GEOLOGIC ATLAS
OF THE
UNITED STATES
STAUNTON FOLIO
VIRGINIA - WEST VIRGINIA

INDEX MAP

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WASHINGTON, D. C.
ENGRAVED AND PRINTED BY THE U. S. GEOLOGICAL SURVEY
WILLIS, EDITOR OF GEOLOGIC MAPS
KUBEL, CHIEF ENGRAVER
1894
The Geological Survey is making a large topographic map of the United States, which are being issued together in the form of a Geologic Atlas. The parts of the atlas are called folios. Each folio contains a topographic map and a geologic map of a small section of country, and is accompanied by explanatory and descriptive texts. The complete atlas will comprise several thousand folios.

**The Topographic Map.**

The features represented on the topographic map are of three distinct kinds: (1) irregularities of surface, called relief, as plains, prairies, valleys, hills and mountains; (2) distribution of water, called drainage, as streams, ponds, lakes, swamps and oases; (3) the works of man, called culture, as roads, railroads, boundaries, villages and cities. Reliefs.—All elevations are measured from mean sea level. The heights of many points are accurately determined and those which are most important are stated on the map by numbers printed in brown. It is desirable to show also the elevation of any part of a hill, ridge, slope, valley, or slope to delineate the horizontal outline or contour of all slopes; and to indicate their degree of steepness. This is done by lines called contour lines, which represent mean sea level, which are drawn at regular vertical intervals. The lines are called contours and the constant interval of elevation between adjacent lines is called the contour interval. Contours are printed in brown.

The manner in which contours express the three conditions of relief (elevation, horizontal form and degree of slope) is shown in the following sketch and corresponding contour map:

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**The Geological Map.**

A geologic map represents the distribution of rocks, and is based on a topographic map—that is, on the map a geologic representation the geologic feature line connecting its type is printed in brown. Scales. — The area of the United States (without Alaska) is about 9,032,000 square miles. On a map 400 feet long and 100 feet high, the United States would cover 5,000 square inches. Each square mile of ground surface might be represented by a corresponding square inch of map surface, and one linear mile on the ground would be represented by a linear inch on the map. This relation between distance in nature and corresponding distance on the map is called the scale of the map. In this special case it is called a "one mile to one inch" scale. A map of the United States half as long and half as high would have a scale half as great; its scale would be "two miles to one inch," or four square miles to a square inch. Scale is often expressed as a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, a scale "one mile to one inch" is expressed by

\[
\frac{1 \text{ mile}}{\text{63,360 inches}}
\]

Three different scales are used on the atlas sheets of the U. S. Geological Survey; the smallest is \(\frac{1}{633,600}\) mile, the second \(\frac{1}{200,000}\) mile, and the largest \(\frac{1}{6,000}\) mile. These correspond approximately to four miles two miles, and one mile of natural length to one inch of map length. On the scale of \(\frac{1}{633,600}\) one square inch of map surface represents and corresponds nearly to one mile; on the scale of \(\frac{1}{200,000}\)н one mile of land on the ground would be represented by a linear inch on the map. This relation between distance in nature and corresponding distance on the map is called the scale of the map. In this special case it is called a "one mile to one inch" scale. A map of the United States half as long and half as high would have a scale half as great; its scale would be "two miles to one inch," or four square miles to a square inch. Scale is often expressed as a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, a scale "one mile to one inch" is expressed by

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pour out of cracks and volatolizes and flow over the surface as lava. Sometimes they are thrown from volcanoes as ash and pumice, and are spread over the surface by winds and streams. Often lava flows are interbedded with ash beds.

It is thought that the first rocks of the earth, which formed during what is called the Archaean period, were igneous. Igneous rocks have intruded among masses beneath the surface and have been thrown out from volcanoes at all periods of the earth's development. These rocks occur together with sedimentary formations of all periods, and their ages can sometimes be determined by the ages of the sediments with which they are associated.

Igneous formations are represented on the geologic maps by patterns of triangles or rhombes printed in a brilliant color. When the age of a formation is not known, the letter-symbol consists of small letters which suggest the name of the rocks; when the age is known, the letter-symbol is the initial letter of the appropriate period prefixed to it.

(4) Allred rocks of crystalline texture. These are rocks which have been so changed by pressure, movement and chemical action that the mineral particles have recrystallized. Both sedimentary and igneous rocks may change their character by the growth of crystals and the gradual development of new minerals from the original particles. Marl is limestone which has thus been crystallized. Mica is one of the common minerals which may thus grow. By this chemical alteration sedimentary rocks become crystalline, and igneous rocks change their composition to a greater or less extent. The process is called metamorphosis and the resulting rocks are said to be metamorphic.

Metamorphism is promoted by pressure, high temperature and water. When a mass of rock, under these conditions, is agitated during movements in the earth's crust, it may divide into many very thin parallel layers. When a rock is exposed to the air or to pressure they are called slates; but when rocks of any kind are found in thin layers that are due to pressure they are called slate. When the cause of the thin layers of metamorphic rocks is not known, or is not simple, the term which applies to both shaly and slaty structures. Rocks of any period of the earth's history, from the Neocene back to the Archean, may be more or less altered, but the younger formations have generally escaped marked metamorphism, and the oldest sediments known remain in some localities essentially unchanged.

Metamorphic crystalline formations are represented on the maps by patterns consisting of short dashes irregularly placed. These are printed in any color and may be darker or lighter than the background. If the rock formations are of very fine grained or shaly structures may be arranged in wavy parallel lines. If the formation is of known age the letter-symbol of the formation is preceded by the capital letter-symbol of the proper period. If the age of the formation is unknown the letter-symbol consists of small letters, as follows:

USES OF THE MAPS.

Topography.—Within the limits of scale the topographic sheet is an accurate and characteristic delineation of the relief, drainage and culture of the region represented. Viewing the landscape, map in hand, each characteristic feature of sufficient magnitude should be recognizable.

It may guide the traveler, who can determine in advance or follow continuously on the map his route along strange highways and byways. It may serve the inventor or owner who desires to ascertain the position and surroundings of property.

It may save the engineer preliminary surveys in locating roads, railways and irrigation ditches.

It provides education for the teacher and student, and serves all the purposes of a map for local reference.

The landform—This sheet shows the areas occupied by the various rocks of the district. On the margin is a legend, which is the key to the map. To ascertain the meaning of any particular colored pattern on the map the reader should look for that rock whose initial letter of the appropriate period prefixed to it will give the name and description of the formation. If it is desired to find any given formation, its name and letter-symbol will be found under the name of the deposit corresponding in a color pattern and may be traced out.

The arrangement of rocks in the earth is the earth's structure, and having traced out the relations and to construct a diagram exhibiting what would be seen in the side of a trench many miles long and several thousand feet deep. This is illustrated in the following figure:

The figure represents a landscape which is cut off sharply from the foreground by a vertical plane. The landscape exhibits an extended plateau on the right, and mountain peaks in the extreme right of the foreground as well as in the distance. The vertical plane cutting a section shows the relationships of rocks. The kinds of rock are determined by the patterns. A natural symbol of lines, dots, and dashes. These symbols admit of much variation, but the following are generally used in sections to represent the commoner kinds of rock:

<table>
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<tr>
<th>Rocks</th>
<th>Symbols</th>
<th>Colors</th>
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</thead>
<tbody>
<tr>
<td>Sandstone</td>
<td>Small vertical</td>
<td>Brown</td>
</tr>
<tr>
<td>Shale</td>
<td>Small horizontal</td>
<td>Gray</td>
</tr>
<tr>
<td>Limestone</td>
<td>Large vertical</td>
<td>Light gray</td>
</tr>
<tr>
<td>Conglomerate</td>
<td>Small horizontal</td>
<td>Red</td>
</tr>
<tr>
<td>Basalt</td>
<td>Large horizontal</td>
<td>Black</td>
</tr>
</tbody>
</table>

The plate in Fig. 2 presents toward the lower land an escarpment which is made up of cliffs and steep slopes. These formations correspond to horizontal beds of sandstone and siltstone shaley shown in the section at the extreme left, the sandstone forming the cliffs, the shales constituting the slopes.

The broad belt of lower land is traversed by several ridge, which, where they are cut by the section, are seen to correspond to outcrops of sandstone that rise to the surface. The upturned edges of these harder rocks form the flanks and the intermediate valleys follow the outcrops of limestone and calcareous shales.

Where the edges of the strata appear at the surface their thicknesses can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred.

When strata which are thus inclined are traced underground in mining or by inference, it is frequently observed that they form troughs or arches, such as the section shows. But these sediments, shales and limestones were deposited beneath the sea in nearly flat sheets. Where they are now bent they must, therefore, have been folded by a force of compression. The fact that strata are thus bent is taken as proof that a force exists which has from time to time caused the earth's surface to wrinkle along certain lines.

The mountain peaks on the right of the sketch are shown in the section to be composed of shales which are traversed by masses of igneous rock. The shales are much contorted and cut up by the intruded dikes. Their thickness cannot be measured; their arrangement underground cannot be inferred. Hence that portion of the section which shows the structure of the shales and igneous rocks beneath the surface delineates what may be true, but is not known by observation.

Structure sections afford a means of graphic statement of certain events of geologic history which are recorded in the relations of groups of formations. In Fig. 3 there are three groups of formations, which are distinguished by their subterranean relations.

The first of these, seen at the left of the section, is the group of sandstones and shales, which lie in a horizontal position. These sedimentary strata, which accumulated beneath water, are in themselves evidence that a sea once extended over their expanse. They are now high above the sea, forming a plateau, and the change of elevation shows that that portion of the earth's mass on which they rest swelled upward from a lower to a higher level. These strata are parallel, a relation which is called conformable.

The second group of formations consists of strata which are not continuous, but the crests of the arches have been removed by degradation. The beds, like those of the first group, being parallel, are conformable.

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second group on the left. The underlying formations and the younger strata must have occurred between the deposition of the older beds and the accumulation of the younger. When younger strata thus rest upon an eroded surface of older strata or upon their upturned and eroded edges, the relation between the two is unconformable, and their surface of contact is unconformable.

The third group of formations consists of crystalline schists and igneous rocks. At some period of their history the schists have been piled on the older and traversed by eruptions of molten rock. But this pressure and intrusion of igneous rocks have not affected the overlying strata of the second group. Thus it is evident that an interval of considerable duration elapsed between the formation of the schists and the beginning of deposition of the second group. During this interval the schists suffered metamorphism and were the scene of eruptive activity. The contact between the second and third groups, marking an interval between two periods of rock formation, is shown in the section and landscape in Fig. 2.

The section and landscape in Fig. 2 are hypothetical, but they illustrate only relations which actually occur. The sections in the Structure-Sec­tion Sheet are related to the maps as the section in the figure is related to the landscape. The profiles of the surface in the section correspond to the actual slopes of the ground along the surface line, and the depth of any mineral-producing or water-bearing structure in the section may be measured from the surface by using the scale of the map.

Stratum section—This sheet contains a concise description of the rock formations which constitute the local record of geologic history. The diagrams and verbal statements form a summary of the facts relating to the characters of the rocks, to the thicknesses of sedimentary formations and to the order of accumulation of successive deposits.

The characters of the rocks are described under the heading "Thickness in feet," in figures which state the least and greatest thicknesses. The average thickness for each formation is shown in the column, which is drawn to a scale, usually 1,000 feet to 1 inch. The order of accumulation of the formations is designated by the vertical column arrangement of the descriptions and of the lithologic symbols in the diagram. The oldest formation is placed at the bottom of the column, the youngest at the top.

The strata are drawn in a horizontal position, as they were deposited, and igneous rocks or other formations which are associated with any particular stratum are indicated in their proper relations.

The strata are divided into groups, which correspond with the great periods of geologic history. Thus the ages of the rocks are shown and the intervals of deposition of deposits occurring within the geologic time. The intervals of time which correspond with the events of uplift and degradation and constitute interruptions of deposition of sediments may be indicated graphically or by the word "unconformity," printed in the columnar section.

Each formation shown in the columnar section is indicated by the description of its character, by its name, its letter-symbol as used in the maps and their legends, and a concise account of the topographic features, soils, or other facts related to it.

J. W. POWELL,
Director.