GEOLOGIC ATLAS
OF THE
UNITED STATES

DEMING FOLIO
NEW MEXICO

BY
N. H. DARSON
GEOLOGIC ATLAS OF THE UNITED STATES.

Geologic Survey is making a geologic atlas of the United States, which is being issued in parts, called folios. Each folio includes topographic and geologic maps of a certain area, together with descriptive text.

THE TOPOGRAPHIC MAP.
The features represented on the topographic map are of three distinct kinds: (1) inequalities of surface, called relief, such as plains, plateaus, valleys, hills, and mountains; (2) distribu-
tion of water, called drainage, as streams, lakes, and swamps; and (3) the works of man, called culture, as roads, railroads, buildings, villages, and cities.

Relief.—All elevations are measured from mean sea level. The heights of many points are accurately determined, and those of the most important ones are given on the map in figures. It is desirable, however, to give the elevation of all parts of the area mapped, to delineate the outline or form of all slopes, and to indicate the position of the various elements of the landscape by lines which represent points of equal elevation above mean sea level, the vertical interval represented by each such line being shown on the map. These lines are called contour lines or, more briefly, contours, and the uniform vertical distance between any two such contours is called the contour interval of the map. Contour intervals and elevations are printed in brown. The number in which contour lines express altitude, form, and grade is shown in Figure 1.

This is in regions like the Mississippi Delta and the Dismal Swamp. For great mountain masses, like those in Colorado, the interval for large and less rugged country con-
tinental contours of 10, 20, 25, 100, and 150 feet are used.

Drainage.—Watercourses are indicated by blue lines. For a perennial stream, the course is shown by an intermittent stream it is broken or dotted. Where a stream sinks and reappears the probable underground course is shown by a broken blue line. Lakes, marshes, and other bodies of water are represented by appropriate conventional signs in blue.

Culture.—The symbols for the works of man and all lettering are printed in black.

Scale.—The area of the United States (exclusive of Alaska and Island possessions) is about 3,557,700 square miles. A map of the United States, drawn to a scale of 1 inch to 1 mile, would cover 3,557,700 square inches of paper and measure about 240 by 183 feet. Each square mile of ground surface would be represented by a square in the inch map, which would be about 10.5 by 10.5 inches. Each linear mile on the ground would be represented by a linear inch on the map. The scale may be expressed also by a fraction, of which the numer-

ator is 1 mile and the denominator is the number of inches or feet which the linear inch represents. A linear inch on the map is equal to 1 mile on the ground.

Altitude and Quadrangles.—The map of the United States is being published on an altitude base, that is, all points of equal altitude are connected. These lines are called contour lines or, more briefly, contours, and the uniform vertical distance between any two such contours is called the contour interval of the map. Contour intervals and elevations are expressed in the same unit, thus: as there are 6,336 inches in a mile, the scale "1 mile to the inch" is expressed by the fraction 1/6336. These scales are used on the atlas sheets of the Geological Survey; they are drawn to a scale, and corresponding approxi-
mately to 1 mile to the inch on the ground, the scale on the map. On the scale of 1 mile to the inch, a square inch of map represents about 1 square mile of earth surface; on the scale of 200 miles to the inch, a square inch of map represents about 16 square miles. At the bottom of each atlas sheet the scale is expressed in three ways—by a graduated line repre-
senting miles and feet, by a linear inch on the map, and by a fraction. All sheet edges and quadrangles.—The map of the United States is being published on an altitude base, that is, all points of equal altitude are connected. These lines are called contour lines or, more briefly, contours, and the uniform vertical distance between any two such contours is called the contour interval of the map. Contour intervals and elevations are expressed in the same unit, thus: as there are 6,336 inches in a mile, the scale "1 mile to the inch" is expressed by the fraction 1/6336. These scales are used on the atlas sheets of the Geological Survey; they are drawn to a scale, and corresponding approxi-
mately to 1 mile to the inch on the ground, the scale on the map. On the scale of 1 mile to the inch, a square inch of map represents about 1 square mile of earth surface; on the scale of 200 miles to the inch, a square inch of map represents about 16 square miles. At the bottom of each atlas sheet the scale is expressed in three ways—by a graduated line repre-
senting miles and feet, by a linear inch on the map, and by a fraction. All sheet edges and

The geologic map of the United States shows, by colors and conventional signs, the distribution of rock masses on the surface of the land, and by means of structure sections, their underground relations, so far as known, and in such manner as to permit the determination and arrangement of the strata in the different areas. The geologic map, as shown on the map of the United States, is based on the assumption that the rock masses are horizontal, and as such all the bends and undulations of the rock masses are represented by curvatures and undulations. The colors used on the map are: red, for igneous; green, for metamorphic; and blue, for sedimentary. The rocks are divided into three classes: igneous, metamorphic, and sedimentary. The igneous rocks are subdivided into three classes: acid, intermediate, and basic. The metamorphic rocks are divided into three classes: schists, gneisses, and phyllites. The sedimentary rocks are divided into three classes: clastics, chemical, and biochemical. The rocks are shown on the map by different colors, as follows:

Rocks are of many kinds. On the geologic map they are distinguished as igneous, sedimentary, and metamorphic. Igneous rocks—Rocks that have cooled and solidified from a magma. They are divided into two groups: extrusive and intrusive. Extrusive rocks are those that have cooled and solidified on the surface of the earth, such as lava flows and volcanic domes. Intrusive rocks are those that have cooled and solidified below the surface of the earth, such as granite and quartzite. Sedimentary rocks—Rocks composed of the transported fragments or particles of older rocks that have undergone disintegration, of volcanic debris deposited in lakes and seas, or of materials deposited in such water bodies by chemical precipitation or are formed by the action of wind or water. Sedimentary rocks are classified as clastics, chemical, and biochemical. Clastic rocks are those that have been transported and deposited by wind or water. Chemical rocks are those that have been formed by the action of water or wind. Biochemical rocks are those that have been formed by the action of living organisms. Sedimentary rocks are divided into three classes: clastics, chemical, and biochemical. The clastics are divided into three classes: conglomerates, sandstones, and shales. The chemical rocks are divided into three classes: limestones, carbonates, and evaporites. The biochemical rocks are divided into three classes: corals, mollusks, and plants. The rocks are shown on the map by different colors, as follows:

Rocks are of many kinds. On the geologic map they are distinguished as igneous, sedimentary, and metamorphic. Igneous rocks—Rocks that have cooled and solidified from a magma. They are divided into two groups: extrusive and intrusive. Extrusive rocks are those that have cooled and solidified on the surface of the earth, such as lava flows and volcanic domes. Intrusive rocks are those that have cooled and solidified below the surface of the earth, such as granite and quartzite. Sedimentary rocks—Rocks composed of the transported fragments or particles of older rocks that have undergone disintegration, of volcanic debris deposited in lakes and seas, or of materials deposited in such water bodies by chemical precipitation or are formed by the action of wind or water. Sedimentary rocks are classified as clastics, chemical, and biochemical. Clastic rocks are those that have been transported and deposited by wind or water. Chemical rocks are those that have been formed by the action of water or wind. Biochemical rocks are those that have been formed by the action of living organisms. Sedimentary rocks are divided into three classes: clastics, chemical, and biochemical. The clastics are divided into three classes: conglomerates, sandstones, and shales. The chemical rocks are divided into three classes: limestones, carbonates, and evaporites. The biochemical rocks are divided into three classes: corals, mollusks, and plants. The rocks are shown on the map by different colors, as follows:

Rocks are of many kinds. On the geologic map they are distinguished as igneous, sedimentary, and metamorphic. Igneous rocks—Rocks that have cooled and solidified from a magma. They are divided into two groups: extrusive and intrusive. Extrusive rocks are those that have cooled and solidified on the surface of the earth, such as lava flows and volcanic domes. Intrusive rocks are those that have cooled and solidified below the surface of the earth, such as granite and quartzite. Sedimentary rocks—Rocks composed of the transported fragments or particles of older rocks that have undergone disintegration, of volcanic debris deposited in lakes and seas, or of materials deposited in such water bodies by chemical precipitation or are formed by the action of wind or water. Sedimentary rocks are classified as clastics, chemical, and biochemical. Clastic rocks are those that have been transported and deposited by wind or water. Chemical rocks are those that have been formed by the action of water or wind. Biochemical rocks are those that have been formed by the action of living organisms. Sedimentary rocks are divided into three classes: clastics, chemical, and biochemical. The clastics are divided into three classes: conglomerates, sandstones, and shales. The chemical rocks are divided into three classes: limestones, carbonates, and evaporites. The biochemical rocks are divided into three classes: corals, mollusks, and plants. The rocks are shown on the map by different colors, as follows:
DESCRIPTION OF THE DEMING QUADRANGLE.

By N. H. Darton.

INTRODUCTION.
RELATIONS OF THE QUADRANGLE.

The Deming quadrangle is bounded by parallels 32° and 32° 30' and by meridians 107° 30' and 108° and thus includes one-fourth of a square degree of the earth's surface, an area of 1,000,000 square miles. It is in southwestern New Mexico (see fig. 1), a few miles north of the international

GENERAL GEOLOGY AND GEOGRAPHY OF SOUTHWESTERN NEW MEXICO.

STRUCTURE.

The Rocky Mountains extend into northern New Mexico, but the southern part of the State is characterized by detached mountain ridges separated by wide desert basins. Many of the ridges consist of uplifted Paleozoic strata lying on older granites, but in some they Mesozoic strata also are exposed, and a large amount of volcanic material of several ages is generally included. The strata are deformed to some extent. Some of the ridges are fault blocks; others appear to be due solely to flexure. The basins, some of which are 30 miles or more wide, are formed by deep valleys, now filled with Tertiary and Quaternary deposits, which in many places are more than 1,000 feet thick and form a nearly level desert floor. This floor is locally trenched by the Rio Grande, which flows through a valley 400 feet deep near El Paso. In some areas lakes are interbedded with the basalt deposits or have overflowed them. The ridges rise abruptly from a few hundred to more than 5,000 feet above the basins and range in length from less than a mile to 90 miles and in places reach a width of 15 miles. The chief ridges of southwestern New Mexico shown in figure 2 are the Cibola Mountains, Caborca Mountains, Cooks Range, Black Range, Burro Mountain, Mogollon Mountain, Florida Mountains, Big Hatchet Mountain, Sierra Maestra, and Polacelio Mountains.

STRATIGRAPHY.

Pre-Cambrian rocks.—Rocks of pre-Cambrian age are exposed at but few places in southwestern New Mexico. They outcrop in the Burro and Florida mountains, in Cooks, San Andres, Caborca, San Cristobal, and Sierra Ocumur ranges, and at a few other places. Granites and granoids are the principal rocks. In the Franklin Mountains, north of El Paso, there are two pre-Cambrian formations, the upper one a cherty phorphyry more than 1,500 feet thick and the lower one (Lanoria quartzite) comprising about 1,500 feet of quartzite and some slate.

![Image 1 - Index map of southwestern New Mexico and adjacent regions](image1)

![Image 2 - Relief map showing the mountain ranges in southwestern New Mexico and the desert plains out of which they rise.](image2)

![Image 3 - Generalized columnar sections showing the stratigraphy of the Paleozoic sedimentary rocks in southwestern New Mexico and the correlation of the formations in the various quadrangle](image3)

Other species of Ordovician age are known in the southern part of Luna County. In the Miners Mountains and in Cooks Range a formation of early Mississippian
The mean monthly and annual temperatures of the Deming region are much milder than in New Mexico. The highest month is June in some years and July or August in other years. December is usually the coldest month.

### Monthly and annual temperature, in degrees Fahrenheit, of Deming, New Mexico

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean Temperature</th>
<th>Range</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>31.6°F</td>
<td>21.5°F</td>
<td>2.3°F</td>
</tr>
<tr>
<td>Feb</td>
<td>32.6°F</td>
<td>22.9°F</td>
<td>2.7°F</td>
</tr>
<tr>
<td>Mar</td>
<td>42.4°F</td>
<td>32.6°F</td>
<td>2.9°F</td>
</tr>
<tr>
<td>Apr</td>
<td>55.6°F</td>
<td>45.9°F</td>
<td>3.0°F</td>
</tr>
<tr>
<td>May</td>
<td>62.8°F</td>
<td>53.0°F</td>
<td>3.1°F</td>
</tr>
<tr>
<td>Jun</td>
<td>71.8°F</td>
<td>62.0°F</td>
<td>3.0°F</td>
</tr>
<tr>
<td>Jul</td>
<td>76.7°F</td>
<td>66.9°F</td>
<td>3.1°F</td>
</tr>
<tr>
<td>Aug</td>
<td>75.2°F</td>
<td>65.4°F</td>
<td>3.0°F</td>
</tr>
<tr>
<td>Sep</td>
<td>65.8°F</td>
<td>56.0°F</td>
<td>3.2°F</td>
</tr>
<tr>
<td>Oct</td>
<td>54.2°F</td>
<td>44.4°F</td>
<td>3.0°F</td>
</tr>
<tr>
<td>Nov</td>
<td>40.0°F</td>
<td>30.2°F</td>
<td>2.9°F</td>
</tr>
<tr>
<td>Dec</td>
<td>31.6°F</td>
<td>21.8°F</td>
<td>2.7°F</td>
</tr>
</tbody>
</table>

### TOPOGRAPHY

The topography is a significant feature of the region. The highest peak is the Sierra Blanca, which rises to 10,500 feet. The Sierra Blanca separates the Deming Basin from the surrounding desert. The surrounding desert is characterized by flat, sandy areas with scattered vegetation.

### RELIEF

The elevation of the area varies from 3,000 feet above sea level in the Deming Basin to about 9,000 feet in the Sierra Blanca. The relief is characterized by gentle slopes and occasional hills.

### SUMMARY

The climate in Deming is characterized by mild temperatures and low humidity. The area is known for its pleasant weather, making it a popular destination for retirees and those seeking a mild climate.

---

*Notes:
- Mean monthly temperature data are averages for the period from 1931 to 1960.
- Temperature variations are presented in degrees Fahrenheit.
- The standard deviation indicates the variability of the temperatures.*
mile—but the rate is considerably higher from Denning northward. The bolson surface appears to be perfectly flat except for some few low mounds of sand and shallow arroyos. Near the mouth of the bolson slope becomes much steeper or gives place to long, sloping alluvial fans, which are especially conspicuous about the Florida Mountains. (See Pl. II.)

GRAINSIDE.

The main stream in the Deming quadrangle is Minnibus River, which has a surface flow only in times of exceptional rainfall. Its flash flow has not been known to reach beyond the central part of T. 25 S., R. 7 W., where the channel spreads out widely on the desert bottom. Nearly every year the water spills spreading at times of heavy rainfall. Not infrequently it extends to Denning and beyond, but its flow period is very short and for the greater part of the year its bed in the Deming quadrangle is dry sand. (See Pl. VI.)

An important alluvial fan is San Vicente Arroyo, which joins the Minnibus a mile south of Spalding and in time of flow brings a large volume of water from the Silver City district. The drainage of Cooks Range, Little Florida Mountains, and the east and south end of Florida Mountains belongs to the main Minnibus system but rarely reaches the river channel. A line from Red Mountain to White Hills and the center of the west side of Florida Mountains approximately defines a wadisaid, south of which the surface slopes into the valley of Palenro Arroyo, whose channel crosses the southwest corner of the quadrangle. This arroyo passes through the gap at the south end of Florida Mountains and into the southern extension of the Minnibus valley near the international boundary. This valley extends into a large incised basin in Mexico.

DESCRIPtIVE GEOLOGY.

STONSTAGHY.

ROCK FORMATIONS.

The rocks of the Deming quadrangle are in part of sedimentary and in part of igneous origin. The sedimentary rocks range in age from Cambrian to Quaternary and include strata known to belong to all the systems except the Triassic and Jurassic, but the Silurian, Devonian, and Cretaceous systems are only slightly represented. The Paleozoic and Mesozoic strata consist of widespread sheets of limestone, shale, and sandstones, which belong chiefly to the Ordovician, Car- boniferous, and Cretaceous systems. The Cenozoic deposits consist in part of volcanic agglomerate and other pyroclastic debris.
specimens unstained fieldpale and subordinate quartz, much of blue to drab color and yellowish brown. In the hand it is intactecous, and the slippiness of the rock is apparent. Microscopic examination of the powdered rock shows that the fieldpale is amorphous, with a little orthoclase and some albite. There is considerable variation in the quartz in the granite from different outcrops. Rock from the slope west of Arco del Diablo contains a moderate amount of quartz but much less than a normally crystalline, and the rock from the pass northeast of The Park contains none that could be detected with the hand lens, although a little could be seen in the powdered rock. A more dense, more silicic rock, with a little orthoclase and some albite, is known as "Window Mountain" mine, southwest of Arco del Diablo, differs from the coarser variety in containing a greater amount of quartz and orthoclase and more feldspar.

The exposed thickness is about 200 feet in the north end of the Florida Mountains, about 100 feet on Fluvio Ridge, and considerably less near Gym Peak.

Edifices.—The rock is well exposed for nearly a mile on the northwestern side of the Florida Mountains, where the coarse sandstone lies on the slightly uneven eroded surface of the ridges. In the flatter parts it is shown more clearly and pebbly. In the expansive west of Fluvio Camp the basal quartzite stands nearly vertical and appears to be separated from the granite by a thin, discontinuous, and non-laminated layer of sandstone. At the top of the formation the sandstone grades into sandy shale and shabby sandstone, which give place abruptly in the El Paso limestone without demonstrable evidence of erosion or unconformity to represent the supposed interval between the deposition of the two formations.

Age and correlation.—No fossils have been found in the formation in the Deming quadrangle, but in the Franklin Mountains near El Paso, the type locality, the Blas sandstone contains Upper Cretaceous fossils. Its stratigraphic relations and general character indicate that it is equivalent to the "sandstone quarties" of central New Mexico and to the basal sandstone of the Silver City group.

Ophiolite system. Rock formations.

In the Deming quadrangle the Ophiolite system is represented by a thick deposit of limestone, the lower part of which is of Permian age, the upper part of which is of Upper Cretaceous age. A large part of Ophiolite

cy, however, is not represented by deposits, the whole of the upper part of the Ophiolite system and Lower Ophiolite being absent, so that there must be an unconformity between the formations. On the basis of lithology, faunal, and stratigraphic grounds the lower formation has been correlated with the El Paso limestone of the El Paso quadrangle, and the upper formation with the Ophiolite of the Franklin Mountains.

Ophiolite is entirely different in various amounts; in general it is subordinated and interstitial. The darker silicates are in inverse proportion to the amount of quartz. They include augite, green hornblende, and biotite. Hornblende is the most abundant and is evident, at least in part, an alternation product of the augite; in some places cores of altered augite surrounded by green hornblende still remain. Biotite is the brown variety, with pleochroism from yellow to deep brown, in places altered to green chlorite. Accessory minerals include magnetite, ilmenite, sphene, titanite, and a little pyrite.

Hornblende dikes.—The dark rock of the dikes cutting the granite southwest of Capulin Dome is an amphibolite composed mainly of feldspar, hornblende, and subordinately feldspar. The rock associated with the granite and probably cut by it has a mile southwest of Fluvio Camp is of similar character. More or less leucocratic bands in both places show that the dark rock southwest of Capulin Dome is almost black, and the banding is brought out by white specks of feldspar. The texture varies, but it is generally similar to hornblende gneiss, and the larger ones lie in definite bands. Under the microscope the powdered rock shows green hornblende as well as feldspar ranging from dolomitic to anorthosite.

The rock south of Capulin Dome is fine grained, and the feldspar is albite. Quartz is also present in small amount. In this vicinity the granite is cut by a dike or includes a mass of porphyritic diorite containing white phenocrysts measuring 8 millimeters across, which contrast strongly with the dense, dark-green to black, fine-grained groundmass. The hornblende is considerably altered to sericite. The groundmass consists of laths of andesine-biotite, between which is packed an aggregate of green and secondary hornblende, subordinately biotite, perhaps also secondary, and chlorite. Magneteite and limonite or limonite are abundant accessories.


Name and distribution.—Lying on the eroded surface of the granite and forming the base of the Paleozoic series is a sandstone that stratigraphists call the Blas sandstone. It is closely similar to the Blas sandstone of the El Paso quadrangle that name Blas is here applied to it. It is exposed in the Florida Mountains for about half a mile on the slope west of Capulin Dome and for about half a mile in the cliffs east of The Park, and on the slope north of Gym Peak. It outcrops also on the southeastern slope of Fluvio Ridge, just west of Fluvio Camp.

Character and thickness.—The formation consists of gray to buff massive sandstone, partly gneissitic, in beds 30 to 40 feet thick, separated and overlaid by beds of shaly sandstone and of sandy shale containing much green glauconite in disseminated grains. It is very prominent in the eastern parts of the Snake Hills, where the thickness exposed is not more than 700 feet. The lowest beds exposed at the east end of the ridges are a typical light-gray shaly limestone, which extends to the first knob west of the county road, where it gives place abruptly to thick massive beds of the Blas sandstone, the base of the formation. The contact displays unconformity by planation, with some slight thinning.

The formation dips steeply for nearly a mile in the knob just west of Fluvio Camp, where it lies on against Blas sandstone, and its nearly vertical beds are so crushed that a thickness of only 50 feet is exposed in the eastern part of the knob and somewhat less farther west.

Finishes and ages.—Fossils are scarce in the formation, but a few brachiopods are found in a few areas of exposure. They were examined by Ulrich and Kirk and most of them are found to be species of Ophiolepis, of Beckenhamian age. A few fossils were collected from the Blas sandstone in the Franklin Mountains. Those at this horizon in the Snake Hills were identified by Edwin Kirk as Doralinella of B. pagonigera Hall and Whitfield and Hormotoma sp. On the west slope of Gym Peak were found Strophomena? near S. pennsyl- vania Hall and Whitfield, Hormotoma sp., and Proxenosus sp. The beachrocks are close to forms described from the upper part of the Pogonip limstone, of the Eureka and White Pine districts in Nevada, and indicate late Beckenhamian age. On the evidence of these fossils and on its close similarity in lithologic character and stratigraphic relations the formation is correlated with the El Paso limestone of the type locality in the Franklin Mountains near El Paso. This is the lower part of the Miners limestone, as it has been called by Gordon, in the region north of the Deming quadrangle.

Upper Cretaceous system. Montoya limestone.

General character.—The Montoya limestone in the Deming quadrangle has the same general character as in the type locality near El Paso. In thicknees in the quadrangle is nearly everywhere about 200 feet. Most of it is a light gray. Several beds contain a large amount of chalk, which makes the rock more resistant to weathering and hence more prominent in outcrop. The color of the chalk is generally alternating with pure limestones. At the base of the formation is a dark gray, more massive member.

The base of the El Paso limestone without noticeable difference in attitude, but in places an abrupt change in lithologic character and some other features indicate unconformity. The upper limit of the formation, as exposed in the quadrangle, is somewhat indefinite and is arbitrarily placed at the top of the highest beds containing distinctive fossils. The upper limit varies from locality to locality, but the formation is defined as occurring on the fluvio ridge near El Paso, at Capulin Dome, at Mineral Peak, and in other places by the Fluvio Ridge formation. As the Fluvio Ridge is thin and not very distinct, it is not separately mapped in this folio.

Distribution and occurrence.—The formation outcrops extensively about Gym Peak and in the Park in the Florida Mountains, at the west end of the Snake Hills, and in the knob south of Fluvio Ridge. A small mass is exposed on the west of Capulin Dome.

The most extensive exposures are along the westward-facing cliffs east of The Park and along the southern and southern slope of Gym Peak and of the ridge next northeast of that peak. The beds extend down the northern slope of Gym Peak in an outcrop 11 miles long and apparently up a mile southwest of Byers Camp. The exposures also occur on the western sides of the two ridges west of The Park. The outcrop west of Capulin Dome extends for more than a mile along the lower slope of the mountain, rising steeply from the edges of Blas sandstone to the dark massive limestone at the base of the Montoya and in places to unconformable overlap by the Lobo formation. At this locality the beds are about 800 feet thick. The rock is gray limestone, in part dolomitic, and contains a few layers or nodules of chert. Most of it is light gray, in beds 2 to 6 inches thick, but about 140 feet of the hand beds is more massive and greenish yellow, subordinately biotite, perhaps also secondary, and chlorite. Magneteite and limonite or limonite are abundant accessories.
replacing a limestone, probably the Montoya, but as the sheet is nearly surrounded by porphyry and is cut out by faults its relations could not be determined.

**Faunas and age.**—In the medial beds of the Montoya limestone between the cherty members fossils are particularly abundant. The following species have been identified by Urlah and Kirk:

- **Peralasmia tetracostata**
- **P. simplex**
- **P. tenuis**
- **P. trilobata**
- **P. quadrata**
- **P. uncinata**
- **P. truncata**
- **P. longa**
- **P. sp.**
- **P. gracilis**
- **P. elongata**
- **P. varia**
- **P. spectabilis**
- **P. stenoptera**
- **P. minor**
- **P. minuta**
- **P. microscapha**
- **P. minutissima**
- **P. pygmaea**
- **P. pusilla**
- **P. acutangula**
- **P. acuticostata**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acuticostata var.**
- **P. acu...
lies on granule, it contains some basal argilaceous sand. A section on the west slope of Capitole Dome is as follows:

Section of Lake formation at Capitole Dome.

Sandstone, soft, reddish, with a few thin conglomeratic layers and some thin beds.

Conglomerate, light-colored, with littoral pebbles.

Conglomerate, pink, soft, with conglomeratic layers.

Shale, red, with thin beds of sandstone and siltstone.

Limestone, light-colored, with pebbles of various sizes.

Limestone, greenish-gray, with pebbles of various sizes.

Limestone, red sand and quartzite pebbles in a red sand matrix.

Some of the limestone beds at this place resemble litho-

conglomeratic rock but are harder and contain only 27 per cent of calcium carbonate, the remainder consisting of 10 per cent of magnesium carbonate and of material insoluble in acid.

In Cooke Range the formation is thinner and of somewhat different character. The following section was measured at the north end of Saratoga Ridge, 4 miles northwest of Fort Union:

Section of Lake formation and underlying beds at north end of Saratoga Ridge.

Lobe formation:

Sandstone, soft, red.

Conglomerate, with miscellaneous pebbles.

Shale, red with small pebbles.

Conglomerate, light-gray.

Limestone, red, with thin beds of sandstone and siltstone.

Limestone, blue, with red and green jasper pebbles.

The three beds at the base of the section doubtless represent Gyan sandstone, for the nodular limestone contains Gyan fossils on the west side of the range.

Age.—No fossils have been found in the Lobe formation, so that its age is not determined. In the central part of Cooke Range it is less uniformly thick than that of late Carboniferous age, and is separated from the overlying Saratoga sandstone (Lower Cretaceous) by an unconformity; hence its age may be Pennsylvanian, Triassic, or even earliest Cretaceous. Because of its unconformable relations with both the overlying and the underlying formations, however, the Lobe is tentatively classified as Triassic.

CRETACEOUS SYSTEM.

The Cretaceous system is represented in the quadrangle by a few hundred feet of sandstone and shale. The sandstone is at the base and of the Comanche (Lower Cretaceous) age, and the shale above is Upper Cretaceous.

COMANCHE SERIES (LOWER CRETACEOUS).

SARATOGA SANDSTONE.

Name and distribution.—The Saratoga sandstone is named from Saratoga Ridge, in the northern part of the quadrangle. Its maximum thickness in the area is 300 feet. It occupies the greater part of Saratoga Ridge and is extensively exposed in Florite Ridge, Goat Ridge, Piny Hills, and along part of the flank of the basaltic, 5-mile-wide, flow of the Chin Tuck.

Character and relations.—The formation consists almost wholly of light-yellow, massive sandstone, most of it quartzite or very fine-grained sandstone. At the base there are more or less conglomerate containing some angular and subangular fragments. Some beds are shale, and a few contain a little calcium carbonate.

The formation lies northerly beneath the thick product of the Lobe forma-

tion, with no notable discordance of dip and only slight evidence of erosional unconformity. In the Piny Hills it lies on and against pre-Cambrium granite, but this relation is prob-

ably due to faulting. Similar relations are suggested in the western part of Florite Ridge, where outcrops of the Saratoga and the granite are closely associated but not in contact. It is overlain by the Colorado shale.

Florite and Goat Ridge.—Some beds of the formation contain abun-

dance of fossils, notably in a horst along a ridge about 10 miles north of Florite Ridge, where a sandy bed not far below the middle of the formation yielded the following species, determined by T. W. Stanton:

Cardina helvethraeformis Cope.
Cardina howardensis Cope.
Pseudotrema tumidum Cope.
Pseudotrema quadriculatum Cope.
Eurypterus clypeatus Cope.
Eurypterus erythrocephalus Cope.
Eurypterus t. taylori Cope.
Anomalops sp.

This fauna, which is nearly the same as that found in the marginal beds of Comanche and southern Kansas near Tecumseh, N. Mex., is regarded by Stanton as indicating that the beds are of the age of the Washita group of the Comanche series of Texas.

The following fossils, which were obtained at the west end of Florite Ridge, are apparently about the same horizon as those enumerated above, were also determined by Stanton:

On the basis of the occurrence at Capitole Dome there is an alteration of less massive beds as follows:

Distribution and character.—Dark gray shale of Colorado age outcrops in two areas northwest of Florite Spring. It occupies the basaltic flows of Cooke Range and possibly underlies an area of considerable extent beneath the agglomerate and bolson deposits between there and Goat Ridge. The outcrops further to the north in the basin is nearly a square mile in extent. The thickness of beds exposed is about 300 feet.

Most of the massive shale-but, there are intercalated beds of sandstone that breaks into thin slabs and some concre-

tions and thin beds of fine-grained dark-blue, bluish-lime, lamination, which was found in this area of underfiery sandstone slab is darker than that below, and a bluffy shale-annate appears at one place. The formation is ascribed from the underlying Saratoga sandstone by an abrupt change in the character of the material but by no notable discordanse of dip and no deposits of coarse fragmental sediments. The bluish at this horizon, however, represents a large part of Cretaceous time.

Florite and Goat Ridge.—The formation contains numerous fossils in the shallow basin 25 miles northwest of Florite Spring. Fragmentary specimens of Staunton, Incusumlocha helvethraeformis, Cope. and Fraseros sp. are found at the Piny Hills. The little pygmy sheep was found in large numbers and accumulate on the surface. A limestone bed in the middle of the exposure contains many sculptured echinoderm, which are difficult to obtain in good condition.

TERTIARY SYSTEM.

AGGLOMERATE AND ASSOCIATED ROCKS.

General character and relations.—The Tertiary system is represented in the quadrangle by a great thickness of irregularly stratified rocks of volcanic origin and fragmental (pyroclastic) character, interbedded with intrusive sheets and volcanic flows. The material here described consists of agglomerate, tuff, volcanic ash, flows of volcanic mud, and some flow breccia. A characteristic ex-

posure of the well-beded rock is shown in Plate IV. The greater part of the fine material is wind borne, but portions have been deposited or rearranged by water. Some beds of sand, sandstone conglomerate, and gravel of ordinary sedi-
evolutary origin are also included.

The thickness of the deposits is more than 2,000 feet. As they are extensively exposed in nearly all of the mountain ranges, it is probable that they underlie a large part of the basin area. They lie unconformably on various formations, including the Colorado shale of middle Upper Cretaceous age, and are believed to be of Tertiary age, although their lower part may be late Cretaceous, and some of the top beds may be Quaternary. They are undoubtedly contemporaneous and

doubtedly associated with the eruption of the volcanic rocks with which they are so extensively interbedded.

The typical agglomerate is a massive rock, mostly very hard, made up of angular fragments of volcanic rocks—chiefly dark gray andesite and parphylite-labrador—embedded in a gray or parphylite matrix of tuff or ash. Some of the rock has a crystal-

line matrix and is porphyritic. Interbedded with the stratified rocks are beds derived from volcanic mud and thin sheets of lava that flowed over coarse fragmental material and in line with volcanic's embankments of it. Accumula-
tions of tuff and volcanic beds of volcanic ash of con-

siderable thickness and extent, in part deposited by water, are abundant. Some of the included beds of sandstone, shale, gravel, and conglomerate, formed of ordinary detrital materials are difficult to distinguish from the volcanic deposits.

Distribution.—The most extensive exposures of pyroclastic rocks are on the north end of the Florida Mountains, the east and southern end of the Little Florida Mountains, and the eastern and south end of the Colorado Mountains. Smaller masses are exposed about Florite and Goat Ridge and on the south end of Red Mountain. Ash and gravel lying beneath basalt of Black Mountain are associated with the formation but may be somewhat younger than the main body of agglomerate in other areas.

Local features.—The agglomerate forming the rugged peaks and deeply dissected slopes of the north end of the Florida Mountains exhibits the relations described in the sections in figure 5. Its greatest thickness is about 1,000 feet, but some of it has been removed by erosion, and doubtless some higher beds underlie the bolson east of the mountains. It lies unconformably on the agglomerate of Colorado age with notable discordance in dip, which is at a slight angle to the east and northwest. Much of the agglomerate of the Florida Mountains is a hard gray rock, but in places it gives way to more or less massive beds 50 to 80 feet thick in many places. (See PI. III.) It consists mostly of large angular fragments of andesite and other contemporaneous eruptive rocks of a similar age. Through the base at Capitole Dome there is an alternation of less massive beds as follows:

North. Agglomerate, very massive pyroclastic gray. 150.
Agglomerate, gray to reddish. 30.
Conglomerate, course; boulders 1 to 4 inches, mostly of andesite; some of blue-gray; andesite; and gray and coarse reddish granite. 60.
Sandstone, light gray to green, slickly, made up mostly of conglomerate volcanic rocks. 50.
Boulders, coarse; largely volcanic rocks, some fine lime-

stones and scarce red beds. 30.
Agglomerate and associated rocks; most of these are gneiss; fine of small angular fragments of andesite and other eruptive rocks. 10.
Kernanopyrites, flow, and massive pyroclastic rocks, with beds of andesite in thinned and thin-layered flows, some showing encrustation. 50.
Agglomerate, with rounded subangular masses of basalt,

limestone, and andesite. 150.
Kernanopyrites, fine, gray, andesite. 50.
Pyroclastic, with rounded and angular masses of basalt and

andesite. 60.
Palaeospa, jasper, conglomerate, with beds of granite, 60.
Palaeospa, jasper, conglomerate, with beds of granite, 60.

The bed base lies on 50 feet of soft reddish sandstone of the Lobo formation (see PI. III), and although there is some evidence of erosion at the contact there is no great difference in direction or rate of dip. In places the middle and upper parts of the series consists of fine-grained beds, such as the body of fine-grained light-colored tuff that has been quarried for build-

ing stone on the west end of a spot 2 miles north of Arroyo del Diablo. The agglomerate in the faulted block 15 miles south-

east of Arroyo del Diablo, is capped by a sheet of considerably less sandstone and contains masses of pyroclastic.

The agglomerate in the Little Florida Mountains has the relations shown in figure 8 (p. 10). Part of it underlies the great sheet of basaltic rhyolite, but a thin layer of coal lies just above.
ente appears to be later than the porphyry intrusions, although no porphyry masses or boulders have been observed in the agglomerate. The deposition possibly has begun at a somewhat earlier date in the Tertiary and may have con-
tinued into the Quaternary, for the relatively young basalt is on
volcanic ash.

**Quaternary System**

**Volcanic Deposition**

In the Dunes quadrangle thick deposits of sand, gravel, and clay of Quaternary age, washed from the mountains, underlie the wide basins. Accumulations of recent alluvium along the lower flanks of the Tertiary range cannot be separated from the older deposits. Some portions of the alluvium consist of loose sand, which flows from place to place and gives rise to local sand bars, a feature which is local to the vicinity of Minden Cutoff near Duning. More or less talus accumulating on the slopes of hills and mountains is of Quaternary age, but its limits are too indefinite for representation on the geologic map.

The deposits in the great basins between the mountains are not very deeply buried by the present streams, but their thicknesses and character are known at certain localities from well borings, a few of which have reached bedrock. A deep bore hole bored in Duning in 1887 penetrated rock at 960 to 1000 feet, having passed through a succession of clay, sand, and mudstone, and 9 to 11 feet thick. A representative record north of the river in sec. 30, T. 28 S., R. 7 W., as follows:

- **Record of boring in sec. 30, T. 28 S., R. 7 W., as follows:**
  - **Leaves and clay**
  - **Gravel**
  - **Clay**
  - **Gravel, with water**
  - **Sand, lighty packed**
  - **Clay**
  - **Sand, packed**
  - **Clay**
  - **Sand**
  - **Granite and sand, water**
  - **Granite, coarse**
  - **Granite**
  - **Sandstone, sand**

**Rhyolitic Rocks**


The younger igneous rocks comprise porphyry of several sorts, an extensive series of lavas and andesites, rhyolites and felsites, and basalt. The porphyry forms lenticular and elliptical outcrops along the line of the dikes, and is believed to be of Tertiary age. The lavas, andesites, and rhyolites are mainly flows and dikes, and are not separated into specific localities. The rhyolites are the most abundant, and the porphyry is the least abundant.

**Quartz Latite**

**Relation and characteristics:** Quartz latite occurs as extensive and thick flows, interbedded at several horizons among the agglomerates and other pyroclastic deposits, and as dikes that cut the agglomerate. It occurs in southward, pink to purple, coarse-grained, porphyritic, and porphyritic. Some varieties are dark grey and vesicular; others are of lighter color and include minerals or less. Two general types are recognized: hornblende-hornblende-latte and hornblende-hornblende-latte—latter differing somewhat in color, texture, and degree of alteration as well as in mineral composition. The varieties can not be separated in the field, for they occur in the same body—in some places as alternate flows, making up the thick sheet. Some of the latter is similar to the andesite but differs from it in being much coarser grained and in containing a large amount of potassium feldspar, the latter distinction being observable

**Distribution:** The largest masses of latite are two thick sheets, separated by a thin layer of agglomerates, and constitutes a smaller section in size, with an average of about 5 million square feet. Quartz latite is rare.

**Andesite**

**Relation and characteristics:** Andesite occurs in great masses of lava, and is of two types: the andesite of the Tertiary and of the older agglomerate and tuff. Although some of the sheets are more or less stratified, the latter and some are lower, they all belong to the same series and are not distinct. A number of these andesite dikes cut Paleozoic slate and granite, latite, and agglomerate. Andesite is rare.

**DISTRIBUTION:** The largest sheet of andesite is in the foot-
hills of Cooks Range, 4 miles northwest of Fort Cummings. It is 200 to 300 feet thick and lies somewhat below the latite. Seventy other sheets and slabs in the tuff 4 miles east and southwest of Fort Cummings are less than 300 feet thick, but the others are thinner and their outcrops are small. A small sheet or stock of andesite is embedded in the agglomerate lies a short distance below the top of the thick sheet 2 miles
northeast of Mirage and forms a small knoll a few hundred yards west of the railroad. An extremely rare 30° dike of andesite cuts the lefite of the main sheet a mile northwest of this locality, but other dikes of andesite, with little or no gneiss, are at most a few miles from Mirage. One of the dikes, or a sheet from it, extends to the railroad and is exposed in a 100-foot cut where it contains a little more than 2 miles of gneiss of the Mirage gneiss. Andesite Peak (see P1 VIII), in the small ridge half a mile west, and in the high ridge north of Pusn Spring. They cut the gneiss- 

The andesite in the Florida and Little Florida Mountains contains little or no gneiss. Fragments of andesite occur in the agglomer- 

The andesite of the area are of medium-dark color, with inclination toward purples. All are fine-grained and compact, and none are vesicular, though flutish texture is commonly revealed by thin sections. Phenocrysts of olivine-andesine or andesite and brown hornblende, with a few quartz and feldspar, are embedded in a finely and in places imperfectly crystallographically gneissed from albite to oligoclase. The hornblende phenocrysts are commonly altered to chlorite or biotite, and in most sections is calcic. The andesite contains more or less gneiss in some localities; in others none is recognizable though it may have been present in small amounts. Accessory minerals are magnetite, titanite, and apatite. 

The andesite occurring in dikes shows no special characteris- 

The andesite in the center and on the eastern slope of the large dome-shaped uplifft a half mile south of Fort Cummings, and the other has been based on the removal of the overlying rhyolite and tuff. It is also exposed along the bases of the ridges, 2 and 3 miles south of the fort, where the outcrop is repeated by faulting, and remnants of a widespread sheet cap some of the ridges on either side of the main road, east and south of Massacre Peak. An interrupted outcrop also extends along the slope southeast and south of that peak, on the west side of the structural dome. The southwesternmost exposure is a quarter of a mile northwest of Pusn Spring. 

The sheet is at least 200 feet thick in the dense south of Fort Cummings, but it thins toward the west and is probably discontinuous in places along its western outcrop. In the center of the dense south of the fort the lower rocks are very coarse grained, whereas the main body appears to be only moderately coarse; both have the same microlitic composi- 

The sheet is overlain by tuff and agglomerate containing a thin sheet of andesite and extending up to the base of the main sheet cutting into the main ridge. This relation is general throughout the area southeast and southwest of the fort, but the thickness of the intervening body of pyroclastic rocks ranges from 10 to 140 feet. Throughout the central part of the sheet there is also some agglomerate between it and the main andesite body. This is well shown in the outcrop 2 miles west of the fort, where 40 feet of such interbeds between the two sheets. 

Petrography—The quartz-basalt has a rough surface and is almost black. It contains moderately abundant phenocrysts of andesine-labradorite. Mica and hornblende phenocrysts in fair abundance are indicated by typical outlines filled with secondary minerals, but the original minerals are gone. In some specimen the olivine, completely altered to an aggregate of what appears to be serpentine and ilmenite, is moderately abundant; in others it is represented only by outlines which resemble it. Angite forms small phenocrysts as well as feldspar and inclusions of angular gneiss are present. It is composed of small plagioclase laths, augite rods, and magnetite specks, in a matrix of poorly crystallographically fibrolitic, some of which, however, is well crystallographically organized. Accessory minerals are apatite, magnetite, and zircon. The rocks from different outcrops differ somewhat either in having more or less albite or in the presence of pyroxene. 

Quartz, in xenocrysts measuring 1.1 millimeters across, is common, some sections showing one or more fragments of it, though it is not abundant in the sheet. Grains are bordered by a reaction rim of augite, and most of these have the irregular outline indicative of resorption by the magma. 

In all these rocks the majority of the feldspar phenocrysts are bordered by rims of inclusion and many of these show indistinct boundaries against the gneiss, as if the pheno-

Distribution and relations.—Kernophyolite occurs in sheets and thin dikes in the Miami and Sanibel areas. The largest 

Distribution and relations.—Kernophyllite occurs in sheets and thin dikes in the Miami and Sanibel areas. The largest 

The Kernophyllite has been developed in the eastern and southern part of the Florida Peninsula. It is a fine-grained, foliated, biotite, and hornblende, and biotite is a pink foliated hornblende. The biotite flakes have a linear arrangement parallel to the foliation. Quartz phenoc-

The Kernophyllite has been developed in the eastern and southern part of the Florida Peninsula. It is a fine-grained, foliated, biotite, and hornblende, and biotite is a pink foliated hornblende. The biotite flakes have a linear arrangement parallel to the foliation. Quartz phenocrysts are abundant and commonly have corroded outlines, although some single crystals which in part have well-rounded outlines are present. Fragments of quartz crystals are partly rounded and associated with other fragments not so affected. These conditions indicate fretting, probably by forceful waves in the rotating wave or during eruption, subsequent to the corrosion by the magma. 

The rhyolite dikes and phenocrysts in excess of copal phenocrysts. The plagio-

The Kernophyllite has been developed in the eastern and southern part of the Florida Peninsula. It is a fine-grained, foliated, biotite, and hornblende, and biotite is a pink foliated hornblende. The biotite flakes have a linear arrangement parallel to the foliation. Quartz phenocrysts are abundant and commonly have corroded outlines, although some single crystals which in part have well-rounded outlines are present. Fragments of quartz crystals are partly rounded and associated with other fragments not so affected. These conditions indicate fretting, probably by forceful waves in the rotating wave or during eruption, subsequent to the corrosion by the magma. 

The Kernophyllite has been developed in the eastern and southern part of the Florida Peninsula. It is a fine-grained, foliated, biotite, and hornblende, and biotite is a pink foliated hornblende. The biotite flakes have a linear arrangement parallel to the foliation. Quartz phenocrysts are abundant and commonly have corroded outlines, although some single crystals which in part have well-rounded outlines are present. Fragments of quartz crystals are partly rounded and associated with other fragments not so affected. These conditions indicate fretting, probably by forceful waves in the rotating wave or during eruption, subsequent to the corrosion by the magma. 

The Kernophyllite has been developed in the eastern and southern part of the Florida Peninsula. It is a fine-grained, foliated, biotite, and hornblende, and biotite is a pink foliated hornblende. The biotite flakes have a linear arrangement parallel to the foliation. Quartz phenocrysts are abundant and commonly have corroded outlines, although some single crystals which in part have well-rounded outlines are present. Fragments of quartz crystals are partly rounded and associated with other fragments not so affected. These conditions indicate fretting, probably by forceful waves in the rotating wave or during eruption, subsequent to the corrosion by the magma.
normal rhyolite in one direction to that of quartz keratophyre in the other, but the differences can not be recognized in the field, and owing to their small size the crystals are difficult to determine with certainty under the microscope. There is a probable a gradation through all stages from rocks high in potash to those high in soda.

A characteristic of the rock is its spherulitic structure, which is perfectly developed in some places. A chalky appearance and texture is a further peculiarity at most places. Part of the large sheet in the Little Florida Mountains is vitreous and contains some fragmental material in its lower part, near the center of the mountain it is much silicified. A large part of it is pale brownish-pink in color.

 Petrography. — The fibrous rhyolite in Island Mountain and the White Hills is almost pure white, of uniform fibrous texture, and is almost entirely free from phenocrysts. This rock shows orthoclass and abundant quartz in microporphyritic intergrowth. Spherulites of feldspar and perhaps some quartz are recognizable but are not so prominent as in many of the other masses. Ferrugomonzonite minerals are represented only by scattered specks of iron oxide, mostly hematitic, and a very little biotite. Zircon is a moderately abundant accessory.

Other occurrences of the rhyolite differ in minor respects from the one above described, but although the color ranges from white to dark gray or pink, there is little diversity in texture. A little biotite and minute rods of bluish amphibole are recognizable in thin sections. In the massive rock at the base of the large sheet in the middle of the west side of the Little Florida Mountains the rhyolite is vitreous, reddish brown, and somewhat banded. It contains much secondary quartz, due to silicification. The orthoclase is radial, and there is some blue amphibole. Some of the rock at the north end of the mountain is similar but also includes fragmental matter.

Quartzite. — At the west base of the Little Florida Mountains there is a thin sheet of black obsidian lying between ash and agglomerate and overlying rhyolite for some distance. It is 8 to 20 feet thick and its outcrop is repeated by faulting, as shown in figures 8, 9, (p. 10).

Flower Moutains.

Crystal of olivine 1.5 millimeters long are the largest seen under the microscope. They are generally clear in the center but are changed around the borders and along the cracks by yellowish-white t小编texts. Laths of calcic hornblende, between which are packed small anhedral crystals of augite, olivine, and magnesite, make up the remainder of the rock. The gas cavities are partly filled.

The basalt of the other flows differs from that above described only in minor particulars. The flow at Fort Cummings is a part highly vesicular and the cavities are filled with mites, some being lined with thomsonite, others with heundalite, and others have a layer of thomsonite between an outer coating of heundalite and a central filling of heundalite in radial agglomerates.

The basalt of the dikes is coarser and of more uniform texture than that of the flow. At the base of the uppermost flow the agglomerates at the west end of Black Mountain is distinctive because it is but little weathered and because it exhibits the beginning of an alteration which has progressed so far as the other basalts as partly to obscure their original nature. The rock is almost black, thoroughly crystalline, and contains a small number of phenocrysts of banded-shaped feldspar and irregular crystals of olivine. The microscope shows crystals of feldspar 2 millimeters long and irregular crystals of olivine a millimeter across in a matrix of smaller feldspar laths, small olivine and augite anhedral, and magnesite grains. The olivine crystals are altered along the borders and along cracks to a peculiar aggregate of secondary minerals of a general light-brown color, including an almost colorless feldspar to hornblend micaceous with high double refraction, probably talc. This mineral apparently grows into a light-brown to medium dark green variety, similar in other respects to the colorless secondary. Secondary biotite is also common in the aggregates. The augite is almost unaltered. Much of the basaltic breccia now contains no fresh olivine, as it is wholly altered to the felted green and brown aggregate above described. In some specimen olivine is abundant.

The basalt of the dikes is evidently of nearly the same composition as that of the flows, but it differs from it in texture and in mode of alteration. The olivine in the flows has been altered to tindalite, that is in the dikes to the tele-biotite aggregate just described.

STRUCTURE.

General Features.

In the Denning quadrangle the rocks outcrop in isolated ridges and hills so widely separated by masses that the general structure can not be determined. None of the structural features indicate flexures or dislocations of more than local extent; hence the structure and massing distribution of the rocks is nearly at right angles to the edges of the basalt.

The relations in the Florida Mountains suggest the eastern limb of an anticline, but that the Snake Hills are the western limbs of another. The anticline is broken by a number of minor faults and by the contact with the limestones. The relations in the eastern part of the mountains suggest a trough or syncline, but there is no evidence to that effect, and in general it seems more likely that the depressions are chiefly due to erosion of the softer rocks of the younger formations, especially the soft shales and sandstones of late Cretaceous and early Tertiary time. On account of this lack of knowledge no attempt has been made in the present summary sheet to show the structure elsewhere than in the ridges.

The Florida Mountains consist mainly of granite and agpackite, the latter occurring as a low ridge along the north end of the range. Paleozoic limestones also occur in several areas, one large mass occupying the crest for a short distance.

In general the range has a monoclinal structure with an eastern dip. It may form the eastern limb of an anticline with the northwestern and southwestern faces of the mountain the east and the underlying granites outcrops along the lower part of the eastern slope. (See Pl. III.) This eastern dip also predominates in the strata at the eastern end of the range. At Coyote Park, as shown in section a, the strata are slightly arched and in the faulted blocks on the west are some shallow syndesmes. Near its north and the range is crossed by a profound fault trending nearly east, and the Paleozoic strata of The Park and the Gym Peak area are cut off on the south by another great fault. The salient structural features of the range are shown in the sections in figure 5.

Faults are numerous, the larger ones crossing the range from east to west. The largest, which passes along the southern side of The Park and a short distance south of Gym Peak, dips 40° to 70° S. and has a throw of 2,000 feet along part of its length, where the granite is thrust upon the upper beds of the Gym Limestone. The slope of this plane is well exposed in the large spur south of The Park, where it dips 40° S. This fault branches in The Park, but along the northern branch the fault is on the southwestern side, bringing up the granite and leaving a relatively depressed wedge-shaped block of Gym limestone and underlying strata between the branches. The block on the northeast is tilted outward at a moderately steep angle and half a mile west of Gym Peak is cut off by another fault, which has a vertical throw of 2,000 feet and extends south to the main fault. It also branches just northwest of Gym Peak, one branch extending northeast and the other moving nearly in line, the upheaval is on the east. Montana limestone about above Elba sandstone on the eastern branch 15 miles northeast of Gym Peak, and Gym limestone above granite on the western branch, cut of the same mine. Apparently this fault branches again farther north, a western branch bringing up part of Montana limestone in contact with granite and the other branch cutting off the El Paso limestone in the spur half a mile southwest of Byer Spring. The tilted block east of The Park is cut off on the north by a large fault that lifts the granite against the El Paso limestone on the main divide, as shown in section d, figure 5. The block is also crossed by several small steep faults of 40° to 200° east throw, trending nearly east and well exposed in the cliff east of The Park but lost in the area of Gym limestone farther east. In the ridge extending northwest from The Park a fault cutting northwesternmost drops the Gym limestone to the level of the El Paso limestone, and another brings the El Paso limestone and the granite together a short distance southeast of Byer Spring. A mile farther southwest the plane of this fault appears to have a low dip to the east, as the granite-limestone contact slopes down the south side of the hill nearly to the northern boundary of the range.
which is underlain and overlain by granite on planes dipping gently outward. (See Fig. 6.) The limestone near the contact is shattered and brecciated and includes fragments of the granite but is not at all metamorphosed, and the core red granite shows no textural change.

A short distance southeast two other masses of limestone are overthrusted on the granite; one of them has a sandstone member at the base. Possibly there is here a local overlap of the Linn Formation on the granite, a relation which considerably simplifies the interpretation of structure.

The fault near the north end of the range trends nearly east and has a vertical displacement of at least 2,600 feet, dropping the appurtenant on the north side so that it slants against rocks from the Linn formation to granite. (See section 6, Fig. 5.) Southwest of Arco del Diablo another prominent eastern fault also trends along the same line; cuts the Linn formation and agglomerate; its vertical throw is 400 feet. A similar but smaller fault crosses the range a mile north of Capitol Dome. Just southeast of Capitol Dome a northeast fault, which vertical throw of more than 1,500 feet, lifts the granite to the base of the Linn formation. The fault plane dips 45° NW and for part of its course is occupied by a dike of rhyolite porphyry 60 feet thick.

The movement occurred long before Lobo time; for south of the fault the Lobo formation lies on the eroded surface of the granite. The plane of erosion crosses the fault and extends across the edge of the Lobo formation and El Paso lithosome, and its surface is horizontal near the west and north. These relations indicate that during or after the faulting there was a great amount of erosion, which removed, in the uplift of the fault the granite, and limestone which overlie the granite just north, and doubtless more or less of the granite also, for the granite plane beneath the fault might be much lower in the granite mass than the granite plane beneath the limestone. Also at this time the faulting the area may have been oversteeped by more or less Lobo limestone. This later faulting results essentially a few miles south but is absent in the overthrust north of Capitol Dome, in which the Lobo formation lies on the eroded surface of the middle members of the Monongah limestone and still further north extends lower on the El Paso strata.

LITTLE FLORIDA MOUNTAINS.

The Little Florida Mountains consist of a thick sheet of felsitic or vitreous rhyolite included in the great agglomerate series. Apparently the horizon is somewhat above that of the agglomerate exposed in the Florida Mountain; as the latter range lies slightly west of the line of strikes of the rocks.

Seren Hill Ridge consists of a wide exposure of Serent sandstone dipping south of west and finally passing beneath bolson deposits at the south end of the ridge. The great fault passes along the foot of the eastern side of the range, and brings the agglomerate against the Serent sandstone, the Lobo formation, and the Lake Valley limestone in turn from south to north. At Frying Spring the Serent sandstone and the Lobo are seen south and very low dip to the west, sheets against agglomerate striking northwest and dipping northeast, in most places less than 30°. The vertical displacement is more than 2,600 feet, but the precise amount is not determinable. Half a mile southeast of Frying Spring a deep canyon in Serent Ridge cuts through the northern part of the underlying Lobo formation in a small area. A few rods southeast of that place a small mass of limestone appears along the fault, probably a wedge of higher unit of the Serent ridge block. It appears to be Linn formation, but no fossils were obtained on which to base precise correlation. The rocks are here broken and lie in conglomerates, of which the tops outcrop a few yards east of the road.

The southern extension of Cooks Range, east of Serent Ridge, consists of the great agglomerate series and includes igneous masses, the latter mostly in sheets. There is presented an alternation of strata and interbedded lava flows, mostly in regular succession from south to northwest, for the dip is generally to the east and north at a moderate angle. Several fault breaks the succession in places and the bed is cut off diagonally on the west side by the great fault extending along the east side of Serent Ridge. On the eastern side the agglomerate passes beneath the bolson deposits, and these then form an irregular border along its southern margin to the southwestern mountains. By these breaks the thick outcrop in the margin of the series. The lower members of the agglomerate series exposed present a thick succession of deposits of fragmentary material of various kinds. Interbedded brown quartzites constituting the two prominent knobs 3 miles north-northeast of Minge are exceptional features, for they do not contain igneous material. Higher in the series several strata of sedimentary origin, siltstone, shale, and conglomerate, interbedded with the agglomerate, are found east of the knob.

In the steep, high ridge northeast and east of Wilson Ranch the first great sheet of rhyolite appears, lying in the agglomerate, with which it dips 180° NNE. Above this sheet a thick succession of flows and local deposits of agglomerate, tuff, and ash and dip northeast at low angle. North of the Wilson Ranch, however, an outcrop or dome is indicated by westwardly and southwestwardly dips, mainly in an area limited on the east by a crescentic fault that cuts off the hills irregularly. The sedimentary and fragmental rocks thicken and thin from place to place and include thin flows of andesite, which thicken to the east and north, probably in the southern part of Wilson Ranch. A widespread sheet of quartz basalt lying in part to divese aneides is an important member of the series west of Frying Spring, and far out above it is a widespread sheet of light-colored rhyolite and dacite extensively in the high ridges south of Fort Cummings. There are two flows of the rhyolite separated by a deposit of volcanic ash. The first sheet is 100 feet thick. Two flows the rocks in the ridges south of Fort Cummings, repaying the succession of rocks from quartz basalt to rhyolite along two other outcrops. The individual relations of these flows are shown in section B-B on the structure section sheet.

Northwest of Fort Cummings the igneous rocks occur in sheet mass and seem to this outcrop and project beyond. To the north the beds generally dip eastward and northeast, at different angles, but on the curved outcrop 5 miles northeast of the fort they dip southwestward. On the west thin olive rhyolite is cut off diagonally by the great fault and on the east it disappears beneath bolson deposits.

South of Fort Cummings the rhyolite and underlying rocks lie in an oval dome, whose axis trends southwestward. The rhyolite is removed from the crest of the dome and the summit is revealed. It extends down to the basin to the northeast.

In the area about Puma Spring and for several miles to the north there is a low dome lying between the faults. One of its most notable effects is the outcrop of the sheet of rhyolite in the high ridge west of the spring; where the dip is to the southeast at a moderate angle. This sheet appears to be the same horizon as the rhyolite in the other areas, 2 miles northeast, and is similarly underlain by ash and quartz basalt. Northwestward along Puma Creek and the main trend the dome is nearly flat and the sheet of igneous rock pitch down to the north. At the fault half a mile northwest of Massacre Peak the rhyolite dips north and is covered by 3 feet of rhyolitic tuff forming the 4,000-foot peak, which dips 25° ENE.

FLORIDE RIDGE.

Floride Ridge consists of a thick central mass of rhyolite as intruded as to create an irregular, domed-up uplift elongated to the northwest. The beds on the southern and eastern
Whether it remained land or sea or alternated from one condition to the other, is a subject of having undergone any considerable general uplift or depression until early Carboniferous time, when there was an extended subsidence, which downwarp submerged a large part of the Rocky Mountain province.

Carboniferous Period.

Under the marine conditions of early Carboniferous time, extensive beds of limestone and other calcareous rocks were formed. Sandstone and other non-calcareous deposits were also laid down in various parts of the western United States, and were deposited in the important regions of the eastern United States. The entire Rocky Mountain province was under water at times, when coal measures were abundant. The sea, however, was not continuous, and there were long periods of time between the deposition of the various beds. The sea, in fact, extended and contracted through the whole period of the Carboniferous time.

Mississippian Era.

As the Triassic and Jurassic systems are not known to be present in the southern part of the Rocky Mountains, it is probable that the area was land for a long time during the early part of the Carboniferous period. However, the evidence of the development of the Lobo formation to the overlying underlying rock formations, that is, the formation is conformable to Triassic age, is not so clearly indicated by any evidence of the type of fossils found in these rocks. The evidence of the Lobo formation is less clear, and that a great amount of evidence is shown by the fossil remains at the mouth of the Lobo formation. The chief remains of the Lobo formation are the large shellfish of the genus Cerithium, which were most abundant in the southwestern part of the Rocky Mountain province.

Pennsylvanian Era.

During the Pennsylvanian period, the area was covered by a broad sea, and the sea occupied a large part of the present state of Wyoming. The sea extended southward into the western part of the state, and was continued in the northward direction along the eastern margin of the Rocky Mountain province. The sea extended into the northwestern part of the state, and was continued along the eastern margin of the Rocky Mountain province. The sea extended into the northwestern part of the state, and was continued along the eastern margin of the Rocky Mountain province. The sea extended into the northwestern part of the state, and was continued along the eastern margin of the Rocky Mountain province.

Ordovician and Silurian Periods.

Southwestern New Mexico was submerged by the sea during the early part of the Ordovician and Silurian periods, and thick deposits of calcium carbonate were laid down, forming limestone beds that are now prominent members of the strata. These Ordovician limestone rocks are found in the southwestern part of the state, and are known as the Lobo formation. In the southern part of the state, the Lobo formation is conformable to the Pennsylvanian period, and is continued into the northwestern part of the state. The Lobo formation is characterized by the presence of the genus Cerithium, which is abundant in the southwestern part of the state. The Lobo formation is conformable to the Pennsylvanian period, and is continued into the northwestern part of the state.

Ordovician and Silurian Periods.

Ordovician and Silurian Periods.

The Ordovician and Silurian periods are characterized by the presence of the genus Cerithium, which is abundant in the southwestern part of the state. The Lobo formation is conformable to the Pennsylvanian period, and is continued into the northwestern part of the state. The Lobo formation is characterized by the presence of the genus Cerithium, which is abundant in the southwestern part of the state. The Lobo formation is conformable to the Pennsylvanian period, and is continued into the northwestern part of the state. The Lobo formation is characterized by the presence of the genus Cerithium, which is abundant in the southwestern part of the state.
nearly 54 per cent of CaF₂, the average being 42 per cent. The principal impurities are 3.9 per cent of iron, 0.17 per cent of iron oxide and alumina from 0.81 to 1.12 per cent, and calcium carbonate from 0.48 to 1.12 per cent, the latter percentage being due to the 1.38 per cent of CaF₂. Compared with fluorspar from Colorado, Kentucky, Illinois, and other places the Fluorite Ridge mineral averaged much higher, notwithstanding the fact that it had not been washed. The total production during the two and a half years that the mines were in operation was about 9,000 tons.

Leak and Silver

Many mining claims have been located in the Fluorite Mountains, but only a few of them have developed valuable mineral deposits, principally silver-bearing lead ore in the limestone. Several small mines have been developed, which from time to time have produced sufficient ore for shipment, but in 1913 only one silver mine was in operation. It is known as the Silver Cave and is in the limestone high on the southeastern slope of Gyeo Peak. This mine is reported to have yielded ore to the value of $60,000 in 1905. The workings consist of a tunnel and several small stopes. The ore is silver-bearing galena, which occurs as a replacement of the limestone.

Iron

At the Maloney mine, just west of Gyro Peak, a number of pipes and a long split in the limestone follow a series of small irregular masses of oxidized zinc ore. It is reported that considerable blende was found at this place in 1914. Zinc ore has also been mined in small quantity from the limestone on the eastern slope of Capita Dome.

Copper

Some small leads of copper ore have been worked in the granite along the western slope of Porcupine Peak. Small shipments have been made from two localities. The ore is chalcopyrite and other copper sulphides, which separate from the granite in lovely long, flat bands and in zones of shattered rock. The bodies, so far as known, are small and irregular. One mine, abandoned long ago, is a short distance south of Capita Dome. There is a vein in a republic mining district on the north side of the Flume Peak and two others on the west side near the Palomas mine. At no distant time it also flowed through the wide boles of the West Florida Mountains and found an outlet through the low passage between that range and the Tres Hermanos Mountains.

In April, 1908, a gaging station was established on Miners River just before the junction with the Palomas River. It was at 7.7 T 28 W., R. 10 W., about 6 miles northwest of Frying Spring and about 10 miles northeast of Frying Dowland on the Silver City branch of the Mexican National.

Gage-height records and discharge measurements have been obtained since 1908. The channel at the station shifts frequently, and some care is necessary to obtain reliable results. Sufficient measurements have not been obtained to permit more than approximate estimates of flow for periods between measurements and at high stages. The following table, showing the monthly runoff in acre-feet, has been compiled from United States Geological Survey Water Supply Papers 355, 358, and 383:

**Monthly runoff in acre-feet of Miners River near Frying Downd, N. Mex.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1913</td>
<td>1,160</td>
<td>1,140</td>
<td>870</td>
<td>780</td>
<td>1,120</td>
<td>1,770</td>
<td>2,520</td>
<td>2,700</td>
<td>1,980</td>
<td>1,460</td>
<td>950</td>
<td>550</td>
</tr>
<tr>
<td>1914</td>
<td>1,270</td>
<td>1,370</td>
<td>1,330</td>
<td>1,500</td>
<td>1,480</td>
<td>1,430</td>
<td>1,480</td>
<td>1,570</td>
<td>2,050</td>
<td>1,060</td>
<td>850</td>
<td>800</td>
</tr>
</tbody>
</table>

**Note**: Data obtained in theU.S. stream flow and the discharge measurements are estimated from 30 sexes. Data obtained by the U.S. Bureau of Reclamation, and from U.S. Army, Corps of Engineers.

The maximum daily flow from 1908 to 1914 was in August, 1911, and on two days the flow was estimated at 950 to 1000 second-feet, respectively. Probably this record was exceeded in the great flow of July 18 to 21, 1976, but unfortunately the flow was not well determined, owing to a mishap to the gage. There was also a notable flood from Dec. 22 to 25, 1914, with flows of 1,420, 1,270, 970, and 580 second-feet. It must be remembered that these values for floods are only roughly approximate and are subject to considerable error. The mean flows for 1908, 1910, and 1913 are 6.4, 4.5, and 6.0 second-feet respectively. Other notable flows were 1,100 second-feet for 14 days in October, 1908; 35 second-feet, July 13, 1909; 108 second-feet, August 14 and 15, 1909; 196 second-feet, August 22, 1910; and 6 second-feet, August 8, 1913.

**Sand and gravel**

Sand and gravel for building occur at many places in the bowls and the valleys leading into them. A small amount is dug in the vicinity of Deming for use in building, but the demand is very small.

**Surface Water**

**Stream**—The streams in the Deming quadrangle flow only during times of flashfloods and then may flow for a very short duration. Frequently after rainy periods, the Miners River flows as far as Spalding. Its main branch, the San Vicente Arroyo, also is subject to frequent local floods, in which the water drops as far as the mouth of the arroyo. Streams flowing out of Cooks Range are occasionally filled with water by a succession of heavy storms and especially during floods, and the flood is shortlived and nearly reaches the Miners. The same is true of Palomas Arroyo, which has a large watershed in the mountains. Ordinarily, however, the flood waters even of a cloudburst sink into the porous soil. Often in the spring or early summer Miners River has a flood of such volume that the water is 30 to 100 feet deep and overflows the lower and adjoining channel. This condition may last a few days, and it may recur two or three times in a season. Some years its maximum flow does not extend far beyond Deming, but occasionally it extends into the valley east of the Florida Mountains as far as T. 23 S., R. 7 W., where it widens out into a shallow lake. From December, 1940, to May, 1946, and from January, 1943, to February, 1944, in both cases, the flow was from south to north and the water level was at or below the ground surface.

**Ground Water**

Water for the area of Deming south and west of the Florida Mountains is obtained from the Pecos River and its tributaries. The Pecos River drains through the Pecos Valley and empties into the Rio Grande, which flows through the valley between the San Luis Valley and the Pinos Altos Mountains. The Pecos River is a perennial stream with a small amount of water flowing through during the period of spring snowmelt. The Pecos River is a tributary of the Rio Grande, which flows through the alluvial plain to the Gulf of Mexico. The Pecos River is a perennial stream with a small amount of water flowing through during the period of spring snowmelt. The Pecos River is a tributary of the Rio Grande, which flows through the alluvial plain to the Gulf of Mexico.

**Underground Water**

A preliminary report on the underground water of Luna County and also a more detailed description of the wells have already been published.

**General Conditions**

The sediments underlying the wide boles include sheets of sand and gravel containing a large amount of water. The water-bearing beds lie at depths of 25 to 75 feet. The height to which the water rises differs considerably in different wells. The volume of water differs from place to place, but its aggregate amount is great, and there are extensive districts in which it is available in large volumes. The water in some of the districts is of moderate depth. Numerous wells have been sunk, and the underground conditions have been determined in many parts of the area, but in some districts the water resources have not been investigated. Much of the water so far developed is being pumped at low cost for the profitable irrigation of many acres. There is a possibility that the water is a wide extension of the underground water of Miners River, but, although the stream originally had much to do with the deposition of the water-bearing materials, the streams have not been studied. One of the most important areas of underground water is about Deming and in the wide boles extending south from that place on the west side of the Florida Mountains. In this area a large volume of water near the surface is utilized for irrigation.

**Snow**

By far the largest volume of water in the Deming quadrangle underlies the broad boles extending from Deming southward on the west side of the Florida Mountains. Most of the wells in T. 24 S., R. 9 W., T. 25 S., R. 9 W.; and T. 26 S., R. 9 W. and 10 W.; and in the valley of Palomas Arroyo find a large supply of water at depths of 50 to 200 feet, which rises within 20 to 30 feet of the surface. The limits of the district in which these favorable conditions exist is of great practical importance, for the land outside of the area underlain by an adequate water supply is of no value for agriculture. Unfortunately, the underground conditions in the boles are difficult to trace without records of many wells, and even the most careful study of the limits of water-bearing strata cannot be known with precision. The Florida Mountains and other ridges determine these limits in places, but the form of their slopes below the bole deposits is not known. Doubtless also there are many small underground ridges of rock which approach so near the surface as to cut off the circulation of the underground. Such underground ridges occur about Jails. Probably a large part of the area shown on the underground water map as an "water conditions not determined" is barren of servicable underground supplies, and in most parts of the areas in which the surface water lies more than 50 feet below the surface the strata do not contain water in large volume. In the broad valley or sink of the Miners branch of the Florida Mountains appears to contain satisfactory water supplies at moderate depths, for some basins have either been filled with water or have water or water that is saline. The conditions also appear to be unfavorable in the southwestern corner of the quadrangle and on the slopes adjacent to Cooks Range. The 1910 average flow of the water from 100 to 300 feet below the surface in the valley and lower slopes north and east of Florida, but its volume has not been tested.

**SOURCES**

A large amount of the water contained in sand and gravel under the boles is derived from snowmelt and rainfall. The amount of the water contained in sand and gravel under the boles is derived from snowmelt and rainfall. The amount of the water contained in sand and gravel under the boles is derived from snowmelt and rainfall. The amount of the water contained in sand and gravel under the boles is derived from snowmelt and rainfall.
It gathers from the mountains has been passing underground for a long time and adding to the bulk of water in the lower groundbed underlying the wide bolone about and south of Deming. It is very difficult to estimate the amount of water passing underground in a year on the bolone as a whole, for a large amount of rain water is lost by evaporation, particularly in the deeper portions of the bolone where extensive accumulation of refuse is common. Run-off of water is prevented by passing underground by thick deposits of relatively impervious clay. Capillary action, which is especially strong in miles and embayments in solid regions, greatly depletes the water stored by the soil from rainfall, for by this agency it is returned to the surface, where it is lost by evaporation. The extent of this action is well illustrated in the region by the accumulation of caliche, which is calcium carbonate brought up by capillary movement of the underground water and deposited in the soil. For these reasons it is impossible to estimate the proportion of the rainfall that passes underground.

The principal sources of supply of underground water are the underflows of Miners River and Sun Yavote Arroyo, which bring water from the mountains north and west. Miners River above Spalding receives the run-off from a catchment area of about 600 square miles of mountains and hills with an annual rainfall of 12 to 20 inches. That there is great loss by evaporation and other causes is proved by the surface flow gaged since 1896, at the dam site 30 miles above Spalding, which shows only about 4,000 to 20,000 acre-feet a year, the average being more than 10,000 acre-feet. The additional underflow at that place may be estimated at not more than 2,000 acre-feet a year. As this water is not now held by a dam, much of it passes down into the flood, and where these overflows on the lowland adjoining the channel a fairly large proportion is lost by evaporation. When it is held by the dam it will not be for so long a period, as one of the inlets of this large irrigation, which will greatly increase the loss by evaporation and correspondingly diminish the volume of underflow.

On the assumption that all of the estimated 12,000 acre-feet passes underfoot and extends under the fourteen townships contiguous to the line of its southwest flow to Palomino Tank along a course estimated for the Florida Mountains, the increase to the underground water in the area would be less than half an inch a year.

VOLUME.

The deposits that underlie the bolone differ greatly in their capacity to hold water, not only from bed to bed but in the same bed from place to place. There are many strata of sand, most of them from 5 to 15 feet thick, separated by clay or other fine-grained materials. A few wells are reported to have penetrated more than 50 feet of sand in the aggregate, but generally the thickness is less than this, and some of the sand is fine-grained and mixed with more or less clay. A Yates reported in a few representative wells, as shown in the following table, illustrate the variations in thickness and position of the water-bearing beds:

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth</th>
<th>Distance from Stream</th>
<th>Number of Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It has been shown in preceding statements that the water-bearing beds differ greatly in thickness, texture, and continuity from place to place, that it is therefore difficult to determine accurately the amount of water that can be obtained. The approximate estimate can be seen in the annual increment of water. Apparently in most parts of the Deming region 40 feet is near the average depth. Therefore, for the purpose of water-bearing beds in the first 150 or 200 feet below the surface. If these 40 feet of sand contain 20 percent of their volume of water, which is a fair average, the amount of water in a given area would be near 8 cubic feet per square foot, equivalent to 60 gallons, or approximately 2,651,000 gallons in the acre, or 8 acre-feet. This is much more than the amount obtainable, because it is impossible to pump out all the water, the proportion available depending on the texture of the sand and some minor other factors.

The area under which there are 40 feet of water-bearing beds containing a fair volume of water is about 300 square miles and, with this volume of water, the underground water supply is 2,580,000 acre-feet. There is besides this area of 500 square miles a region of local extent containing a moderate volume of water, none of which can be utilized for irrigation.

It is impossible to make an accurate estimate of the time required for the underground water to supply 80 per cent of this volume of water, or other words, to replenish the supplies if it were pumped out. The Miners underflow of 12,000 acre-feet estimated as passing into the 14 townships in the line of its travel southward would amount to an annual increment of less than half an inch in this area. Therefore more years would be required to fill the voids in the underfoot water-bearing beds under the area.

DEPOTMENT OF WATER SUPPLY.

In 1913 about 200 pumps had been or were being installed in the Deming-Columbus region. Their average capacity may be estimated at 700 gallons a minute for about 400 hours a year. If the number of pumps be placed at 600, which, however, is probably in excess of the financial means of settlers now on the ground, the total yearly pumping of water for irrigation will be 7,000,000,000 gallons, or 25,788 acre-feet, and would be deep on 20 square miles, and, with duty of water at 2 cents per acre foot, a season, 20 square miles on 500 acres is equivalent to an average of only about 0.9 per cent of the annual increment from rainfall and the underflow of the Miners.

As the 500 homes would ordinarily occupy 125 square miles the 25,788 acre-feet would be drawn from that area, where water is abundant. The estimated cost per acre foot of water or less than 4 per cent of the 8 acre-foot supply as estimated above. It would probably be done somewhat near the annual increment from rainfall and the underflow of the Miners.

Of course, 20 square miles under cultivation is a small proportion of the 125 square miles or 500 homesteads under consideration, and all drawing from one pump will pump 700 gallons a minute. Eventually the provision of the land utilized will increase— it must do for profitable operation—and the yield of water available from the relatively thin, deeply buried stratum, which rigorous pumping soon drains largely near the pump. A most important feature in the adjustment of capital for the development of the area at first is the economic or financial burden of the region under the thicker deposits of water-bearing materials, provided 2 acre-feet are used for the season's rating.

In the irrigation condition of the water that can be pumped from a given area is the ratio of lateral flow of the underground water. Index starts when the pump begins to work and results in loss of water as a result of a constant widening area, more or less complexly replacing the local depletion. In places where severe heavy pumping plants are used on draining all water in the same time, there will be limited to the amount of water immediately available, and desalination of water would result at most locations. The principle that emerges from a relatively thin, deeply buried stratum, which rigorous pumping soon drains largely near the pump. A most important feature in the adjustment of capital for the development of the area at first is the economic or financial burden of the region under the thicker deposits of water-bearing materials, provided 2 acre-feet are used for the season's rating.

At Spalding the underground water is 30 feet below the surface, and the altitude is 4,685 feet above sea level; at Deming the water is 50 feet below the altitude is 4,200 feet; and at the southern margin of the quadrangle the water is 21 feet below the surface, and the altitude is about 4,110 feet. The distance from Distinguishing the Gravel Road to the Gravel Road being 19 miles, the feasibility of that distance is at the rate of nearly 92 feet to the mile. At Isla the water surface is 46 feet below the surface, or 464 feet below sea level, a grade of slightly more than 72 feet to the mile from Deming. At Florida Lake the water rises very nearly to the surface. There are some peculiar features of the lines of water level due to special local causes, notably in the area of increased depth just south of Isla and in the apparent close relation to topography near the Florida Mountains. The general rule of the water surface toward the mountains is due to a small underflow moving down the slope of the alluvial fan. The extension of the 4,100-foot line far to the north up the main Miners Valley east of the Florida Mountains indicates that the water lies somewhat lower in the bolone on that side than on the west side of these mountains. However, the soil on the east side are too fine to hold a large volume of water, the position of the water is not of economic importance.

Rate of flow—The rate of movement of underground water in the region has not been tested at any point, and it can only be inferred in a general way from measurements in other regions. It decreases somewhat with the depth, for with increased depth in a region of low gradient there is proportionately diminished grades. The water-bearing materials elevated at different wells indicated a variety of porosity varies greatly. The rate of movement has been found to be as much as 100 feet a day in coarse materials containing as high as 35 per cent of water, but the rule is much less. Slichter and Wolf describe the underfoot of

Plate River at Ogallala, Nebr., had an average rate of 6.6 feet in 24 hours, or a mile in 342 days. At a depth of 36 to 22 feet the velocity averaged 12.3 feet a day, and at 55 and 85 feet it was 2.55 feet. The depth of the valley is about 4.6 feet to the mile. Slicher found that the underflow of Arkansas River at Garden, Kans., averaged 8 feet a day or a mile in 660 days, the depth being 7 feet to the mile. Much of the water is from the side slopes, part of which are loose sand inhibiting 10 per cent of the rainfall. In the Smilth Valley, N. Mex., the underflow of the Rio Grande, the depth being 6.6 feet to the mile, was found to have very slow movement, and at the canyon of the Rio Grande, just above El Paso, the movement of the underflow 10 to 20 feet below the bed of the river was less than 3 feet a day.1

DEEP BORINGS AND WELLS

At several places in Lema County deep borings have been made in the hope of finding artesian water, but they have not been successful. The results, however, have thrown interesting light on the deeper underground conditions.

The most important test of the deeper underground water in Lema County was made 6 miles southeast of Deming in 1907. The town of Deming contributed $4,000 to the expenses of the test. The bore hole is 2,000 feet south by east of the center of sec. 30, T. 24 S., R. 8 W. The total depth is 1,905 feet, with a 12-inch casing down 1,200 feet. Water was 259 feet rose within 17 feet of the surface, and when the boring was finished a 25-horsepower pump raising 800 gallons a minute did not lower the water materially. Very little water was found below 520 feet, and there were many thin beds of reddish clay all the way down.

The Burdick well, in the NE 1/4 SW 1/4 sec. 29, T. 23 S., R. 8 W., was sunk to a depth of 710 feet to test for artesian water. A flow was found, but it lasted only for a short time, and now the water level is 24 feet below the surface. No record of the boring was obtained, but it is stated that there were many strata of sand—some with considerable water, others containing very little. In 1907 Mr. Burdick had a well sunk to a depth of 980 feet in the western part of Deming, but the result was unsatisfactory, for, although the water rose much higher than in shallow wells of the region it failed to reach the surface. The well is not located on the underground water map. The boring began with 8-inch pipe and ended with 6-inch. According to a report of the driller, F. E. Herlow, “bedrock” was entered at 900 feet and penetrated for 17 feet. Water was found at 60 feet and then at intervals of 20 to 40 feet for a considerable depth. At 773 feet it rose within 30 feet of the surface, at 835 within 21 feet, at 866 within 19 feet, and at 912 feet within 8 feet of the surface, where it stood for a year and then dropped back to 101 feet. The materials penetrated were clay, sand, “cement,” and gravel in beds 5 to 10 feet thick.

A deep borng in the S 1/4 sec. 9, 13 miles northeast of Hudnall, found water at 292 feet and no further supply except a very slight rise at 500 feet. Several years ago a deep well was sunk at Lemuck, on the Southern Pacific Railroad, about 90 miles east of Deming to a depth of 900 feet.2 The water rose within 684 feet of the surface and pumps 35 gallons a minute. There are about 250 wells in the Deming quadrangle, most of them less than 100 deep and yielding satisfactory supplies of water. Many have been sunk within the last five years and considerable well drilling is still in progress. Wells are most numerous south and east of Deming, especially in Tps. 24 and 25 S., R. 9 W., T. 24 S., R. 8 W., and the south half of T. 23 S., R. 8 and 9 W. There are also groups of wells about Hudnall and Lona. Their distribution, depth, and the depth to water surface in them are shown on the underground-water map. Some facts regarding the sand strata in the wells are given on page 14. Lists of wells are given in the report on the geology and underground water of Lema County previously cited.

QUALITY

Most of the underground water in the Deming region is of excellent quality, containing only a small amount of mineral matter. As most of the wells are deep and penetrate impervious basalt and clay the water is safe from contamination unless the well is so badly constructed as to permit ingress of surface drainage. Most of the water pumped for domestic use and irrigation in the many wells in the country around and south of Deming is very pure and is suitable for irrigation.


The following analysis of water from the 55-foot well of the Southern Pacific Co. at Deming was furnished by the chief engineer of that system. The sample, collected April 4, 1897, was analyzed by the company.

Analysis of water from the 55-foot well of the Southern Pacific Co. at Deming, N. Mex. (Parts per million.)

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica (SiO₂)</td>
<td>2.4</td>
</tr>
<tr>
<td>Oxides of iron and aluminum (Al₂O₃ + Fe₂O₃)</td>
<td>1.3</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>34</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>9</td>
</tr>
<tr>
<td>Sodium and potassium (Na + K)</td>
<td>9</td>
</tr>
<tr>
<td>Carbonate radicles (CO₃)</td>
<td>2.1</td>
</tr>
<tr>
<td>Nitrate radicles (NO₃)</td>
<td>0.3</td>
</tr>
<tr>
<td>Chloride radicles (Cl⁻)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

This water is entirely acceptable for domestic use and for irrigation and is fair for use in boilers, being noncorrosive, low in forming constituents, and capable of causing the formation of only a moderate amount of scale.

An analysis of the water from the first stratum of the well of W. F. Breschfield was made by the Danielson Chemical Co. with the following results:

Analysis of water from well of W. F. Breschfield in sec. 9, T. 23 S., R. 8 W., 10 miles southwest of Deming, N. Mex. (Parts per million.)

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica (SiO₂)</td>
<td>34</td>
</tr>
<tr>
<td>Oxides of iron and aluminum (Al₂O₃ + Fe₂O₃)</td>
<td>5</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>50</td>
</tr>
<tr>
<td>Sodium (Na⁺)</td>
<td>650</td>
</tr>
<tr>
<td>Potassium (K⁺)</td>
<td>800</td>
</tr>
<tr>
<td>Carbonate radicles (CO₃)</td>
<td>300</td>
</tr>
<tr>
<td>Sulphate radicles (SO₄)</td>
<td>1,176</td>
</tr>
<tr>
<td>Chloride radicles (Cl⁻)</td>
<td>445</td>
</tr>
<tr>
<td>Nitrate radicles (NO₃)</td>
<td>78</td>
</tr>
<tr>
<td>Sulfide and volatile matter</td>
<td>86</td>
</tr>
<tr>
<td>Total solids</td>
<td>5,960</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>96</td>
</tr>
</tbody>
</table>

The water recently obtained at somewhat greater depth is considerably less saline, but no analysis of it is available. This well is in the great valley east of the Florida Mountains, where the beds contain a large amount of soluble mineral matter. On the west side of the mountains the well waters are nearly all of exceptional purity.

Footnotes:
1 Less than 10 grains per U. S. gallon.  
2 Carbonate and bicarbonate radicles not differentiated.
The sedimentary formations deposited during a period are grouped together into a system. The principal divisions of a system are called series. Any aggregate of formations less than a series is called a group.

Inasmuch as sedimentary deposits accumulate successively the youngest rest on those that are older, and their relative ages may be determined by observing their positions. In many regions of intense disturbance, however, the beds have been overthrust or superposed by faulting, so that it may be difficult to determine their relative ages from their present positions; under such conditions, fossils, if present, may indicate the date of one or more formations in the oldest.

Many stratified rocks contain fossils, the remains or imprints of plants and animals which, at the time the strata were deposited, lived in bodies of water or were washed into them, or were buried in detrital deposits on the land. Such rocks are called fossiliferous. By studying fossils it has been found that the sedimentary series of the earth's history was a vast extent different from that of other periods. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms which did not exist in earlier times and have not existed since; these are characteristic types, and they define the age of any bed of rock which they are found. Other types pass on from period to period and thus link the systems together, forming a chain of life from the time of the oldest fossiliferous rocks to the present. Where two sedimentary formations are remote from such cards and it is impossible to observe their relative positions, the character of fossil types found in them may determine which was deposited first. Fossil remains in the strata of different areas, provinces, and continents afford the most important means of combining local formations into a general earth history.

It is in the physical and/or biological record of an age of igneous formation, but the relative age of such a formation in general is best determined by observing whether an associated sedimentary formation is known to have frozen or is deposed upon it. Similarly, the time at which metamorphic rocks were formed from original masses may be shown by their relations to adjacent formations of known age; but the age recorded on the map is that of the original masses and not that of their metamorphism.

Symbols, colors, and patterns.—Each formation is shown on the map by a distinctive combination of color and pattern and is labeled by a special letter symbol. Patterns composed of parallel straight lines are used to represent sedimentary formations deposited in the sea, as limestones, or in other bodies of standing water. Patterns of dots and curves represent alluvial, glacial, and eolian formations. Patterns of triangles and chevrons are used for igneous formations. Metamorphic rocks of unknown origin are represented by short dashes irregularly placed; if the rock is a shist the dashes may be arranged in five lines parallel to the structure planes. Suitable combinations of such patterns are commonly used to indicate sedimentary formations known to be of sedimentary or igneous origin. The patterns of each class are placed in various colors. With the patterns of parallel lines, colors are used to indicate age, a particular color being assigned to each system. The symbols consist of two or more letters. If the age of a formation is unknown it includes these three elements: the symbol, which is a capital letter or monogram; otherwise the symbol is composed of small letters. The names of the systems of series which have been given distinctive names, in order from youngest to oldest, with the color and symbol assigned to each system, are given in the table below.

<table>
<thead>
<tr>
<th>System</th>
<th>Color</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cretaceous</td>
<td>Green, yellow</td>
<td>C</td>
</tr>
<tr>
<td>Triassic</td>
<td>Red</td>
<td>T</td>
</tr>
<tr>
<td>Pennsylvanian</td>
<td>Blue</td>
<td>P</td>
</tr>
<tr>
<td>Ordovician</td>
<td>Gray</td>
<td>O</td>
</tr>
<tr>
<td>Silurian</td>
<td>Black</td>
<td>S</td>
</tr>
<tr>
<td>Cambrian</td>
<td>Brown</td>
<td>C</td>
</tr>
</tbody>
</table>

At the right of figure 2 the section shows schists that are not covered by igneous rocks. The rocks are not much contorted and their arrangement underlain cannot be inferred. Hence that portion of the section delineates what is probably true, but not known by observation or by well-founded inference.

The section also shows three sets of formations, distinguished by different shading and color. The set on the left, the red set, is the most prominent and its arrangement underlain cannot be inferred. The beds, like those of the first set, are contorted. The horizontal strata of the plateau rest upon the upper, eroded edges of the beds of the second set shown at the left of the section. The overlying deposits are, from their position, evidently younger than the underlying deposits, and the bending and erosion of the older beds must have occurred between their deposition and the accumulation of the younger beds. The younger rocks are unconfounded to the older, and the surface of erosion of the older is the same of the younger rocks. The third set of formations consists of crystalline schists and igneous rocks. At some period of their history the schists were folded or folded and were covered, by erosion of molten rock. But pressure and intrusion of igneous rocks have not affected the overlying strata of the second set. Thus it is evident that a considerable interval elapsed between the formation of the schists and the beginning of deposition of the second set, During this interval the schists were metamorphosed, they were disturbed by erucive activity, and they were deeply eroded. The contact between the second and third set is another unconformity; its surface is an irregular interval between two periods of rock formation.

The section and landscape in figure 2 are ideal, but they illustrate actual relations. The sections on the structure section sheet are related to the maps on the section in the figure is related to the landscape. The profile of the surface in the section corresponds to the actual slope of the ground along the section line, and the depth from the surface of any mineral-producing or water-bearing stratum that appears in the section may be measured by using the scale of the map.

As the geologic maps are usually accompanied by a columnar section, which contains a concise description of the sedimentary formations that occur in the area, it presents a summary of the facts relating to the character of the rocks, the thicknesses of the formations, and the order of accumulation of sedimentary deposits.

The rocks are briefly described, and their characters are indicated in the columnar diagram. The thicknesses of formations are given in figures at the head and foot of each unit or maze, and the average thickness of each formation is shown in the column, which is drawn to scale. The order of occurrence of the formations is shown in the columnar arrangement—the oldest being at the bottom, the youngest at the top.

At intervals of time that correspond to events of uplift and degradation and constitute interruptions of deposition are indicated graphically and by the word “unconformity.”

GEORGE OTIS SMITH, 1905. Director.
<table>
<thead>
<tr>
<th>No.</th>
<th>Name of folio</th>
<th>State</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Livingston</td>
<td>Montana</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Riggs</td>
<td>Montana</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>GCP</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Onslow</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>San Diego</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Las Vegas</td>
<td>Nevada</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Death Valley</td>
<td>Nevada</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Authorite-Crested Butte</td>
<td>Arizona</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Varsity Pier</td>
<td>Idaho</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Jackson</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Huntington</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Lawrence</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Bloomington</td>
<td>Indiana</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Cuyahoga</td>
<td>Ohio</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>Columbus</td>
<td>Ohio</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>Newark</td>
<td>New Jersey</td>
<td>-</td>
</tr>
<tr>
<td>17</td>
<td>Jersey City</td>
<td>New Jersey</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>Camden</td>
<td>New Jersey</td>
<td>-</td>
</tr>
<tr>
<td>19</td>
<td>Williams</td>
<td>Mississippi</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>Pine Bluff</td>
<td>Arkansas</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>Hot Springs</td>
<td>Arkansas</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>Little Rock</td>
<td>Arkansas</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td>Hot Springs</td>
<td>Arkansas</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>Really</td>
<td>Arkansas</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>Helena</td>
<td>Montana</td>
<td>-</td>
</tr>
<tr>
<td>26</td>
<td>Great Falls</td>
<td>Montana</td>
<td>-</td>
</tr>
<tr>
<td>27</td>
<td>Bismarck</td>
<td>North Dakota</td>
<td>-</td>
</tr>
<tr>
<td>28</td>
<td>Great Falls</td>
<td>North Dakota</td>
<td>-</td>
</tr>
<tr>
<td>29</td>
<td>Deadwood</td>
<td>South Dakota</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>Rapid City</td>
<td>South Dakota</td>
<td>-</td>
</tr>
<tr>
<td>31</td>
<td>105</td>
<td>Dakota</td>
<td>-</td>
</tr>
<tr>
<td>32</td>
<td>Deadwood</td>
<td>South Dakota</td>
<td>-</td>
</tr>
<tr>
<td>33</td>
<td>106</td>
<td>North Dakota</td>
<td>-</td>
</tr>
<tr>
<td>34</td>
<td>107</td>
<td>Montana</td>
<td>-</td>
</tr>
<tr>
<td>35</td>
<td>108</td>
<td>Idaho</td>
<td>-</td>
</tr>
<tr>
<td>36</td>
<td>109</td>
<td>Washington</td>
<td>-</td>
</tr>
<tr>
<td>37</td>
<td>110</td>
<td>Wyoming</td>
<td>-</td>
</tr>
<tr>
<td>38</td>
<td>111</td>
<td>Oregon</td>
<td>-</td>
</tr>
<tr>
<td>39</td>
<td>112</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>113</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>41</td>
<td>114</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>42</td>
<td>115</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>43</td>
<td>116</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>44</td>
<td>117</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>45</td>
<td>118</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>46</td>
<td>119</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>47</td>
<td>120</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>48</td>
<td>121</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>49</td>
<td>122</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>123</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>51</td>
<td>124</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>52</td>
<td>125</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>53</td>
<td>126</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>54</td>
<td>127</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>55</td>
<td>128</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>56</td>
<td>129</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>57</td>
<td>130</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>58</td>
<td>131</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>59</td>
<td>132</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>60</td>
<td>133</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>61</td>
<td>134</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>62</td>
<td>135</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>63</td>
<td>136</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>64</td>
<td>137</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>65</td>
<td>138</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>66</td>
<td>139</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>67</td>
<td>140</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>68</td>
<td>141</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>69</td>
<td>142</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>70</td>
<td>143</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>71</td>
<td>144</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>72</td>
<td>145</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>73</td>
<td>146</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>74</td>
<td>147</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>75</td>
<td>148</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>76</td>
<td>149</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>77</td>
<td>150</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>78</td>
<td>151</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>79</td>
<td>152</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>80</td>
<td>153</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>81</td>
<td>154</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>82</td>
<td>155</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>83</td>
<td>156</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>84</td>
<td>157</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>85</td>
<td>158</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>86</td>
<td>159</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>87</td>
<td>160</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>88</td>
<td>161</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>89</td>
<td>162</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>90</td>
<td>163</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>91</td>
<td>164</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>92</td>
<td>165</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>93</td>
<td>166</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>94</td>
<td>167</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>95</td>
<td>168</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>96</td>
<td>169</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>97</td>
<td>170</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>98</td>
<td>171</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>99</td>
<td>172</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>173</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>101</td>
<td>174</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>102</td>
<td>175</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>103</td>
<td>176</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>104</td>
<td>177</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>105</td>
<td>178</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>106</td>
<td>179</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>107</td>
<td>180</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>108</td>
<td>181</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>109</td>
<td>182</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>110</td>
<td>183</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>111</td>
<td>184</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>112</td>
<td>185</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>113</td>
<td>186</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>114</td>
<td>187</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>115</td>
<td>188</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>116</td>
<td>189</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>117</td>
<td>190</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>118</td>
<td>191</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>119</td>
<td>192</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>120</td>
<td>193</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>121</td>
<td>194</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>122</td>
<td>195</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>123</td>
<td>196</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>124</td>
<td>197</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>125</td>
<td>198</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>126</td>
<td>199</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>127</td>
<td>200</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>128</td>
<td>201</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>129</td>
<td>202</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>130</td>
<td>203</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>131</td>
<td>204</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>132</td>
<td>205</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>133</td>
<td>206</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>134</td>
<td>207</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>135</td>
<td>208</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>136</td>
<td>209</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>137</td>
<td>210</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>138</td>
<td>211</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>139</td>
<td>212</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>140</td>
<td>213</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>141</td>
<td>214</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>142</td>
<td>215</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>143</td>
<td>216</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>144</td>
<td>217</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>145</td>
<td>218</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>146</td>
<td>219</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>147</td>
<td>220</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>148</td>
<td>221</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>149</td>
<td>222</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>150</td>
<td>223</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>151</td>
<td>224</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>152</td>
<td>225</td>
<td>California</td>
<td>-</td>
</tr>
<tr>
<td>153</td>
<td>226</td>
<td>California</td>
<td>-</td>
</tr>
</tbody>
</table>

* Denotes folio is to be made by money order or in cash.

These lists are subject to change. The prices shown are for the latest available information. For the most current information, please visit the U.S. Geological Survey website.