juab Valley. Foutz (1960, p. 31), Smith (1956, p. 25), and Johnson (1959, p. 32) each point out recent movement as evidenced by offset alluvial slopes in the Nebo region, an area where Eardley (1933, 1934) earlier noted the small scarps. Movement of up to 70 feet is measurable at the base of Mount Nebo, where even from a distance (Plate 1, fig. 2) the scarp shows as a prominent white line.

Erosion along the major mountain front has long ago obliterated most of the fault surface, but faceted spurs, well shown on Maple Mountain (Plate 1, fig. 1) record periods of intermittent activity. Eardley (1933) points up intermittent movement as evidenced by valley profiles and other physiographic evidence, as well.

Most of the ranges west of the Wasatch Mountains owe their present block form to faulting. Steep escarpments have been interpreted in the past as fault line features. Pediments are carved at the base of a few, but most are partially buried in alluvial debris.

FEATURES RELATED TO MASS MOVEMENT

Landslides, creep masses, and related phenomena are localized mostly within the outcrop band of the Manning Canyon Shale and the North Horn-Flagstaff sequence. Other minor features such as talus and rock creep occur throughout the region where sufficient slope is present to generate movement.

In Payson Canyon, large creep masses and toreva blocks of North Horn-Flagstaff sediments, veneered thinly by volcanic rocks, form the hummocky upper reaches of the valley, producing the irregular topography conducive to small reservoirs and lakes. Payson Lakes are ponded on the back-slope of large toreva blocks. Much of the step-and-slope topography in the vicinity of Maple Dell Scout Camp is related to the block-like creep of these same formations at lower elevations.

Active creep of North Horn-Flagstaff sediments through a gap in the Navajo Sandstone hogback north of Thistle, in Sec. 28, T. 9 S., R. 4 E., forms a hummocky slope area on the west side of the canyon. The highway was moved from the west to the east side of the canyon, in spite of obvious difficulties, because of the constant movement of the creep mass. The old highway grade can be seen ending against the rolling topography at the southern margin of the slide area.

Similar age rocks are also involved in major mass movements along the western slope of the range, south of Santaquin. North Horn-Flagstaff sediments are in active creep off the low uplands east of the highway. In one instance, in Sec. 27, T. 10 S., R. 1 E., they have pushed as a long tongue up to one-half of a mile from the foothill front.

On the western slope of Mount Nebo, in Sec. 34, T. 11 S., R. 1 E., 2 miles east of Mona, Manning Canyon Shale has moved down the subsequent valley formed in the shale and has accumulated as a hummocky slide mass at the base of the range. Relations of the slide area are particulrly well shown on the Santaquin sheet topographic map.

FEATURES RELATED TO GLACIATION

Pleistocene glaciation produced limited effects within the field trip area, principally only cirque development at high elevation. Six cirques were developed on the northwestern slope of Mount Nebo (Plate 1, fig. 2). Three of these are carved in Paleozoioc carbonates near the crest of the peak and are well defined when viewed from the west and northwest near Mona. These cirques formed at 10,000 feet and above, with valley lobes of the glaciers extending to below 9,000 feet.

Loafer Mountain, to the northeast, was similarly glaciated with cirques developed above 9,500 feet, particularly on the northern flank. Less well-defined criques are also present on the south, east, and western flanks as well.

Maple Mountain, shown on the topographic map as Spanish Fork Peak, was glaciated at the same time as Mount Nebo and Loafer Mountain. A small tarn lake is present in a deeply excavated cirque on the northeastern side of the peak. A lateral moraine shows well along the eastern side of the Right Fork of Maple Canyon, in Sec. 20, T. 8 S., R. 4 E. The moraine reaches down to approximately 7600 feet. Other smaller cirques are present along the ridge north of the peak and fed into the same canyon.

Provo Peaks and Mount Timpanogos, east and northeast of Provo, have been glaciated as well (Atwood, 1909, p. 74-75). Basins formed above 9000 feet and locally glaciers moved down to approximately 6000 feet.

FEATURES RELATED TO LAKE BONNEVILLE

Wave-cut and wave-built terraces ring Utah and Juab Valleys and are etched into the folded Paleozoic rocks which form the foot of the Wasatch Mountains or into the deep bajada fans which flank the uplands. Such terraces are evident in the eastern Utah Valley area, particularly in the Spanish Fork Canyon region (Plate 1, fig. 1).

Depositional features, such as deltas, bay bars, spits and beach ridges are common features. The broad delta of Provo River, upon which Brigham Young University is built, and the broad delta of Spanish Fork River and Hobble Creek form the level bench lands along the eastern margin of Utah Valley. The distal edge of these latter deltas shows well at the southern edge of Springville and southwestward to Spanish Fork City. The gentle rise from Springville to the bench southeast of town, along U.S. Highway 89, is characteristic of this feature.

At the eastern edge of Payson, a long spit is developed. Gravel and sand extend northward through the eastern part of town as a gentle mound.

A bay bar, now partially breached, formed between Juab and Utah Valleys at the point where U.S. Highway 91 now crosses the Utah-Juab County line. It is a locally important source for gravel and can be seen west of the highway.

RIVER TERRACES AND RELATED FEATURES

Tributaries and the main stream of Spanish Fork River have left a series of terraces, in part erosional and in part depositional, along their courses. Prominent terraces near Cold Spring are apparently related to stillstand of Lake Bonneville and damming of the river flow. Some of the terraces may be in part lake formed, but in a deep embayment up the canyon.

In Diamond Fork, north of Thistle, terraces are prominent along the south and east side of the now relatively broad canyon. These are sloping stream terraces, but may owe much of their development to fluctuations of Lake Bonneville, the base level of the stream.

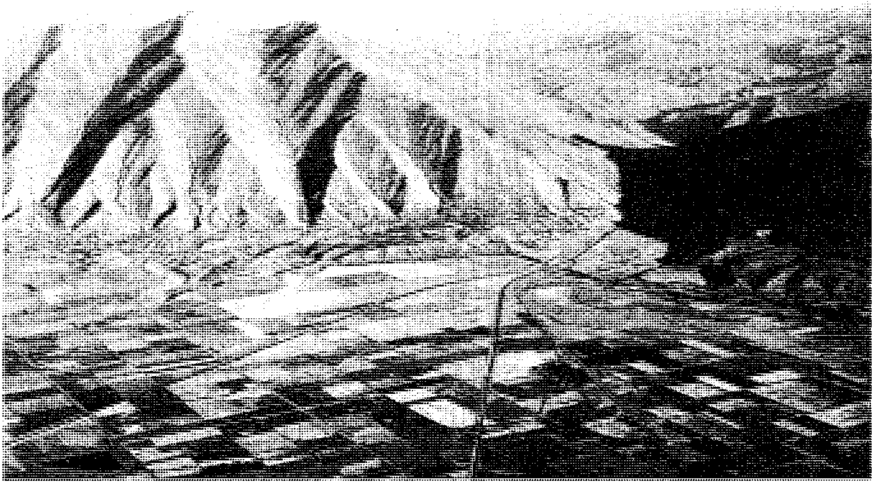
Irregular, high, gravel-covered terraces are noticeable in the region of Thistle and to the east and south. Several cycles of terracing are evident in the vicinity of Birdseye where both the relatively young and the much older high-level features are evident. The younger terraces may be related to fluctuations in Lake Bonneville, but the upper ones seem adjusted to a level much above that of the lake and may represent a cycle disrupted by relatively recent movement along the frontal Wasatch Fault, with subsequent adjustment of the stream gradient. Eardley (1933, 1934, p. 393) suggests that even older erosion cycles are evidenced by mature topography in the higher parts of the main valleys in the Southern Wasatch Mountains.

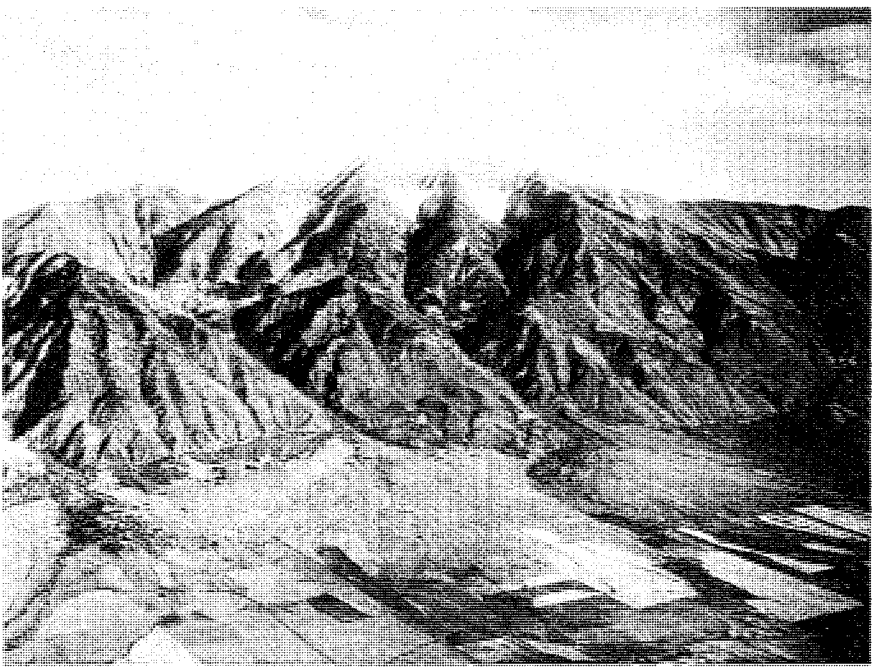
EXPLANATION OF PLATE 1

FIG. 1.—Low oblique air photo of the south flank of Maple Mountain and the mouth of Spanish Fork Canyon from the northeast. Faceted spurs and Lake Bonneville terraces are well shown on Maple Mountain. A small branch fault of the Wasatch fault offsets the flat-topped delta surface at the mouth of Spanish Fork Canyon. Upland in the distance is the flat-topped Wasatch Plateau.

FIG. 2.—Low oblique air photo of west side of Mount Nebo showing the cirque development on the peak and a recent fault scarp its base (white line). Landslide mass of Manning Canyon Shale float can be seen at base of Mount Nebo at the right of the picture, superimposed on a broad alluvial fan.

RIGBY—PLATE 1





FEATURES RELATED TO SOLUTION

Many small caves are known in the Wasatch Mountains where strong relief accentuates solution effects. A group of small sinkholes is developed in Kirkman Limestone at the mouth of Pole Canyon, a tributary to Spanish Fork Canyon (Rawson, 1957, p. 3, 4, Plate 1, figs. a, b). These circular depressions are up to 40 feet in diameter and are apparently collapse structures. Recent slumping in some may indicate current solution and enlargement.

REFERENCES CITED

Atwood, W. W., 1909, Glaciation of the Uinta and Wasatch Mountains: U.S. Geol. Survey Prof. Paper 61, 93 p.

Eardley, A. J., 1933, Strong relief before block faulting in the vicinity of the Wasatch Mountains, Utah: Jour. Geol., v. 19, p. 243-267.

————, 1934, Structure and physiography of the southern Wasatch Mountains, Utah: Mich. Acad. Sci. Papers, v. 19, p. 377-400.

Foutz, D. R., 1960, Geology of the Wash Canyon area, Southern Wasatch Mountains, Utah: Brigham Young Univ. Research Studies, Geol. Ser., v. 7, no. 7, 37 p.

Johnson, K. D.,1959, Structure and stratigraphy of the Mount Nebo-Salt Creek area, Southern Wasatch Mountains, Utah: Brigham Young Univ. Research Studies, Geol. Ser., v. 6, no. 6, 49 p.

Peterson, D. J., 1956, Stratigraphy and structure of the West Loafer Mountain-Upper Payson Canyon area, Utah County, Utah: Brigham Young Univ. Research Studies, Geol. Ser., v. 3, no. 4, 39 p.

Rawson, R.R.,1957, Geology of the southern part of the Spanish Fork Peak quadrangle, Utah: Brigham Young Univ. Research Studies, Geol. Ser., v. 4, no. 2, 33 p.

Smith, C. V.,1956, Geology of the North Canyon area, Southern Wasatch Mountains, Utah: Brigham Young Univ. Rsearch Studies, Geol. Ser., v. 3, no. 7, 32 p.

Woolley, R. R.,1946, Cloudburst floods in Utah 1850-1938: U.S. Geol. Survey Water Supply Paper 994.