# PHYSIOGRAPHIC DIVISIONS OF THE UNITED STATES

NEVIN M. FENNEMAN

Third Edition Revised and Enlarged

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NOTE ON THE THIRD EDITION

This paper was originally published in the Annals of the Association of American Geographers, Volume VI, pages 19-98. About 700 reprints were made and kept for sale by the Association. As these were quickly exhausted a second edition of 600 was printed in 1921. For the present edition both the paper and the map have been revised. All changes have been submitted to the physiographic committee of the U. S. Geological Survey. Unless otherwise stated the system of physiographic units here described is identical with that in use by the U. S. Geological Survey.

The only purpose of this paper is to designate physiographic divisions and trace their boundaries. No attempt is made to describe them except so far as this is necessary in order to justify their recognition as separate divisions. Physiographers are invited to offer criticisms and suggestions with respect to areas of which they have special knowledge.
INTRODUCTION

Need of Natural Divisions.—That the earth's surface must be divided into smaller parts in order to be described, is too obvious for argument. No continent, and probably not the tenth part of any continent (unless it be in western Australia) is simple enough to be described as a physiographic unit. Each division to be described should be as homogeneous as possible; that is, it should admit of the largest possible number of general statements before details and exceptions become necessary.

A number of attempts have been made to divide the United States into natural or physical units, but no attempt has heretofore been made to define boundaries so that such units shall not overlap or leave spaces unaccounted for. Without such boundaries it is not possible to tabulate the population, resources, and industrial statistics of each natural division so as to show in an effective way the influence of physical environment on human life. It is not surprising, therefore, that demands for such homogeneous units, properly delimited, have come from many diverse sources: from half a dozen government scientific bureaus; from state and national surveys; from transportation companies and the bureaus that supervise them; from a great variety of agricultural interests; from colleges and universities, somewhat in the interests of geology, but more especially of geography.

Official surveys, State and National, are annually describing a large number of small areas. In most cases some attention is given to the geographic setting of such areas and to physiographic description or explanation. Such chapters or paragraphs are commonly headed Geography or Physiography or Topography. In describing a quadrangle, county, or other area, it is common to refer it to some larger area, generally called a "province," though that word has been used very loosely. The implication of this, beside merely locating the field, is that the province is recognized as having certain characteristics common to the whole and that in locating the field within it, a general impression of the character of the smaller area is imparted. The province, with its known characteristics, is mentioned chiefly to give a setting for the smaller field. When used in this way, the value of the province depends largely on its homogeneity.

Work of the Association of American Geographers.—For several years previous to 1915, the Association of American Geogra-
phers interested itself in the work here proposed. Two lengthy papers were presented at the Princeton meeting in December, 1913, and published in the Annals of the Association, Vol. IV, 1914. At the Chicago meeting of the Association in December, 1914, a round-table conference was devoted to the subject.

Following these events a committee was appointed to devise a systematic division of the United States. This committee consisted of Messrs. M. R. Campbell and F. E. Matthes of the United States Geological Survey, Professors D. W. Johnson of Columbia University, Eliot Blackwelder, then of the University of Illinois, and Nevin M. Fenneman of the University of Cincinnati (chairman). The detailed work of this committee was performed largely by a subcommittee consisting of Messrs. Matthes, Campbell, and Fenneman. From December 1915, to April 1916, this subcommittee sat from three to four half-days per week. Between these sessions information was sought and conferences held by the chairman with most of the members of the U. S. Geological Survey who had special familiarity with any part of the United States.

The results of the committee’s work were incorporated in the map similar to the one that accompanies this paper showing divisions of three orders, called respectively, major divisions, provinces, and sections. The map, together with the naming and classification of the several units, constituted the committee’s report. The report was unanimous except on several points to which exception is taken in footnotes to this paper.

This paper is not a part of the committee’s report. It has, however, been generally accepted as expressing the committee’s judgments. The map nomenclature and classification have been accepted by the U. S. Geological Survey and have since that time served as the basis of physiographic description in its reports.

No member of the committee would claim finality for this work, especially as to the exact locations of boundary lines. Minor

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1W. L. G. Joerg, The Subdivision of North America into Physiographic Regions, Annals of Assoc. of Amer. Geogr., Vol. IV, 1914, pp. 55-84. This paper dealt more particularly with divisions of a more generalized character, based not on physiography alone, but even more on vegetation as the result of and index of physiography and climate.

Nevin M. Fenneman, Physiographic Boundaries within the United States, ibid., pp. 84-134. This paper was accompanied by a proposed preliminary map. Most of the boundary lines given on that map are retained on the map here presented, though some are changed in rank and many new lines are added.
changes in this respect are to be expected with increasing knowledge. Some new divisions may be recognized and subdivisions of lower orders are to be expected. There is, on the other hand, little reason to doubt that nearly all of the divisions here given will continue to be recognized and distinguished from their neighbors on the ground here mentioned.

The committee's responsibility ends with the United States, but most of the major divisions and many of the minor ones extend into Canada or Mexico. It was necessary, therefore, to give considerable study to those countries when dealing with units which overlap international boundaries. As the result of such a study it is expected that when the time comes to delineate the physiographic divisions of the continent of North America, those now set forth for the United States can be incorporated without change.

General Principles.—Necessarily the first consideration of the committee pertained to the basis or criterion of division. It is not enough to say that a division shall be natural or even physiographic. Various elements enter into the "nature" and "physiography" of an area. It is plain that the division of a continent or country into its natural units will depend on what elements of nature are considered as dominant. An area may be homogeneous, that is, a unit, with respect to one element or principle, and heterogeneous with respect to another:

The dominant factors in topography are, as designated by Professor W. M. Davis, (a) structure, (b) process, and (c) stage. In this formula the word structure is used in a very comprehensive sense, covering all the work of constructional agencies. In addition to the strict geologic meaning of the term, it is made to include the nature of the material and even the initial form before the work of erosive agencies began. In other words it stands for that upon which erosive agents are, and have been, at work.

The second factor, process, refers to the erosive agency by which the original structure is being destroyed. It may be normal erosion,\(^2\) glacial, wind, or wave erosion. Each of these processes

\(^2\)The term "normal erosion" is plainly open to criticism on the ground that one mode is just as normal as another, but no other satisfactory term has been proposed. The term "stream erosion" excludes the very important work of unconcentrated wash; "water erosion" would include the work of waves on shores, which must be treated as a distinct type.
produces its own characteristic forms, differing according to the structure upon which it acts. The third factor, stage, indicates that in the destruction of a land form by any one of the above-named processes, the form passes through a regular cycle of changes as the work progresses. Each stage has its own characteristics, differing according to the process at work and the structure involved. A type of topography may therefore be designated by stating the initial structure, the erosive process at work and the stage reached in the cycle.

This is not very different from saying that physiographic types (or regional divisions) are distinguished by their physiographic histories. But in the erosional history of an area the more recent events are vastly more important than the older, and more often determine the classification. The last peneplain may erase all older records. In a maturely dissected plateau it matters little whether the summit level was the initial land surface or a peneplain at the end of a long series of cycles. Recent glaciation may dominate all other factors and obscure the older events.

On the other hand the influence of structure is very persistent and is almost sure to be observed wherever the surface is not peneplaned. A folded area with rocks of diverse strength may pass through a dozen cycles, but in each one the effect of folding reappears. When this is remembered, it is not surprising to find that strong topographic contrasts between large areas are more often caused by structural contrasts than by different agents of erosion or a different stage in the cycle. Many well marked topographic divisions can best be defined by stating that they are co-extensive with certain elements of structure.

Criteria Considered.—The distinctions shown on the map here presented are based on features believed to be most outstanding, that is, those features which attract first attention and deserve first mention in referring an area to a physiographic type. It goes without saying that such an ideal can only be approximated. Questions may well be raised as to what is the most outstanding characteristic of an area, or whether a certain small area has more in common with one large region or with another.

It is not to be inferred that the most distinctive characteristics from a physiographic standpoint are always those which appeal first to the careless traveler. On such a basis the High Plateaus of Utah have sometimes been mapped as a continuation of the Wasatch Mountains, and the Piedmont Lowland of New Jersey
might equally well be included with the Coastal Plain. The topographic features considered must be such as lend themselves to rational discussion and historical explanation. If the end products of two diverse histories are superficially similar it may still be necessary to distinguish them on the map if the map is to be useful to all classes of users. In like manner it may happen that the map includes, in one province, forms which are superficially diverse, because of their physiographic relationship. Such is the case with the hilly inner edge and the flat outer edge of the Coastal Plain. Hence, in making form the primary basis of subdivision, it is understood to be form as the result of certain processes. Otherwise the descriptions must be merely empirical.

All the above considerations are concerned with the history of a province, or what is nearly the same thing, with the explanatory description of its topography. For such purposes the usefulness of provinces is in proportion to their homogeneity. The great end desired is that in each case the maximum number of general statements may be made with the minimum necessity for considering details and exceptions. It is, however, a matter of coordinate importance that these divisions shall also be useful in the consideration of the effect of topography on human affairs. Thus the consideration of physiographic divisions looks both ways—backward to geology and forward to geography. With reference to the former, topography is an effect; with reference to the latter it is a cause. In geology, topography is an end product; in geography, with its various biologic and economic phases, it is a point of departure. The demand for physiographic provinces has naturally been strongest among geographers and others whose work is based on such distinctions; but to determine what these units are and to define and delimit them must be largely the work of geologists.

Nature of Boundary Lines.—In speaking of the criteria by which provinces are distinguished, a distinction must be made between the essential characteristics of the province and the basis on which the exact boundary is determined. Ideally, it would seem that the line should be drawn where the characteristics of one province leave off and those of the next begin. If every case were simple, if there were no gradations, no odds and ends of doubtful or neutral character, if no generalizing were necessary, if a province were characterized by just one essential, or if the several leading characteristics of an area were coextensive, it would be
easy to draw the line as stated above. In practice it happens that a province may be so strongly characterized as to compel the recognition of its individuality, though its boundary may be very indefinite, or the characteristics may come to an end one by one. This is illustrated in the boundary between the Great Basin and the Columbia Plateau, two of the most strongly individualized provinces of the United States. In delimiting one from the other (see pp. 337, 343), it is impossible to draw the entire boundary by any one criterion. The practice followed in making the divisions here presented has been to determine, first, whether a given region deserves recognition and then to choose the boldest or the most consistent line available. It may thus happen that the major divisions are locally separated by very poorly defined lines while nearby lines separating minor divisions may be very distinct.

The boundaries of most of the units in the system here presented correspond more or less exactly to geologic lines which indicate the reasons for the contrast in elevation or style of topography. Frequently such geologic lines may be regarded as interpretative. For example, the eastern boundary of the Cumberland Plateau not only agrees with the edge of the Carboniferous strata, but is to be explained by it. A similar relation exists between the western boundary of the Texas coastal plain and the Balcones fault. In like manner most of the sections of the Central Lowlands are separated by lines which mark the limits of glacial drift sheets. Most of the lines are subject to some such interpretation related to the underlying rocks, that is, to structure in the broad sense used by Davis.

In a few cases the contrast of topography or elevation between adjacent divisions is not accompanied by, or dependent on any structural feature or difference in materials. Such topographic contrast may indicate different stages in the erosion cycle. This is illustrated by the east foot of the Blue Ridge and a few other escarpments which follow no interpretative lines. Some lines are arbitrary. Some of these follow natural lines, arbitrarily chosen, as Missouri River is chosen to delimit the Ozark Plateaus on the north, or Wabash River to separate the Till Plains from the Eastern Lake Section of the Central Lowland. Others, like the line cutting off the Floridian Section of the Coastal Plain, are merely straight lines, which, within limits of a number of miles, might as well be drawn at one place as another. The Floridian Section is a good example of a strongly characterized division,
deserving recognition, but not capable of separation from its neighbor by any well-marked line.

All lines are necessarily generalized because of the scale of the base map. The determination as to whether a certain point near a boundary lies in one division or the other must rest ultimately on the definition and description of the several units and not on the accuracy of the map maker. Where the boundary between a high plateau and a low one is exceedingly irregular, like the western escarpment of the Cumberland Plateau, the flat promontories are portions of the higher province and the flat valleys intervening are portions of the lower province. They should be so represented on maps of sufficiently large scale.

The nature of topographic boundaries is such that exactness is possible only within limits. The limits may be a few feet or a few miles. When the natural boundary is vague it is not well to use categorical language in speaking of localities which are close to the generalized conventional boundary line. Probably much more than nine-tenths of the area of the United States can be spoken of unequivocally as lying in one province or another, but the remaining fraction must be spoken of in terms which suggest gradation or in some cases even uncertainty. A few concrete cases will illustrate the spirit of this:

On the map the Laurentian Highland in northeastern Minnesota is separated from the Western Lake Section of the Central Lowland by a broken line which ignores all detail. This is because the characteristics of the Laurentian Highland disappear not only gradually but interruptedly. The two provinces are, so to speak, interlocked (p. 290). To follow the map rigorously and speak of places near the line as belonging categorically to one province or the other without suggesting the gradation, would leave a false impression. Such a locality may well be described as lying in the zone of gradation but related by its character to one or the other province. This does not invalidate the Laurentian Plain as a major division of the continent, but it acknowledges the local weakness of the boundary.

Hamilton County, Ohio (containing Cincinnati), lies wholly within the technical limits of the Till Plains (see p. 316). But in order to leave a correct impression it is necessary to state that the area considered is on the southern border of the Till Plains where their character gives way gradually to that of the Interior Low Plateau.
A number of counties in eastern Nebraska may well be spoken of as "in the zone where the Central Lowland merges into the Great Plains," though they may be said to be on this or that side of "the line conventionally taken as the boundary" (see p. 310).

To speak of the Joplin District in southwestern Missouri as within the Ozark Plateau would be technically correct if the customary conventional limit is used (see p. 326), but to use language implying categorical distinctions and sharp outlines would leave an exaggerated impression of the difference between this county and the adjoining county in the Osage Plains of Kansas.

A further result of generalization is the occurrence of outliers or inliers. The Black Hills, Little Rockies, and Highwood Mountains are of the same types as some of the Rocky Mountains, but if a Great Plains province is justified at all it must completely surround and include these isolated mountains. They themselves are not "plains," but they are in the Great Plains province, being exceptional features of it, and not a part of the Rocky Mountain province in the sense here used.

Major and Minor Divisions.—The continent of North America is first divided into eight strongly characterized parts, all of these being represented in the United States and all but two of them in Canada. These are here called major divisions. The term "division" cannot, however, be restricted to this one sense. Units of the next smaller order are here called provinces, many of them having borne that designation for a long time though without assigned limits. Units of the third order are here called sections. The word district is sometimes used for divisions of low, generally undetermined order whose boundaries may be as yet undefined.

The basis on which the major divisions are distinguished is not essentially different from that which is assumed in distinguishing the smaller units. It is easier, however, to correlate the major divisions with the great constructional events of geologic history. Differences based on erosional histories may be relatively more important in distinguishing the units of lower order, but the bases recognized in the two cases differ only in degree. The distinction is not absolute.

All orders of divisions rest ultimately on existing differences in topography and elevation. But the differences considered are those which pertain to physiographic types and not merely superficial appearance. It would be difficult to formulate a rule to determine which units should be made major and which minor. Size can not be wholly ignored. The degree of unity or com-
plexity is probably more important. Closely related to this is the strength of the characteristics or individuality of an area. Concerning the satisfactoriness of correlations made by such indefinite criteria it can only be said that, while the recognition and the delimitation of most of the units involved much discussion and conference in the committee above mentioned, there was little difference of opinion concerning the rank to be assigned to each unit.

The Naming of Divisions.—So far as possible each division of whatever order has been given a proper name and a topographic designation. In a few cases the proper name is replaced by such terms as “central” or “interior,” or by other distinctive terms as in case of the Dissected Till Plains. In some cases the proper names are applied in their customary sense, e.g., the Rocky Mountain and Appalachian major divisions, or the Piedmont and Ozark plateaus. In other cases it has been necessary to take a proper name from an important city or other feature in the larger area, e.g., the Walla Walla plateau and the Salton trough.

In all cases where the name is descriptive, it is assumed to designate the most prominent characteristic of the area and not the character of the whole. Thus the Great Plains Province is by no means all great plains, nor are the Appalachian Highlands all highlands.

Where topographic character is so varied or complex that any single descriptive term would be misleading, the proper name is followed by the mere word province, e.g., the New England province.

CLASSIFIED LIST OF DIVISONS

The tabular summary (pp. 274-8) shows the divisions of the several orders in classified form. The provinces are numbered consecutively and the sections of each are lettered. These numbers and letters correspond to those on the map, on which each section bears the number of its province and its own letter. In the column headed “characteristics,” exactness of detail is necessarily sacrificed to brevity. Characteristics are stated wherever possible in terms of a genetic classification of land forms in order to convey to physiographers the best mental pictures in the fewest words.
Tabular Summary
Pages 274-279

Degrees of relief are herein spoken of as low, moderate, strong, and high. As used here high relief is measured in thousands of feet; moderate relief in hundreds of feet. Strong relief may be anything approaching one thousand feet with a wide latitude on both sides.
PHYSIOGRAPHIC DIVISIONS

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<td>b. Northern section</td>
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<td>Appalachian Highlands</td>
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<td>8. Appalachian Plateaus</td>
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<td>a. Mohawk section</td>
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<td>b. Catskill section</td>
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<td>c. Southern New York section</td>
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<td>g. Cumberland Mountain section</td>
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<td>a. Seaboard Lowland section</td>
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<td>b. New England Upland section</td>
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<td>c. White Mountain section</td>
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<td>d. Green Mountain section</td>
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<td>e. Taconic section</td>
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1928] TABULAR SUMMARY 275

OF THE UNITED STATES

CHARACTERISTICS*

1. Submaturely dissected, recently glaciated peneplain on crystalline rocks of complex structure.
2. Sloping submarine plain of sedimentation.
3a. Submaturely dissected and partially submerged, terraced coastal plain.
3b. Young to mature terraced coastal plain with submerged border.
3c. Young marine plain; sandhills, swamps, sinks, and lakes.
3d. Young to old belted coastal plain.
3e. Flood plain and delta.
3f. Young, grading inland to mature, coastal plain.
4a. Submaturely dissected peneplain on disordered resistant rocks; moderate relief.
4b. Less uplifted peneplain on weak strata; residual ridges on strong rocks.
5a. Maturely dissected mountains of crystalline rocks; accordant altitudes.
5b. Mature to subdued mountains of disordered crystalline rocks.
6a. Second-cycle mountains of folded strong and weak strata; valley belts predominating over even-crested ridges.
6b. The same, but even-crested ridges predominate over valleys except on east side.
6c. Glaciated peneplain on weak folded strata.
7a. Rolling lowland, glaciated; in part covered by young marine plain.
7b. Young marine plain with local rock hills.
8a. Maturely dissected, glaciated plateau; varied relief and diverse altitudes.
8b. Maturely dissected, plateau of mountainous relief and coarse texture (glaciated).
8c. Mature, glaciated plateau of moderate relief.
8d. Mature plateau of strong relief; some mountains due to erosion of open folds.
8e. Mature plateau of fine texture; moderate to strong relief.
8f. Submaturely dissected plateau of moderate to strong relief.
8g. Higher mature plateau and mountain ridges on eroded open folds.
9a. Peneplains below 500 ft. past-maturely eroded and glaciated; few monadnocks.
9b. Dissected and glaciated peneplains on complex structures; monadnocks.
9c. Subdued and glaciated mountain masses of crystalline rocks.
9d. Linear ranges of subdued and glaciated mountains and residual plateaus.
9e. Maturely dissected and glaciated mountains and peneplain on resistant folded strata.
10. Subdued mountains and dissected peneplain, glaciated.

*Prepared by Nevin M. Fenneman and Douglas W. Johnson.
<table>
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<td>Interior Low Plateaus</td>
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<td>b. Lexington Plain</td>
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<td>c. Nashville Basin</td>
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<td>d. Possible western section (not delimited)</td>
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<td>Central Lowland</td>
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<td>b. Western lake section</td>
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<td>Interior Plains</td>
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<td>e. Dissected Till Plains</td>
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<td>f. Osage Plains</td>
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<td>Great Plains Province</td>
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<td>b. Missouri Plateau, unglaciated</td>
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<td>c. Black Hills</td>
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<td>k. Central Texas section</td>
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<td>Ozark Plateaus</td>
<td>a. Springfield-Salem plateaus</td>
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<td>Ouachita Province</td>
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<td>Southern Rocky Mountains</td>
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<td>Wyoming Basin</td>
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<td>Middle Rocky Mountains</td>
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<td>Northern Rocky Mountains</td>
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</table>
THE UNITED STATES—Continued

CHARACTERISTICS

11a. Young to mature plateau of moderate relief.

11b. Mature to old plain on weak rocks; trenched by main rivers.

11c. Mature to old plain on weak rocks; slightly uplifted and moderately dissected.

11d. Low, maturely dissected plateau with silt-filled valleys.

12a. Maturely dissected and glaciated cuestas and lowlands; moraines, lakes, and lacustrine plains.

12b. Young glaciated plain; moraines, lakes, and lacustrine plains.

12c. Maturely dissected plateau and lowland invaded by outwash plain. (Margin of old eroded drift included.)

12d. Young till plains; morainic topography rare; no lakes.

12e. Submaturely to maturely eroded till plains.

12f. Old scarped plains beveling faintly inclined strata; main streams entrenched.

13a. Glaciated old plateaus; isolated mountains.

13b. Old plateaus; terrace lands; local badlands; isolated mountains.

13c. Maturely dissected domed mountains.

13d. Broad inter-valley remnants of smooth fluvial plains.

13e. Submaturely to maturely dissected plateau.

13f. Late mature to old elevated plain.

13g. Trenched peneplain surmounted by dissected, lava-capped plateaus and buttes.

13h. Late mature to old plain.

13i. Young plateau with mature margin of moderate to strong relief.

13k. Plateau in maturity and later stages of erosion.

14a. Submature to mature plateaus.

14b. Submature to mature plateau of strong relief.

15a. Gently folded strong and weak strata; peneplain with residual ridges.

15b. Second-cycle mountains of folded strong and weak strata.

16. Complex mountains of various types; intermont basins.

17. Elevated plains in various stages of erosion; isolated low mountains.

18. Complex mountains mainly anticlinal ranges; intermont basins.

19. Deeply dissected mountain uplands, not anticlinal ranges; intermont basins.
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<td>b. Blue Mountain section.</td>
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<td>c. Payette section.</td>
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<td>b. Uinta Basin.</td>
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<td>Intermontane Plateaus</td>
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<td>b. Middle Cascade Mountains.</td>
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<td>f. California Coast Ranges.</td>
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<td>g. Los Angeles section.</td>
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<td>25. Lower Californian Province</td>
<td>a. Lower Californian Province.</td>
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</tbody>
</table>
THE UNITED STATES—Concluded

CHARACTERISTICS

20a. Rolling plateau with young incised valleys.
20b. Complex mountains and dissected volcanic plateaus.
20c. Young plateaus of prevalingly weak rocks; broad alluvial terraces. (Applies to northern part only.)
20d. Young lava plateau.
20e. Young lava plateau; in effective drainage; features of recent vulcanism.
21a. High block plateaus; in part lava-capped; includes terraced plateaus on south side.
21b. Dissected plateau; strong relief.
21c. Young to mature canyoned plateaus; high relief.
21d. Young plateaus; smaller relief than 20c into which it grades.
21e. High block plateaus, trenched by Grand Canyon.
21f. Lava flows entire or in remnants; volcanic necks.
22a. Isolated ranges (largely dissected block mountains) aggraded desert plains.
22b. Widely separated short ranges in desert plains.
22c. Desert alluvial slopes and delta plain; Gulf of California.
22d. Isolated ranges (largely dissected block mountains) aggraded desert plains.
22e. Mature block mountains of gentle dip; block plateaus; bolsons.
23a. Sharp alpine summits of accordant height; higher volcanic cones.
23b. Generally accordant summits; higher volcanic cones.
23c. Volcanic mountains variously eroded; no very distant range.
23d. Block mountain range tilted west; accordant crests; Alpine peaks near east side.
24a. Lowlands of diverse character; in part submerged.
24b. Generally accordant crests; local alpine peaks.
24c. Uplifted peneplain on weak rocks, dissected; monadnocks of igneous rock.
24d. Uplifted and dissected peneplain on strong rocks; extensive monadnock ranges.
24e. Low fluviatile plains.
24f. Parallel valleys and ranges on folded faulted rocks; rounded crests of subequal height.
24g. Narrow ranges and dissected fault blocks; alluviated lowlands.
25. Dissected west-sloping granite upland (in northern part).
DEFINITIONS

The following definitions of major divisions, provinces, and sections are intended to give where possible, the essential reason for the recognition of the area as a unit, and at the same time, by implication, to indicate its extent. In some cases this definition consists of a statement of character, similar to that given in the table, pp. 274 to 278, but with special reference to those features which distinguish the area from its neighbors. In some cases, especially those of mountains or intermontane valleys, the distinguishing character of an area is sufficiently implied in its name. In such cases, the location is the only additional element which can be given. Many of the names are already in use but with no exact limitations to their application. The essentialthing in such cases is to make clear the sense in which the term is used. To specify the location of each unit in its definition would generally be a useless form of words since this is shown on the map without which the definition would have little value.

THE LAURENTIAN UPLAND is that major division of North America lying chiefly in Canada, whose topography is characterized by a peneplain developed on strong rocks of complex structure and by the effects of later erosion and recent glaciation which has produced many rock-basined lakes.

1. The Superior Upland is that part of the Laurentian Upland which extends into the United States (extent in Canada undetermined).

THE ATLANTIC PLAIN is a major division of North America consisting of the Atlantic (including Gulf) Coastal Plain and the Continental Shelf.

2. The Continental Shelf is the submerged margin of the continental surface.

3. The Coastal Plain is that portion of the former Continental Shelf which has been raised above the sea without essential deformation.

3a. The Embayed Section of the Coastal Plain is that part which is deeply indented by estuaries or cut off by sounds from the mainland.

3b. The Sea Island Section of the Coastal Plain is that part which drains to the Atlantic Ocean between the Embayed and Floridian sections.
3c. The Floridian Section of the Coastal Plain consists of the peninsula of Florida arbitrarily (for the present) delimited.

3d. The East Gulf Coastal Plain is that part which drains to the Gulf of Mexico between the Mississippi Alluvial Plain and the Floridian section.

3e. The Mississippi Alluvial Plain consists of the delta of the Mississippi and that portion of its floodplain which lies within the limits of the Coastal Plain.

3f. The West Gulf Coastal Plain (in the United States) is that portion which lies west of the Mississippi Alluvial Plain.

THE APPALACHIAN HIGHLANDS constitute a major division characterized in general by its relative altitude but including certain related lowlands.

4. The Piedmont Province consists of the plateaus and plains lying between the Coastal Plain and the first mountain range inland. (Conventionally, west of Hudson River only.)

4a. The Piedmont Upland is the uplifted and partially-dissected plain of the Piedmont Province, developed on strong rocks having a complicated structure.

4b. The Piedmont Lowlands are two small lowlands developed on weak, mainly Triassic, strata, including or surrounding residual ridges on volcanic rocks.

5. The Blue Ridge Province is the easternmost belt of mountains in the Appalachian Division, consisting of crystal-line rocks having a complicated structure.

5a. The Northern Section of the Blue Ridge Province is the narrow portion north of Roanoke River whose summit levels in general indicate a former peneplain.

5b. The Southern Section of the Blue Ridge Province is the broad portion south of Roanoke River whose summits in general do not indicate a peneplain.

6. The Valley and Ridge Province is the longitudinal belt of valleys and included mountains which traverses the Appalachian Highlands.

6a. The Tennessee Section of the Valley and Ridge Province is its southern part, characterized by longitudinal drainage; also by nearly straight, parallel mountain ridges and valleys produced by erosion on regular folds of alternating strong and weak strata.
6b. The Middle Section of the Valley and Ridge Province is that part which is characterized by transverse and trellised drainage; also by zigzag mountain ridges and canoe-shaped valleys produced by erosion on pitching folds of alternating strong and weak strata.

6c. The Hudson Valley is a section of the Valley and Ridge Province drained by Hudson River and consisting of a broad valley without mountain ridges.

7. The St. Lawrence Valley is the lowland north of and continuous with the Hudson Valley, enclosed between the New England Province, the Adirondack Province, and the Laurentian Highland.

7a. The Champlain Valley is a section of the St. Lawrence Valley between the New England and Adirondack provinces and characterized by greater relief than the average for the province.

7b. The Northern Section (or sections) of the St. Lawrence Valley embraces all north of the Adirondack Province and Champlain Valley and consists mainly of a young marine plain.

8. The Appalachian Plateaus comprise that portion of the Appalachian Highlands which consists essentially of elevated and more or less dissected horizontal strata.

8a. The Mohawk Section of the Appalachian Plateaus is that part which lies north of the escarpment which overlooks the Mohawk Valley from the south.

8b. The Catskill Section of the Appalachian Plateaus is that portion in the northeast which rises with mountainous relief above the general level.

8c. The Southern New York Section is that maturely dissected portion of the Appalachian Plateaus which was covered by the later continental ice.

8d. The Allegheny Mountain Section is that northern part of the eastern margin in which open folding causes linear ranges or elevated belts.

8e. The Kanawha Section is the maturely dissected middle portion of the province.

8f. The Cumberland Plateau Section of the Appalachian Plateaus is the southern portion of the province most of which is not yet maturely dissected.

Exact naming and possible subdivision of the Canadian portion is deferred.
8g. The Cumberland Mountain Section is that southern part of the eastern margin which consists of linear ranges and dissected plateau higher than the adjacent section.

9. The New England Province is the broad northeastward continuation of the Eastern Appalachian provinces, characterized by dissected peneplains with monadnocks.

9a. The Seaboard Lowland Section is the seaward margin of the New England province, generally less than five hundred feet high.

9b. The New England Upland Section is the non-mountainous part of the New England Province, generally more than five hundred feet high and characterized by sharp valleys.

9c. The White Mountain Section of the New England Province is the area, including and adjacent to the White Mountains, characterized by abundant monadnocks and residual mountain ranges.

9d. The Green Mountain Section of the New England Province consists of the linear mountain ranges having a granite axis.

9e. The Taconic Section of the New England Province is the belt of mountains and peneplains on the western border, whose topography is conditioned by strong metamorphic rocks greatly deformed.

10. The Adirondack Province is the area of crystalline rocks in northern New York, having a complex structure with a topography of subdued mountains bordered by peneplain.

THE INTERIOR PLAINS embrace those portions of the interior of the continent which are characterized by small local relief, regardless of absolute altitude.

11. The Interior Low Plateau Province is the dissected plateau (with included low plains) which lies west of and distinctly lower than the south end of the Appalachian Plateaus.

11a. The Highland Rim Plateau is the dissected plateau portion of the Interior Low Plateau.

11b. The Lexington Plain whose central part is the (“Bluegrass section” of Kentucky) is the area in northern Kentucky which is bordered by an inward-facing escarpment.

11c. The Nashville Basin (“Bluegrass section” of Tennessee) is a corresponding area in Tennessee.
11d. The (possible) unnamed section on the west (boundary not fixed) is the low western extension of the Highland Rim Plateau characterized by silt-filled valleys and minor features due to faulting.

12. The Central Lowland is the relatively low eastern portion of the interior plains, being surrounded, except on the south, by provinces of greater altitude.

12a. The Eastern Lake Section is the area embracing the Great Lakes (except Superior) characterized by varied features due to recent glaciation (including moraines, morainic lakes, and lacustrine plains of glacial lakes).

12b. The Western Lake Section is the corresponding area west of the Superior Upland.

12c. The Wisconsin Driftless Section is essentially the unglaciated area in Wisconsin and adjacent states, but includes an extensive lowland covered by glacial outwash; also on the north and west a border of much eroded drift.

12d. The Till Plains are a section of the Central Lowland covered by glacial drift (regardless of age) characterized by nearly level surfaces without lakes and not yet dissected by streams. This section consists of two subsections distinguished as older drift (Illinoian) and younger drift (Wisconsin).

12e. The Dissected Till Plains are that section of the Central Lowland which is covered by glacial drift of a formerly plain topography on which drainage systems are now well developed.

12f. The Osage Section is that part of the Central Lowland which lies south of the glaciated area.

13. The Great Plains Province is the plateau which slopes east from the Rocky Mountains and the northern end of the Mexican Highland.

13a. The Missouri Plateau (glaciated) is that part of the Great Plains province whose topography has been modified by the continental ice-sheets.

13b. The Missouri Plateau (unglaciated) is the northern section of the unglaciated Plains, from which the original sedimentary surface has been entirely stripped.
13c. The Black Hills Section consists of an eroded mountain dome and the residual monoclinal ridges which surround it.

13d. The High Plains are a north-south belt within the Great Plains, characterized by remnants of the former flat surface of sedimentation.

13e. The Plains Border is the eroded margin of the Great Plains which is elsewhere narrow and included in the High Plains but greatly expanded in Kansas.

13f. The Colorado Piedmont is the western portion of the Great Plains in Colorado diversified and degraded by erosion.

13g. The Raton Section of the Great Plains is that portion in southern Colorado and northern New Mexico which is characterized by higher mesas, canyons and volcanic features.

13h. The Pecos Valley Section is that part of the Great Plains which lies between the Mexican Highland and the High Plains.

13i. The Edwards Plateau is the southern end of the Great Plains, not covered by the Tertiary formations which underlie the High Plains.

13k. The Central Texas Section is the deeply eroded area lying between the young plateaus on the west and south and the lowlands on the east and north.

THE INTERIOR HIGHLANDS are the uplifted region in south central United States surrounded by lowlands.

14. The Ozark Plateaus comprise that portion of the Interior Highlands which is characterized by a plateau topography developed on nearly horizontal strata.

14a. The Springfield-Salem Plateaus comprise the non-mountainous, or less mountainous, portion of the Ozark Province.

14b. The Boston Mountains are a deeply dissected plateau of mountainous relief rising above the Springfield-Salem Plateaus at the southern margin of the province.

15. The Ouachita Province is that portion of the Interior Highlands whose topography is conditioned by folded strata.

15a. The Arkansas Valley Section is the northern part of the Ouachita Province whose topography is conditioned by gentle folds giving rise to low monoclinal ridges or cuestas.

15b. The Ouachita Mountains are that section of the Ouachita Province whose topography is conditioned by close
folds subjected to baselevelling and to renewed erosion in one or more partial cycles.

THE ROCKY MOUNTAIN SYSTEM is a generally mountainous belt consisting of the Northern, Middle, and Southern Rocky Mountain Provinces and the intervening Wyoming Basin.

16. The Southern Rocky Mountains comprise the continuous mountain system which lies south and east of the Wyoming Basin. (To be divided into sections or ranges.)

17. The Wyoming Basin is an area of plateau, crossing the Rocky Mountain division, being continuous with the Great Plains on the east and the Colorado Plateau on the south.

18. The Middle Rocky Mountains, consisting of linear, generally anticlinal ranges, are limited on the northwest by Yellowstone and Madison rivers.

19. The Northern Rocky Mountains, consisting largely of dissected uplands in which ranges do not correspond to individual uplifts, comprise the mountains north and west of Yellowstone Park, extending into Canada.

THE INTERMONTANE PLATEAUS (southern division) embrace all the area west and south of the Rocky Mountain system in which mountains are either wanting or are isolated in relatively small ranges separated by desert plains. (A northern division of these plateaus lying almost wholly in Canada and Alaska consists largely of worn-down mountains.) (See footnote p. 336.)

20. The Columbia Plateau is that part of the Intermontane Plateau division which is characterized by a substratum of nearly horizontal lava flows.

20a. The Walla Walla Plateau is that section of the Columbia Plateau which lies north of the Blue Mountains.

20b. The Blue Mountain Section of the Columbia Plateau Province is the mountainous area entirely surrounded by plateau surface. (Not shown on east for narrow.)

20c. The Payette Section of the Columbia Plateau is the part west of the Snake River Plain whose substratum consists in large part of lacustrine sediments. (Applies to northern part only.)

20d. The Snake River Plain is a part of the Columbia Plateau Province characterized by nearly horizontal strata.
20e. The Harney Section is that southwestern part of the Columbia Plateau which is distinguished by ineffective drainage and detrital cover.

21. The Colorado Plateau is a portion of the Intermontane Plateau division characterized by nearly horizontal strata greatly elevated and along certain lines deeply eroded.

21a. The High Plateaus of Utah are a belt along its western margin consisting of exceptionally high plateaus, for the most part separated from one another by deep valleys or fault scarps or both.

21b. The Uinta Basin is a great north-sloping terrace of Eocene rocks abutting against the Uinta Mountains on the north and limited on the south by the south-facing Book Cliffs.

21c. The Canyon Lands section is that portion of the Colorado Plateaus south of the Book Cliffs which is deeply and intricately dissected by canyons.

21d. The Navajo Section of the Colorado Plateaus is a poorly defined area of scarped plateaus in northeastern Arizona and northwestern New Mexico, less dissected than the Canyon Lands.

21e. The Grand Canyon Section of the Colorado Plateaus is that southwestern portion in which Carboniferous strata are exposed or locally covered by volcanic rocks.

21f. The Datil Section of the Colorado Plateaus is that southeastern portion whose topography is in large part determined by lava flows and other volcanic features.

22. The Basin and Range Province is that portion of the Intermontane Plateau division which is characterized by isolated, subparallel mountain ranges rising abruptly above desert plains.

22a. The Great Basin is a section of the Basin and Range Province, characterized by elevated desert plains and approximately equal areas of mountain and plain.

22b. The Sonoran Desert is a section of the Basin and Range Province characterized by the low level of its desert plains and the relatively small proportionate area occupied by its mountains.

22c. The Salton Trough is that depressed portion of the Basin and Range Province which is occupied, except at its northern end, by the Gulf of California.

22d. The Mexican Highland (in the United States) is a portion of the Basin and Range Province lying south of the
Colorado Plateau, and characterized by elevated desert valleys and approximately equal areas of mountain and desert plains.

22e. *The Sacramento Section* of the Basin and Range Province is a belt on its eastern margin, whose mountains are in large part simple dissected cuestas.

THE PACIFIC MOUNTAIN SYSTEM consists of the contiguous mountain ranges and associated valleys bordering the Pacific Ocean.

23. *The Sierra-Cascade Mountains* are the continuous, approximately north-south chain at the eastern edge of the Pacific Mountain division.

23a. *The Northern Cascade Mountains* are the northern section of the Sierra-Cascade Province, the summits of which are, in general, not formed by recent volcanic rocks.

23b. *The Middle Cascade Mountains* are that portion of the Sierra-Cascade Province whose rocks are volcanic and whose height is due in part to volcanic accumulation and in part to crustal uplift.

23c. *The Southern Cascade Mountains* are that portion of the Sierra-Cascade Province whose height is due essentially to accumulation of volcanic materials.

23d. *The Sierra Nevada* is the southernmost section of the Sierra-Cascade Mountains, whose elevation is due to uplift and not to volcanic accumulation.

24. The Pacific Border Province is that portion of the Pacific Mountain division which lies west of the Sierra-Cascade Mountains.

24a. *The Puget Trough* is the intermontane lowland west of the Middle and Northern Cascade Mountains.

24b. *The Olympic Mountains* are the isolated group lying west of the north end of Puget Trough.

24c. *The Oregon Coast Range* is the section of the Pacific Border Province west of the Puget Trough and consisting of Tertiary rocks.

24d. *The Klamath Mountains* are the section of the Pacific Border Province adjoining the Cascade Mountains on the west and consisting of relatively old and resistant rocks.

24e. *The California Trough* is the intermontane lowland west of the Sierra Nevada.
24f. The California Coast Ranges are the mountains of the Pacific Border Province lying west of the California trough.

24g. The Los Angeles Section is that part of the Pacific Border Province which lies south of the California Coast Ranges and Sierra Nevada, beginning with those ranges which have an easterly trend.

25. The Lower Californian Province consists of the mountains and related valleys south of the Los Angeles Ranges.

DESCRIPTION AND INTERPRETATION OF BOUNDARIES

LAURENTIAN HIGHLAND

As a major division lying mainly in Canada, the Laurentian Highland is a peneplain with local monadnocks, somewhat eroded after uplift, and thoroughly glaciated. Poor drainage is an almost universal characteristic so far as the region is known. Lakes and swamps abound and streams are relatively few. The prevailing thinness of the glacial drift, except locally on the southern border, has caused the entire region to be frequently spoken of as the "rocky lake country." These general characteristics are so closely associated with the resistant pre-Cambrian rocks that the Laurentian Highland must be treated as essentially coextensive with the great continuous area of pre-Cambrian rocks around Hudson Bay.

Eastward from Lake Superior the boundary of the Laurentian Highland is boldly marked for more than a thousand miles by the contact of pre-Cambrian with Paleozoic rocks, the surface on the latter being lower. South and west of Lake Superior, the glacial drift is, for some distance, so thick that the nature of the underlying rock has no physiographic significance. From this region the boundary of the pre-Cambrian terrane turns north into Canada and is again accompanied by a contrast in the surface features on its two sides. On the accompanying map the boundary of the Laurentian Plateau east and south of Lake Superior is drawn at the edge of the pre-Cambrian terrane, except that between the Laurentian Plateau and the Wisconsin Driftless Area the boundary is drawn at the edge of the younger glacial drift.

The name Superior Upland is here applied, without a definite northern limit, to that portion of the Laurentian Highland which
surrounds Lake Superior. In Wisconsin and the northern peninsula of Michigan, the fairly typical character of the province is represented here and there almost to its edge and the boundary line in this region is taken from the Willis Geologic Map of North America. In northeastern Minnesota the topography is highly characteristic, exhibiting penplain, monadnocks, rocky lakes, and imperfect drainage in typical form. The limits assigned to this province on the accompanying map west of Lake Superior are somewhat narrower than those of the pre-Cambrian area. The attempt has been made to separate in a general way the area whose topography is to some extent dependent on the pre-Cambrian rocks from the area in which the glacial drift is so thick that the topography is independent of the bed rock surface.

The Adirondack Province (p. 307) is geologically related to the Laurentian division, though no more closely than to the Appalachian Highlands.

**Atlantic Plain**

*Landward Boundaries of the Coastal Plain.*—The coast line divides the Atlantic Plain into two provinces, the Coastal Plain and the continental shelf. The outer limit of the Atlantic Plain is the edge of the continental shelf. Its inner or landward limit is the inner edge of the Coastal Plain. The theoretical landward limit of a coastal plain is difficult to fix. In practice, however, there is general agreement concerning the inner edge of this one throughout the greater part of its length. By common agreement it is placed at the inner edge of the Cretaceous rocks, or of the Tertiary where the Cretaceous rocks are absent.

As to the northern limit of the Coastal Plain, usage is not uniform. If Long Island and other islands east of it, together with Cape Cod, are to be considered parts of the Coastal Plain, they are thereby (according to the definition given on page 280) assumed to be parts of an upraised continental shelf and to have an existence as land surfaces by reason of such uplift. If it be assumed that they are purely accumulations of glacial drift on the sea bottom, they are not technically coastal plain. A part of Long Island, at least, would certainly be above water even if the drift were all removed. This being the case, the whole island should be included in the province. It is not clear that the islands farther east and Cape Cod are essentially anything more than deposits of glacial drift on a shallow sea bottom, though they contain some masses of Tertiary rocks. On the map here
presented Cape Cod and the islands mentioned are included in the Coastal Plain. The line from Long Island to Texas is a generalization of the above-mentioned geologic line. Between the 37th and the 40th parallels this boundary is known as the Fall Line, being marked by rapids in most of the streams and by a considerably greater altitude of the country on its west side. The essential reason for the Fall Line is the difference in strength between the rocks on its two sides but the difference in altitude must be otherwise explained. South of the 37th parallel the features of the Fall Line are less marked but the use of the term is often extended, and not inappropriately, to Central Alabama. In Missouri and Arkansas the Mississippi Alluvial Plain abuts against a similar steep slope.

The inner limit of Cretaceous and younger strata serves very well as a boundary for the Coastal Plain Province until Texas is reached. It fails there, partly because the lower Cretaceous in Texas consists of distinctly resistant rocks underlying the country far inland and having a distinct plateau topography, and partly because of the pronounced Balcones fault scarp, a feature which is inconsistent with the essential character of a coastal plain. This seaward-facing scarp is for several hundred miles a bold topographic feature and is here adopted as the inner boundary of the Coastal Plain. Throughout the greater part of its length this fault lies close to the boundary between the lower and upper Cretaceous outcrops. The former is the typical substratum of the adjacent plateaus. The latter is similar in its influence on the topography to the sediments elsewhere included in the Coastal Plain. From the point where the Rio Grande crosses the 101st meridian the scarp extends east to the 98th meridian and north to Waco. There it becomes faint and the boundary line of the Coastal Plain is continued north to the Ouachita Province along the western edge of the Upper Cretaceous terrane, here marked by the "Eastern Cross Timbers" which separate the Grand Prairie on the west from the Black Prairie on the east. The line on the accompanying map, so far as it follows the Balcones fault scarp, has been generalized from Hill's topographic map of the Texas Region.

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Sections of the Coastal Plain.—The northern (embayed or depressed) section of the Coastal Plain (see definitions, p. 280) is here limited by an arbitrary straight line drawn across the Province through Cape Lookout. Neuse River marks the boundary approximately. The line which separates the Floridian section from its neighbors is even more arbitrary. The Floridian section is strongly characterized, but the zone of gradation is at least fifty miles wide. The lines which bound the Mississippi Alluvial Plain differ little from those given on the geologic map of North America. The effort has been made to extend this section just far enough east and west to include all distributaries with their attendant natural levees and delta lakes.

APPALACHIAN HIGHLANDS

Piedmont Province

Boundaries.—The definition of the Piedmont Province (p. 281) necessarily fixes its western limit at the line where the plain or plateau topography gives way to one of mountains. Isolated mountains (like the many monadnocks in Virginia and the trap ridges of New Jersey) entirely surrounded by relatively level surface, are of course included in the Piedmont. Throughout the greater part of the boundary thus fixed there is not much room for difference of opinion as to its location. In New York, New Jersey, and Pennsylvania a distinct topographic break occurs along the line of contact between the weak Triassic of the Piedmont and the strong Cambrian and pre-Cambrian. In Maryland and Virginia as far south as the Chesapeake and Ohio Railroad west of Charlottesville, almost all of that which appears on the Virginia geological map (1911) as pre-Cambrian granite and granite gneiss, belongs to the Piedmont, the boundary of the mountain area lying but little east of the strong Catoctin schist. This formation and the strong Lower Cambrian are the essential substrata of the Blue Ridge in this latitude. The same formations farther east make the Catoctins which are entirely within the Piedmont area as here delimited.

South of Charlottesville and the Chesapeake and Ohio Railroad, geological contacts and contrasts seem to have nothing to do with determining the extent of mountain and plateau. The common boundary traverses a belt of crystalline rocks which are

not differentiated on available geologic maps. The inner edge of the Piedmont has an elevation of about 800 feet just south of Charlottesville, but its altitude increases to 1,500 feet in southern Virginia, North Carolina and Georgia. A glance at most of the topographic sheets crossed by this boundary line is sufficient to show a contrast between the lower country with its gentler slopes and closely woven web of roads, and the mountain country with its closely crowded contour lines and absence of cultural features.

For most of its length the western margin of the Piedmont province contains so many monadnocks that the question arises whether this belt might not better be included in the Blue Ridge province. For the purpose here in hand it has seemed best to retain the classification by which this belt was included in the Piedmont province but its exceptional character should be pointed out. Whether assigned to one province or the other it needs separate description. Bushy Mountain and South Mountain in North Carolina are essentially isolated mountain masses surrounded by the rolling Piedmont Upland; but they stand so close to the mountain province on the west that they might, with perhaps equal propriety, be considered as projections of it. As the boundary line is drawn on the accompanying map, the former course is adopted.

In northwestern Georgia the number and size of outlying mountains on the edge of the Piedmont (Pine Log Mountain and others) is so great as to leave in doubt the propriety of terminating the mountain province at Coosawattee River or extending it southward to include Pine Log Mountain. The latter course has the advantage of precedent and is here adopted,\(^8\) but the transitional character of this southern extension should not be forgotten.

In southeastern Pennsylvania where, for forty miles, the Blue Ridge is absent or represented only by isolated hills, there is little contrast in topography between the Piedmont and the Appalachian Valley which borders it. The line here used follows the contact of Triassic rock (typical of the northern Piedmont) and the older Paleozoic (typical of the Appalachian Valley Province).

In Georgia and Alabama south of the mountain province, the Piedmont is terminated on the west, not by a rise, but by a fall to the Great Valley. This break follows essentially the line of

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contact between the pre-Cambrian and Ocowee (Cambrian) series on the one hand and the younger and weaker Cambrian and Ordovician on the other.9

The topographic break along this line is easily traced westward from Georgia into Alabama. Turning more to the south again in the latter state, the topographic break becomes less clear. This is partly because of outlying ridges on the strong Chilhowee (Cambrian) series, these ridges being partly or wholly surrounded by the valley floor and separated geologically from the Piedmont by outcrops of the upper and softer Cambrian formations. Hence, in so far as the topographic break (and therefore the province boundary) can be referred to a geologic contact, it is drawn at the edge of the Ocowee outcrop. Farther north where the eastern boundary of the Great Valley is against the Blue Ridge province, the Chilhowee rocks and the mountains which they form are included in the area of the latter.

The remaining boundaries of the Piedmont on the east and south are all against the Coastal Plain.

Sections of the Piedmont Province.—The belt adjacent to the Blue Ridge, characterized by many monadnocks, should be recognized as distinct but its rank has not been fixed. For the present it stands as a part of the Piedmont Upland which comprises all that part of the province, much the larger part underlain by strong rocks and distinguished from the remainder by greater altitude and deeper valleys. The northern part of the province embraces two "Piedmont Lowlands," mainly on the relatively weak Triassic rocks extending in a narrow belt from New York to Virginia, but including several small contiguous areas of Ordovician limestone like the famous agricultural tracts around Lancaster, Pa. and Frederick, Md. These lowlands entirely surround or include on their margins some hilly belts and low mountain ridges like the Trap Ridges of New Jersey. As any detailed description of the Piedmont province must recognize other small divisions, these two lowlands are tentatively regarded as of lower rank than that of sections.

Blue Ridge Province

Boundaries.—The Blue Ridge Province embraces the Blue Ridge (range) and all the mountains strictly contiguous with it.

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The boundaries of this division are well marked. At very few points along its margin is there a zone of any considerable width whose reference to one province or the other might be in question if it be agreed that the belt of isolated monadnocks on the east shall be assigned to the Piedmont. As here outlined it embraces mountain country only, and is bordered by lower plateau country and valleys. The largest valleys within this mountain province can be comprehended in a single view and are seen to be surrounded by mountains. Isolated mountains rise also within the neighboring provinces, but they are entirely surrounded by the style of topography appropriate to those provinces. The boundary line on the accompanying map follows a topographic break, as traced on the large scale topographic sheets of the United States Geological Survey.

Throughout much of its extent this boundary line may be interpreted by noting its more or less close agreement with a geological contact. In such cases the logical description of the province is aided by using the line of contact as the province boundary, but it should be remembered that the contact is used merely as a means of interpreting a line which has been fixed by the criterion of topography. The western, or rather northwestern, boundary is thus determined throughout its entire length. For all practical purposes it agrees with the line where the stronger rocks of the pre-Cambrian or earlier Cambrian give way to the limestones and shales of the later Cambrian and Ordovician.

The boundary in Pennsylvania is a sharp topographic break, essentially at the contact of the "Cambrian Quartzite," shown on the geologic map of Pennsylvania (1893), with the Cambro-Ordovician rocks farther west. This is not quite equivalent to drawing the province boundary between the Georgian and the later Cambrian, since the topmost member of the former as mapped in the Mercersburg-Chambersburg Folio,\textsuperscript{10} plainly belongs to the Great Valley. It is sufficient for the present to say that the quartzitic lower formations of the Cambrian, mapped by the Pennsylvania Survey as quartzite, lie within the mountain province and their contact with the weaker rocks on the west determines the province boundary.

Crossing into Maryland, the line continues to be determined, as in Pennsylvania, by the hard sandstone members of the Cambrian which underlie (stratigraphically) what is here as elsewhere

mapped as Cambro-Ordovician. The Weverton sandstone is the chief one of these in Maryland.\textsuperscript{11}

On the state geological map of Virginia (1911) the distinctively Cambrian formations (generally strong) are distinguished from the Cambro-Ordovician, consisting of limestone and shale. From the Potomac to the Tennessee boundary the topographic break between mountain and valley occurs at the contact between these strong Cambrian sandstones and quartzites on the east and the limestones and shales of the Cambro-Ordovician on the west. The line is closely followed in turn by Shenandoah River, by a part of New River, and by branches of the Holston. Throughout nearly the whole distance the Norfolk and Western Railroad (or its branches) runs parallel to the line thus indicated, always on the side of the limestone, and for more than half the distance it is less than five miles away from the contact.

In Tennessee the topographic break is likewise clear, as shown in the numerous folios of the United States Geological Survey. The older Cambrian (Chilhowee series) and the Ocowee belong to the mountain province and the Knox Dolomite and younger formations to the Valley.\textsuperscript{*} The same relations continue in Georgia where the Ocowee series is not differentiated from the granite on the most recent geologic map.\textsuperscript{12} At about latitude 34° 30' the mountain province ends. South of this the valley province is bounded by the Piedmont. The southern limit and eastern boundary of the mountain province have been described above.

Sections of the Blue Ridge Province.—The two sections of the Blue Ridge Province (defined on p. 281) are separated with a fair degree of accuracy by Roanoke River. The northern section bears the name Blue Ridge (along with local names) throughout its entire length. This name is also applied to the main water-parting of the southern section, which follows the eastern edge of the province, but most of the mountains of the southern section bear other names. They are distinctly excluded from the Blue Ridge, though included in the Blue Ridge Province.

Appalachian Valley and Ridge Province

General Relations.—The Valley and Ridge Province and St. Lawrence Valley together comprise a continuous series of depressions

\textsuperscript{11}Cf. Maryland Geol. Map, 1906, with Harpers Ferry Topographic Sheet.
\textsuperscript{*}See page 247.
\textsuperscript{12}Georgia Geological Survey, Bulletin 23, 1910.
throughout the entire length of the Appalachian Highland. These two valley provinces merge in latitude about 43° 30', though at their juncture the valley is only three or four miles wide, and even this narrow passage is in part occupied by isolated hills related to the New England Province. The Valley Province occupies a medial position in the Appalachian Highlands; the St. Lawrence Valley lies on the western flank of the Appalachian Highlands and is bounded on the west by the Laurentian Highland. The continuity of the Appalachian Valley Province is so striking that the exact locations of transverse boundaries between subdivisions are more or less arbitrary. While it is essential that this continuity be recognized, it is none the less necessary to divide the province into three sections for the discussion of its character.

**Tennessee and Middle Sections.**—The distinguishing characteristic of the Middle and Tennessee (southern) sections is a topography of parallel longitudinal valleys and mountain ridges made by erosion in the second (or later) cycle after folding. The middle section is distinguished from the Tennessee section by having on its southeast side a broad belt which is characteristically free from mountain ridges. The two sections differ also in the plans of their ridges and valleys, those of the southern section being relatively straight, while many of the ridges of the Middle section, especially in its northern part, have a zigzag plan, thus enclosing canoe-shaped valleys. The master streams of the Tennessee section are longitudinal; those of the Middle section transverse. Aside from these differences, the two sections are much alike. The drainage pattern of both sections is in large part trellised. The boundary between them is here placed at the divide between the Tennessee drainage system and that of New River. These two sections are distinguished from the neighboring provinces by lines over which there can be little disagreement. The next province on the west has a plateau surface and, in general, dendritic drainage. The provinces on the east show so little parallelism of valleys as to suggest at once a more complex structure and rocks of different character.

The southeastern boundary of these sections separates them from the Blue Ridge Province and from the Piedmont. It has been traced and described in bounding those provinces. In eastern Pennsylvania, New Jersey, and New York the boundary is against that extension of the New England Province which has been
called the "Reading Prong," better known in New Jersey and New York as "The Highlands." It is marked by a perfectly clear topographic break which approximately corresponds in position with the contact of the pre-Cambrian with Paleozoic rocks. At its southwest end the Valley Province merges into the Coastal Plain with no sharp topographic contrast. For the sake of consistency elsewhere, the boundary line should follow the inner edge of the Cretaceous rocks.

The northwestern boundary of this part of the Valley and Ridge Province is the escarpment of the Appalachian Plateaus whose course is as follows: Beginning at the south in the vicinity of Birmingham, Ala., the eastern edge of the plateau is represented by Sand Mountain and after a short distance by Blount Mountain and farther north by Lookout Mountain. These are east-facing scarps of plateaus of Carboniferous Coal Measures. Lookout Mountain terminates at Chattanooga and the province boundary passes to the front of a more westerly plateau which bears the name Walden's Ridge. The east-facing scarp for a long distance north of Chattanooga is called the Cumberland Front.

Lookout Mountain is a large outlier of the plateau whose main portion lies to the west. It is entirely surrounded by valleys which are typical of the Appalachian Valley Province. But since the outlier is broad in comparison with the separating valleys, it is considered best to draw the boundary line around it, thus including in the plateau province the valleys of Wills and Lookout Creeks.

North of Chattanooga the boundary line follows the foot of Walden's Ridge and Cumberland Mountain and thus the edge of the Carboniferous rocks. The same line may be traced northward into Pennsylvania between the plateau generally capped by Carboniferous rocks but having local marginal benches of Devonian, and the valley underlain by Devonian and older rocks. The scarp, though locally absent in southern Virginia and West Virginia, is generally clear, and the contrast of elevation and topography on the two sides is marked. The edge of the plateau bears in succession the names Sand Mountain, Blount Mountain, and Lookout Mountain in Alabama and Georgia; Walden's Ridge and Cumberland Mountain in Tennessee and Kentucky; Stone Mountain, Rich Mountain, and Allegheny Front in Virginia and West Virginia, besides numerous other local names. It overlooks in succession the valleys of Cahaba and Coosa Rivers in Alabama and Georgia; Tennessee River, Clinch River and its tributary Powell River,
Bluestone and East Rivers (Pocahontas Quadrangle), Greenbrier River, Valley River, New Creek, and Potomac River. The following railroads run essentially at the foot of the great scarp: the Alabama Great Southern south of Lookout Mountain, the Chattanooga Southern east of Lookout Mountain, the Cincinnati Southern from Chattanooga to latitude $36^\circ$ (Harriman Junction), branches of the Southern Railroad from this point north to latitude $36^\circ 20'$ (the jog in the Briceville quadrangle), the Norfolk and Western along Clinch River and to latitude $37^\circ 30'$, and the Chesapeake and Ohio along the Greenbrier.

In Maryland the edge of the plateau is called Dans Mountain.$^{18}$ It overlooks Potomac River and its northern tributary Wills Creek. The foot of the escarpment is followed through Maryland and north into Pennsylvania by branches of the Baltimore and Ohio Railroad. In western Maryland an extensive outlying plateau of Carboniferous (Pennsylvanian) strata is separated from the main plateau to the west by an anticlinal valley. This plateau whose eastern escarpment is called Dans Mountain is analogous to Lookout Mountain and is included in the Plateau Province for the same reason.

From the southern boundary of Pennsylvania north and east to the elbow of the Susquehanna east of Williamsport, the perfectly definite escarpment is known as the Allegheny Front. It is followed for forty miles by the Susquehanna River and for one hundred miles by the Bald Eagle branch of the Pennsylvania Railroad. Eastward from the west branch of the Susquehanna River the plateau surface is on the Pocono and Catskill formations and is essentially coextensive with these around the edges of the anthracite coal fields. The synclinal Wyoming Valley makes a long northeasterly extension of the valley province surrounded by steep inward-facing slopes. At Mauch Chunk the regular north-east trend is resumed, the scarp being formed first by the Pocono formation and then by the Catskill, overlooking Delaware River and in turn Neversink Creek, Rondout Creek and Hudson River. The Delaware and Hudson Canal and several railroads run close to the foot of the scarp.

The above described boundary lines, as shown on the accompanying map, are generalizations from the topographic sheets of the United States Geological Survey wherever such sheets are available. South of central Pennsylvania the boundary differs

little from the edge of the Carboniferous as generalized on the geological map of North America. In New Jersey and New York as far north as latitude 42° 15', the boundary on the accompanying map differs little from the edge of the Catskill formation as shown on the geologic map of New York.¹⁴

**Hudson Valley.**—The Hudson section of the Valley and Ridge Province is distinguished from the Middle and Tennessee sections by the absence of mountain ridges. In structure it is similar to the two sections farther south, but the folded strata are almost uniformly weak. Distinguished in this way, the Middle section ends with a fair degree of clearness at Hudson River, Shawangunk Mountain being the northernmost of the characteristic even-topped mountain ridges. South of latitude 42° the Hudson is taken as the eastern boundary. Between the Catskill Mountains and Hudson River is a continuous strip of lowland about six miles wide. Across this the section boundary must be drawn arbitrarily.

The plateau escarpment described above continues northward as the eastern slope of the Catskill Mountains overlooking the Hudson Valley. East of this and near the river, the Helderberg formation makes a low cuesta. This cuesta with its east-facing scarp becomes higher toward the north, and beyond the parallel of 42° 15' constitutes a distinct plateau which is here included in the Appalachian Plateaus Province. West of Albany the escarpment of this plateau turns west as the southern limit of the Mohawk Valley. Another east-facing scarp, however, continues north along the 74th meridian as the western boundary of the Hudson Valley. It does not correspond to any important geologic line, but it separates a lowland of 300 to 500 feet altitude from a dissected plateau 1,000 to 1,400 feet high. When followed northward this escarpment becomes less clear and merges with the eastern boundary of the Adirondack Province, which there limits the Hudson Valley on the west.

The eastern boundary of the Hudson section is against the Taconic section of the New England Province (p. 305). At the north the Hudson Valley section is continuous with the Champlain section of the St. Lawrence Valley Province. Near the low divide which separates the drainage of the two sections the valley is only three to four miles wide and interrupted by hills which have the character of the neighboring Taconic Mountains. On the accompanying map the two provinces are separated by a line

¹⁴ Merrill, 1901.
crossing the valley at its narrowest point a little north of latitude 43° 30'.

St. Lawrence Valley

The St. Lawrence Valley is an important province in Canada, strongly individualized, its characteristic level plain abutting along most of its boundary against the highlands which surround it. Within the United States the St. Lawrence Valley is represented by the Champlain Valley and a narrow strip north of the Adirondack Mountains. The former constitutes a distinct section of the St. Lawrence Valley Province. Its boundary against the Adirondacks is marked by the contact of Paleozoic and pre-Cambrian rocks. The greater part of the eastern boundary is at the foot of the Green Mountains. This line agrees in the main, but not accurately, with the contact of Paleozoic and pre-Cambrian rocks. In its narrow southern extension the relation of the Champlain Valley to the Taconic Mountains on the east is the same as that of the Hudson Valley described above.

Appalachian Plateaus

Boundaries.—The essential features of the Appalachian Plateau Province are those of a dissected plateau, although considerable areas in its southern portion are still in the youth of their erosion cycle. Except on its western side in Tennessee and adjacent states, all its boundaries are against other provinces which are not dissected plateaus. The southern half of its western boundary separates this province from the Highland Rim Plateau, which is likewise a somewhat dissected plateau, but so clearly distinguished by its lower elevation that popular usage has made the distinction in name and recognizes the same boundary which is used by geologists.

The absolute altitude of this province is not a criterion for its delimitation. Its uplands rise above 3,000 feet near the middle and fall as low as 500 feet at its southern extremity in Alabama, but the topography remains that of a more or less dissected plateau. Occasional folds give rise to certain local variations in topography but these in general are surrounded by flat-lying strata. Thus the province is characterized by a certain unity of structure and topography.

Throughout at least four-fifths of its boundary this province is higher than its neighbors and is separated from them by an out-
ward-facing escarpment. The best known escarpment is on the east side, where it is known in succession from north to south as the Catskill Mountains, the Allegheny Front, and the Cumberland Front. No one system of rocks forms the plateau surface or makes the scarp everywhere. The upper Carboniferous is most prominent but in central Pennsylvania a narrow bench on the Catskill formation (Devonian) constitutes the eastern margin. The eastern escarpment of this province has been described as a boundary of the Appalachian Valley Province which it overlooks. The line was there traced from central Alabama to the Adirondack Mountains in New York.

The Appalachian Plateaus border on the Adirondack Mountains from longitude 73° 45' (near Saratoga, N. Y.) to longitude 75° 30'. In the eastern half of this boundary the Adirondack Province is distinctly higher than the plateau. The relatively weak strata which compose the plateau abut against the crystalline mass which makes the mountains. Through most of the western half, the topographic relations are reversed. The Adirondack Province in this part is almost a peneplain and the plateau consists of a great southwest-sloping dissected cuesta, with its north-east-facing scarp locally five hundred feet high, overlooking the Adirondack Province. At the foot of this scarp flows Black River which marks the province boundary. On its lower (southwest) side this cuesta borders the Eastern Lake section of the Central Lowland. The boundary is fairly definite, and the character of the cuesta as a whole is strongly contrasted with that of the lowland to the west.

A short distance west of Utica the line which marks the western edge or foot of this dissected cuesta meets the east-west escarpment which is the northern limit of the Southern New York section. This latter escarpment is approximately on the outcropping edge of the Helderberg limestone. Between this place and the point west of Albany mentioned on page 300 it does not deviate greatly from this geologic line. The outcrop of the Helderberg is the chief determining factor in the escarpment as far west as Oneida Lake where the edge of the Onondaga takes its place. This in turn gives way to the Tully limestone. Between Cayuga and Seneca lakes the edge of the plateau shifts to the outcrop of the Portage sandstone which it follows to a point south of Buffalo. From the Mohawk Valley to Buffalo the escarpment here traced was essentially the south shore of the Pleistocene lake
at the time when the first continuous lake stretched from the Erie basin to the Mohawk.  

Between a point south of Buffalo and southern Ohio, the line here used as the limit of the Appalachian Plateaus follows no outcrop indicated on the geological maps of New York, Pennsylvania, or Ohio. To a point in northeastern Ohio it lies within the Devonian and beyond that in the Lower Carboniferous. The line is described by Leverett from the Genesee Valley to southern Ohio and is traceable on all the United States Geological Survey topographic sheets along its course, separating the somewhat dissected plateau on the south and east from lake flats and rolling plains on the north and west. South of latitude 40° 30' the line lies near the edge of the glacial drift, but the thin edge of the latter generally overlaps the plateau, its edge almost following the western limit of the Pennsylvanian Coal Measures. It seems best, on the whole, however, to follow the line of the topographic break a little farther west, since neither the edge of the Coal Measures nor that of the drift could be followed far either north or south.

From Chillicothe, Ohio (latitude 39° 15') southward, the topographic break agrees essentially with the Carboniferous-Devonian contact and this relation continues as far south as Kentucky River. At that place the western edge of the Carboniferous is also essentially the western edge of the Coal Measures. North of that point the topography on the narrow strip of Lower Carboniferous is not materially different from that of the Coal Measures on the east. South of that point the western edge of the Coal Measures is marked by an increasingly bold escarpment which separates the Cumberland Plateau (Pennsylvanian) from the Interior Low Plateau (Mississippian). The province boundary follows this contact southwestward to the boundary of the Coastal Plain.

Sections of the Appalachian Plateaus.—The sections of the province are distinguished in some cases by altitude, in others by degree of dissection, in still others by features dependent on

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16Frank Leverett, Glaciation in the Erie and Ohio Basins, U. S. Geol. Surv. Mon. 41, p. 67. A part of the plateau, in Northeastern Ohio is so strongly characterized by glacial features as to raise the question whether it might better be included in the Eastern Lake Section of the Central Lowland. It seems best, however, to treat it as a local and exceptional district of the plateau province.
the attitude of the rocks. The main portion of the Mohawk section is a strike valley at the foot of the Helderberg-Onondaga escarpment. The ends of this valley are lowlands and belong to other provinces, but between Utica and Schenectady the Mohawk is entrenched in a dissected plateau, a part of the Mohawk section. The northwestern extension of this section is, as stated above, a dissected cuesta which rises to a maximum altitude of two thousand feet. The Catskill section is almost coextensive on its north and east sides with the strong Catskill conglomerate. On the south and west sides the same strata are much more extensive but less elevated.

South of the escarpment in central New York is the Southern New York (glaciated) section extending from the Hudson Valley to central Ohio. The southern boundary of this section almost marks the limit of advance of the later continental ice sheet (the earlier ice having gone farther south) but the contrast in topography between the two sides of the boundary are not sharp. Except in Ohio the topographic effects of glaciation disappear gradually over a wide transitional zone. The much generalized boundary is drawn, as near as possible, at the line where glaciation ceases to be obvious. The southern margin of this section, although approximately mature in its erosional development, differs in important respects from the Kanawha section to the south. The latter has not only a stronger relief but is more minutely dissected by tributaries. Where New River enters the plateau province, is a small area of high lying plateau remnants on hard horizontal sandstones. On the accompanying map this small area is for convenience included in the Kanawha section, but its character is exceptional. On a more detailed map it should be recognized as a unit of lower order.

The eastern margin of the province (Allegheny Mountain section) is affected by open folds or structural undulations. South of latitude 41° these give rise to anticlinal ridges, and north of that to indefinite higher belts either synclinal or monoclinal.

The Cumberland Plateau section is characterized by broad uncut remnants between deep valleys. Toward the southwest this character gives way to milder relief. A small area at the south end on Warrior River is a maturely eroded hill country. The Cumberland Mountain section in southern Kentucky and northern Tennessee is analogous to the Allegheny Mountain section. At its south end it includes a small area of ruggedly dis-
sected plateau which is higher than the adjacent submature Cumber-
land Plateau.

New England Province

General Relations.—The New England Province is in a sense the northeasterly extension of all the Appalachian provinces except the plateaus. It is much like the Appalachian provinces in the age of its rocks and their general deformation. Its erosional history differs only in detail, but unlike the more southerly provinces it has been glaciated.

The recognition of a separate New England Province is largely a matter of convenience. The Appalachian belt (east of the plateaus) is very narrow in the latitude of New York City. The northward continuation of its several provinces, while very real geologically, is not usable geographically. Instead of simplifying geographic treatment it makes it more complex. Glaciation is also important in New England though its southward extent does not coincide exactly with that of the physiographic province. Severe metamorphism, with its corresponding effects on the style and history of erosion, affects the Taconic section, while farther south the ridges of the Valley and Ridge province are almost free from such effects.

Sections of the New England Province.—The treatment of the physiography of this region is facilitated by assigning to the New England province all that lies east of the Hudson Valley lowland. The rocks underlying that valley are weak, as are those of the other valleys of the Valley and Ridge Province. East of the Hudson Valley in the Taconic Mountains the same rocks and others have been profoundly metamorphosed and rendered resistant. It is largely on this account that the topography in this folded zone differs from that of the ridges in the Valley and Ridge Province. The relations of topographic form to geologic structure are less close. Farther south peneplains dominate the topography and monadnocks above the highest peneplains are less numerous. In the Taconic section the most conspicuous feature is a range of residual mountains above the highest peneplain. This section includes the Rensselaer Plateau on the west, a peneplain on metamorphosed rocks, imperfectly dissected. On its eastern side it includes the long continuous limestone valley occupied by Hoosatonic River and other streams.

East of the Taconic section is the Green Mountain section. Geologically this is a northern extension of the Blue Ridge prov-
ince and physiographically it is more like its southern correlative than is the Taconic section like the Appalachian ridges. This section may be recognized on the geologic map by its axis of pre-Cambrian granite but some other rocks are included. The mountain summits suggest a much dissected peneplain or perhaps remnants of several peneplains.

Another section\(^\text{17}\) consists of irregular patches of subdued residual mountains rising above a plateau surface, like the White Mountains in New Hampshire and the Calendonian in Vermont and numerous monadnocks more or less separated. The entire area within which such mountains stand sufficiently close to give the country a mountainous character is, for purposes of general discussion, treated as the White Mountain section. Valleys and subordinate strips and patches of peneplain are implied in the definition of the section. For more detailed treatment it may be wise to subdivide this into two or more parts. In any case, further refinement will demand units of a smaller order. The generalized boundary may be improved, but the essential fact remains that the area within the boundary here given is of the mountainous character here described and differs from the surrounding country in which a plateau character prevails.

The surrounding country constitutes another section, the New England Upland. It consists of peneplains cut by rather sharp and narrow valleys, giving the surface a plateau aspect. Monadnocks appear here and there, and the effects of glaciation are everywhere. In general this surface ranges in height from 1,100 feet or more, around and among the mountains farthest from the sea, down to less than 600 feet at the boundary of the Sea-board Lowland.

To the general statements here made about the New England upland there are three important exceptions requiring recognition of units of a lower order or perhaps justifying an increase in the number of sections. These are (a) The Connecticut Valley, a peneplain lowland on the weak Triassic rocks in Massachusetts and Connecticut like the lowlands of the northern section of the Piedmont province (p. 294), even to the Trap Ridges. (b) The wide Lowland of the Penobscot Valley, allied by its

\(^{17}\)For the information which makes this outline of sections possible the writer is indebted to Arthur Keith whose detailed studies (as yet unpublished) will make possible a much greater degree of refinement than is here shown. The writer is responsible for the rather free generalization.
character with the Seaboard Lowland with which it connects by a narrow neck. It may be treated with that section or with the New England Upland according to the purpose in hand. (c) The Nurrumbega Highland, a district of low mountains between the Penobscot and the Coast.

The Seaboard Lowland is the low margin of the New England province, rising but little above five hundred feet on its landward side, though occasional monadnocks rise above it. It includes the islands of the Maine coast but not necessarily Cape Cod or the islands south and west of it which may be considered as isolated parts of the coastal plain province. In contrast with the plateau surface which is cut by narrow valleys, this section is more than half valley floor, the intervening hills being generally rounded.

Adirondack Province

The boundaries of the Adirondack Province have already been stated in describing those of neighboring divisions. The distinctive topography of this province is due to the crystalline rocks which compose its substratum. In general, these are stronger than the Paleozoic rocks which surround them; hence the Adirondack Mountains. In the western part, however, mountains are wanting and the adjacent plateau rises five hundred feet above the Adirondack Province.

Geologically this province might be called a peninsula of the Laurentian Highland with which it is connected by a very narrow neck of crystalline rocks. Topographically, it is more like the White Mountains and others of New England, and it has shared the physiographic history of the Appalachians.

INTERIOR PLAINS

Interior Low Plateaus

Features of the Province.—This province lies west of, and distinctly lower than, the southern part of the Appalachian Plateaus. It has been known as the "Interior Lowlands," but the portions which may strictly be called lowlands are essentially isolated even though very important. The rest is typical plateau, even though in the western part the uplands and divides have an altitude of only about 500 feet. The altitude on the eastern side is about 1,200 feet. East of the Nashville Basin in Tennessee,

18C. W. Hayes, Physiography of the Chattanooga District, U. S. Geol. Surv., 19th Am. Rep., Pt. II.
where dissection is submature, the plateau is known as the Highland Rim, but the country thus designated grades without a break into the lower and maturely dissected upland of western Kentucky and southern Indiana and Illinois. Its essential plateau character is continuous even though the summit levels decline gradually to about five hundred feet. Within this area are two basins (the Nashville and the Lexington) which are recognized as sections.

**Boundaries.**—The boundaries assigned to the province are as follows: Beginning in southern Ohio where the edge of the glacial drift intersects the western edge of the Carboniferous rocks, the province boundary is traced south along the western edge of the Carboniferous to Kentucky River. Throughout this distance the narrow belt of Mississippian is thrown in with the Kanawha section of the Appalachian Plateaus. South of Kentucky River the boundary between the Interior Low Plateau and the Cumberland Plateau is the escarpment at the western edge of the Coal Measures, the Mississippian being the substratum of the Highland River section. This line is a bold one in Tennessee, less bold but still adequate in Kentucky, but faint in northern Alabama where the Cumberland Plateau itself is low. Stream erosion has made the boundary very irregular. In the mapping of large areas it is necessarily generalized.

In northwestern Alabama the low plateau borders the Coastal Plain along the Carboniferous-Cretaceous contact. This line is ragged and indefinite and generally not marked by an abrupt change in elevation or topography. On the plateau side (north-east) the Cretaceous appears in isolated patches capping hills and uplands. These should be allotted to the plateau. On the side of the Coastal Plain the Carboniferous appears only in stream valleys. Such should be counted in the Coastal Plain. The transition belt is thus narrowed to a few miles. Within this zone are some points where the contrast is sharp, being expressed in topography or in soils or in both.

In western Tennessee and Kentucky this province borders the Coastal Plain, the line being the Paleozoic-Cretaceous contact. For practical purposes Tennessee River may be considered the boundary. The same contact is followed west through southern Illinois almost to the Mississippi. A small area east of that river is allied by the character of its rocks, its elevation and its topography, with the Ozark province on the west. On the map here given
the attempt is made to draw the western boundary of the Interior Low Plateau in such a way as to allot to the Ozark province the distinctly high and rougher western part of Illinois south of the Till Plains. The portion thus assigned to the Ozarks has a distinct eastward slope in agreement with the dip of its rocks.

Eastward from the Mississippi the edge of the glacial drift constitutes the boundary between the Till Plains on the north and the Interior Low Plateau on the south. Its general course is eastward to the Appalachian Plateau. East of Louisville it does not deviate much from the course of Ohio River, but west of that it bends far northward around southern Indiana which has a topography much like that of Kentucky west of the Lexington Plain. The edge of the drift is not sharply marked. Locally the drift thins out gradually thru a zone of twenty miles or more.

Sections of the Interior Low Plateau.—The two lowland sections within the Interior Low Plateau comprise the areas of rock older than Carboniferous. The edge of the latter forms an escarpment, locally frayed and irregular, entirely around the Nashville Basin and around the Lexington Plain on the east, south, and part of the west sides. Throughout practically its entire extent this escarpment is plainly visible as a range of hills, when viewed from the basin floor. The northern boundary of the Lexington Plain is the edge of the glacial drift, that is, the outer boundary of the province. The plateau between and around these two basins is the Highland Rim Plateau or section. The western end of the province, beside being lower, shows local topographic effects of faulting and also of valley filling. It is not improbable that these features justify the recognition of a distinct section.

Central Lowland

Boundaries.—An irregularly shaped region stretching north, south and east from central United States, is essentially a low plain. It is in the main bounded by lands which are either not low or not plains. The northern, eastern, and southern boundaries of this province have already been described throughout most of their extent. The Central Lowland extends far north into Canada with boundaries similar to those which prevail in adjacent parts of the United States.

The separation of this province from the Great Plains Province on the west is made necessary, not so much by the sharpness of

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19See map by Leverett, U. S. Geol. Surv., Mon. 38, Pl. VI.
the dividing line as by the contrast in general character between the two areas. The Great Plains are described on page 317. The Central Lowland, while not now at its local baselevel, is nevertheless characterized by relative lowness and relative levelness. Large areas adjacent to the Great Plains are peneplain. The boundary line between these two provinces, not itself a bold topographic feature, is, throughout most of its length, an east-facing escarpment. While but a few hundred feet high, the streams which cross this escarpment generally find themselves on its east side not very far above their local baselevels. The surface west of the escarpment is a few hundred feet higher and actively dissecting.

Beginning in North Dakota, the Plateau of the Missouri (not the Missouri Coteau but the plateau on which the latter rests) terminates on the east, or northeast, in an escarpment 300 to 400 feet high. Through most of its length of more than three hundred miles in North Dakota, railroads follow the foot of this escarpment. On one side of the line lie the fertile prairies of North Dakota, adapted to farming; on the other, above and beyond the escarpment, the high grazing lands of the Altamont moraine, the real Coteau of the Missouri, where topographic surveys have not been made. The line here used is taken from the reconnaissance soil map of western North Dakota.\(^{20}\) The topographic break is shown very clearly on the Edgely and adjacent topographic sheets of the United States Geological Survey. Continuing into South Dakota the line becomes less clear. It is nowhere far from the Missouri-James divide.\(^{21}\)

In Nebraska alone, the line is almost wholly arbitrary. Between typical low Prairie on the east and typical Great Plains on the west there is complete gradation with no abrupt change of altitude or style of topography. Neither bed rocks nor glacial drift are topographic factors of importance, for both are buried by loess whose maximum depth reaches more than sixty feet. However, since the line in the Dakotas is plain and a similar line in northern Kansas is fairly plain, and the edge of the glacial drift in Nebraska (so far as determined)\(^{22}\) is essentially in line with the escarpments in South Dakota and Kansas, this line, the edge of the glacial drift, is arbitrarily taken as the boundary in Nebraska.


\(^{21}\)The data for the location of this boundary were furnished by N. H. Darton.

In northern Kansas the outcrop of the Dakota sandstone forms a rugged belt known as the Smoky Hills, reaching from the Nebraska line almost to Arkansas River. The Smoky Hills, the eastern eroded margin of a highland which is continuous toward the west, determine the natural western boundary of the Central Lowland.

The eastern margin of the hilly belt is, of course, frayed and irregular, but forms a natural boundary between contrasted topographic types from the Nebraska line southward to the center of Kansas; that is, to a point not far west of McPherson. Fifty miles straight south of this point a similar contrast is found, the low plain on the east being uninterrupted, though its altitude declines southward. On the west is a narrow belt of dissected upland called the Red Hills, its substructure being of the Permian "Red Beds." The ragged escarpment is 300 to 400 feet high. These Red Hills are merely the narrow dissected margin of the plains on the west. On the map herewith presented they are included in the Great Plains province.

The break of fifty miles in Kansas between the Smoky Hills and the Red Hills is due to a gradual transition from lowland on the east to highland on the west. The escarpment is thus interrupted and there is a westward extension of level prairies south of Arkansas River known as the Great Bend Lowland. It is a smooth surface rising to the westward and is quite as high on any one meridian as the crests of the Smoky Hills upland on the north and the Red Hills upland on the south. It is not a lowland in the sense of lying near sea level, being 1,500 feet high on the east and rising steadily to 2,300 feet on the west. Neither is it low by comparison with neighboring areas north and south. It is a lowland only in the sense of being near to its own local baselevel, for the Arkansas has been unable to entrench itself deeply here, probably because of the strong rocks crossed farther east. The parallel streams on the north and south have cut their channels from 100 to 300 feet lower on the same meridians. Their tributaries have therefore dissected into "Smoky Hills" and "Red Hills"—the plateau which here remains as the "Great Bend Lowland."

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This level prairie, being agriculturally favored, is commonly thought of as an arm of the Central Lowland extending into the Great Plains, but its topography and geologic history are those of the Great Plains. (See below under that subject.) Indeed, all but a narrow strip along the river preserves the flat surface of the High Plains (the central division of the Great Plains), having been saved from erosion by the inability of the Arkansas to erode deeply because of the disadvantage mentioned above.

Whether this "Great Bend Lowland" be included in the Central Lowland or in the Great Plains, there are difficulties in drawing the boundary. On the whole, it seems best to include it in the Great Plains where it naturally belongs by reason of its geologic and physiographic history. Otherwise, arbitrary boundaries on the north and south must be selected. Its separation from the Central Lowland on the east must also be by an arbitrary line. However, if the two free ends of the well-established boundary be connected by a straight line across the fifty-mile gap in southern Kansas, the resulting line will not be far from the eastern edge of the Cretaceous and Tertiary rocks, both highly characteristic of the Great Plains.

It is worthy of note, also, that even from an agricultural point of view the western end of the Great Bend Lowland differs quite as much from the typical prairies of the Central Lowland as the eastern end does from the border of the Great Plains. 25

East of the meridian of 97°, and entirely surrounded by typical prairie of the Central Lowland, is a north-south belt called the "Flint Hills," extending northward from northern Oklahoma about halfway across the state of Kansas. This belt has been described by Adams 26 as belonging to the Great Plains Province. The character of the belt would justify this, but it is impossible to connect it with that province without including in the same boundary almost an equal area of typical prairie lowland. It seems better to describe the Flint Hills as a local feature, as must be done for the Wichita Mountains in Oklahoma, the Turtle Mountains in North Dakota, and many other exceptional features. This is the more appropriate because the Flint Hills constitute but one, although the largest, of a series of parallel cuestas caused by outcropping strong strata in the Osage section of the Central Lowland.

26Geo. I. Adams, loc. cit.
It is thus seen that throughout the six states traversed by the eastern boundary of the Great Plains, the line in four of these and a part of the fifth (Kansas) is satisfactory. It has geological significance, conforms to popular usage and is marked by a topographic contrast within a narrow belt. The satisfactory character of three-fourths of the entire line justifies the somewhat arbitrary character of the remaining fourth.

In southern Kansas just north of the Oklahoma boundary the Red Hills escarpment divides into two parts. The outcrop of the upper beds continues westward in a strong escarpment capped by the Tertiary beds of the High Plains. It then turns south and with varying distinctness crosses Oklahoma into the Panhandle of Texas. This is the real "break of the plains" and the boundary of the Great Plains province.

The outcrop of the lower beds of the Red Hills escarpment turns south near the 99th meridian and then southeast. For the first one hundred miles in Oklahoma these beds outcrop in a rugged escarpment, locally several hundred feet high, known as the "Gypsum Hills." Farther south this feature becomes indefinite. Both east and west of it are similar, though smaller, east-facing escarpments. The presence of these is one of the characteristics of the Osage section of the Central Lowland. Several of these in northeastern Texas are very prominent, but the topography east and west of them is the same and allied to the Central Lowland rather than to the Great Plains, hence the former province is made to extend west to the line previously indicated.

This southwestern part of the Central Lowland differs from the remainder of the province not only in the magnitude of its escarpments but also in the sharp entrenchment of its major streams. Extensive undissected peneplains are, however, its dominant feature and these are apparently continuous with those of the province elsewhere and, for aught that is known, of the same age.

_Driftless Sections of the Central Lowland._—The Central Lowland is subdivided into sections on the basis of features due to glaciation. Locally, as in Wisconsin, there appear clearly marked subdivisions determined by the underlying rocks, but the lines which are clearly marked in this state are serviceable for only a short distance beyond its limits. The use of such lines would therefore leave the major part of the province undivided, whereas its several parts are clearly distinguished on the basis of glacial features. On
this basis the most evident distinction is between drift-covered and driftless. Two of the section are driftless or nearly so. One of these, the Osage Plains, lies south of the southern limits of glaciation. It is separated from the Dissected Till Plains to the north by a line following approximately the course of Kansas River. The boundary is not very clear for the drift on the north is thin and very much eroded. Furthermore, a covering of loess on both sides of the line reduces the contrast still further. The character of this section has been mentioned in discussing the province boundary.

The Wisconsin Driftless section lies three hundred miles north of the southern limit of glaciation and is entirely surrounded by drift-covered areas. The essential topographic feature of this area is its dissected plateau character. Its topography is not unlike that of western Kentucky. In the northern part of this area the valleys have been filled by outwash, making plains of such wide extent that the hilltops rise above them as isolated buttes. The contrast with the lake section on the east is sharp, the boundary being marked by the front of the late Wisconsin terminal moraine, one of the boldest terminal moraines on the continent. On the other sides the boundary line is indefinite. On the west and north are margins of old and much eroded drift. Their topography is much more like that of the Driftless Area than like that of the neighboring sections. It is partly for this reason, but largely because the areas are too small to justify their recognition as independent sections, that they are included in this section. For the purpose here in hand the Wisconsin Driftless section is made to cover essentially the area whose topography is not affected, or but little affected, by glacial drift, other than outwash.

Lake Sections of the Central Lowland.—East and west of the Wisconsin Driftless section are two large sections of the Central Lowland whose topography is dominated by recent glaciation in a region of moderate relief. Terminal moraines, with their various features; ground moraines embracing mildly rolling plains, rounded and veneered hills; outwash plains, in some cases profusely pitted; broad lacustrine plains: these occupy most of the area. Lakes and swamps of glacial origin are numbered by the thousand, and include four of the Great Lakes. On the whole the drainage is poorly developed.
Some of the features of the Lake sections are shared with the Laurentian Highland. On the whole the glacial drift in the former is much thicker than in the latter. The proportion of relief due to the drift and not dependent on the underlying rock is much greater here than in the Laurentian Highland. For many purposes, especially geographic, it may be convenient to group the two lake sections with the Superior Upland, thus approximately restoring Powell's "Lake Plains." 27

On its northern side the Eastern Lake section borders on the Laurentian Highland along the line already described. On the west it ends with the bold terminal moraine of the late Wisconsin glacial stage. West of this lies the Wisconsin Driftless section and farther south the Till Plains.

The separation of the Eastern Lake section from the Till Plains is based purely on the topography of the drift. Throughout a considerable part of the boundary the drift on its two sides is of the same age, but the contrast in topography is marked. Through northeastern Illinois the line on the accompanying map follows the outer edge of certain late Wisconsin moraines. 28 South of Kankakee River these moraines form the western rim of the "Kanka-kee swamp." On the southern margin of this great swamp (now drained) the line turns east to Logansport, thence it follows Wabash River to Fort Wayne. 29 East and north of the line thus described the surface is much more characterized by morainic topography, lakes, swamps, and lacustrine plains.

East of Fort Wayne is the lacustrine plain of glacial Lake Maumee. Plains of this kind are important constituents of the two lake sections. They are found on the border of all the Great Lakes and are allied to them in history. The boundary of the Eastern Lake section runs east from Fort Wayne along the southern shoreline of glacial Lake Maumee to the point where that line intersects the boundary of the Appalachian Plateaus near Cleveland. The boundary between the latter and the Eastern Lake section, while not determined by the former extent of the Great Lakes, is nowhere far from the edge of the lacustrine plains.

The Western Lake section borders on the Superior Upland and the Great Plains along lines already described. Its southern

boundary is the outer edge of the drift of the Wisconsin glacial stage. Generally within a very few miles a clear contrast may be observed between the rolling (at places morainic), little eroded and poorly drained country on the north, and the Dissected Till Plains on the south. Its boundary against the area of Iowan drift in northeastern Iowa is discussed below.

The northern portion of the Western Lake section includes the vast lacustrine plain of glacial Lake Agassiz, most of which is in Canada. It is represented in the United States by the broad and very flat valley of the Red River of the North.

*Till Plains Sections of the Central Lowland.*—The character of the Till Plains (not the Dissected Till Plains) is implied in their name. Their surface is characteristically (though not universally) plain and topographically young. There are some morainic ridges, but they are relatively narrow and low and without lakes. In many cases they are so low and of such gentle slope that their presence is revealed chiefly by their control of drainage lines (as in eastern Indiana). Without this indication, some of them would not be detected by the unaided eye. Exceptions to its general character are found in a few strong moraines, particularly those of Illinois north and east of the center of the state. But even here glacial deposition was not of such a character as to produce lake basins. In a comprehensive view the country has the aspect of a plain.

With respect to absolute age and to geological history, the southern and western margins of this section are older than the rest (Illinoian Glacial Epoch). As it is on these sides also that the Ohio and Mississippi rivers have cut their valleys, these edges are in places much eroded, but nowhere is it necessary to go back more than a few miles from these large streams to find remnants of the original flat surface.

Except on the west, the boundaries of this section have already been described. They lie in succession against the Wisconsin Driftless section, the Eastern Lake section, the Appalachian Plateaus and the Interior Low Plateaus. The boundary between this section and the Ozark Plateaus is essentially at the Mississippi. North of the Ozark Plateaus the western boundary is at the contact of the Illionian and Kansan drift sheets. In practice it is best to follow the Mississippi River as far north as Iowa. Further north the Till Plains cross the Mississippi into Iowa. Here their limit is locally marked by a terminal moraine at the margin
of the Illinoian drift sheet but elsewhere merely by the greater amount of erosion which the country on the west has suffered (Kansan drift sheet).

The Dissected Till Plains, separated from the Ozark Province by Missouri River, are coextensive with the drift of the Kansan and Iowan glacial stages where not covered by later deposits. The topographic character is implied in the name given to the section. Remnants of plain surface, perhaps one-fifth of the total area, indicate by their uniformity of altitude that the region in its topographic youth was like the Till Plains on the east and not like the Lake sections on the north.

The area covered by the Iowan drift sheet in northeastern Iowa is included in this section because its topography resembles that of the Kansas drift to the south rather than that of the Wisconsin drift to the north. The eroded surface of the former was over-ridden by the ice of the relatively recent Iowan glacial epoch and a thin mantle of new drift was deposited but the topographic effects were not great.*

Great Plains Province

General Relations.—Between the Rocky Mountains and the Central Lowland is a great eastward-sloping plateau, universally known as the Great Plains. The area which is topographically related to these plains is somewhat greater than the one commonly designated by the name, but the term Great Plains Province is more distinctive of the entire area than any other that might be chosen.

The unity of this large region consists in its plateau character. It is thus sharply distinguished from the mountains on the west and, for the most part, satisfactorily delimited from the low plains on the east. It is conceded to be impossible to distinguish plateau from low plains on the basis of mere elevation above sea-level. The characteristics are always more or less relative, but the underlying thought is that a plateau, if not already dissected, lies high enough above baselevel to admit of sharp dissection while a low plain does not. Consciously or unconsciously this principle underlies our distinctions, but to give an exact rule for the use of these terms may be impossible. This is the principle borne in mind in determining the boundary between the Central Lowland and the Great Plains. It has already been shown (p.

*Frank Leverett and Wm. C. Alden—personal communications.
that, throughout the greater part of its length, this province is separated by a natural line (generally a dissected escarpment) from the Central Lowland on the east.

Boundaries.—It is unnecessary to describe in detail the boundary line between the Great Plains and the mountains on the west. If drawn in the field by various observers the several lines selected would nowhere diverge more than a few miles. For most of the distance the boundary is approximately at the contact of Mesozoic and younger rocks on the east with Paleozoic and older rocks on the west. At the immediate foot of the mountains these younger rocks are generally upturned, the harder strata forming foothills of the hogback type. Generally the first prominent ridge of this kind encountered in approaching the mountains should be taken as the boundary. Where such foothills are not present, as in the Lewis Mountains in northern Montana, and locally in the Bighorn of Wyoming and the Sangre de Christo of Colorado, the rise from the plain is generally so abrupt that the boundary may be drawn with sufficient accuracy on the United States Geological Survey contour map of the United States. (Scale 40 miles to 1 inch.)

The criteria here given suffice for the tracing of the province boundary southward from Canada at the foot of the Lewis Mountains, and eastward around the Big Belt and Little Belt Mountains in Montana. South of the Little Belt Mountains the real mountain front swings fifty miles westward to the Bridger Range on the 111th meridian, and then again eastward at the northern base of the Snowy and Beartooth Mountains which border the Yellowstone Plateau on the north. This great embayment of the mountain front is partially occupied by the Crazy Mountains, an isolated mass similar to other volcanic centers on the Great Plains. South and west of the Crazy Mountains is a strip of valley, continuous with and resembling the Great Plains, but north of these mountains the valley is high and rough. It seems best, therefore, to include the Crazy Mountains in the Northern Rocky Mountain Province. The province boundary on the accompanying map is therefore drawn at their eastern base.

In a similar manner, after skirting the Beartooth Plateau, the province boundary is made to cut arbitrarily across the mouth of the Bighorn Basin (40 miles) to the end of the Bighorn Range. The Bighorn Basin is thus treated as a feature of the mountain
province, similar to some other basins smaller than this which are entirely enclosed by mountains.

Along the foot of the Bighorn Mountains the line is determined both geologically and topographically within narrow limits. South of that for forty miles the Great Plains must be arbitrarily cut off from a similar plateau, the Wyoming Basin. This cut-off is inevitable, as it is impossible to treat southwestern Wyoming and northwestern Colorado as an extension of the Great Plains. The line from the Bighorn Range to the Laramie is described on page 332.

Along the Laramie Mountains of Wyoming, the Rocky Mountain Front Range in Colorado, and the Wet Mountains south of the Arkansas River, there are few breaks in the line of hogback foothills. The province boundary is thus well marked. The line as here drawn passes behind Huerfano Park (southwest of the Wet Mountains) allotting it to the Great Plains. It likewise passes west of the Spanish Peaks which are isolated volcanoes east of the Rocky Mountains, and continues southward between the horizontal strata of the Plains (late Cretaceous and early Tertiary) and the upturned strata of the foothills (Cretaceous and Carboniferous). The line on the accompanying map follows essentially the lower contact of Mesozoic rocks as shown on the geologic map of Colorado (Colo. Geol. Surv., 1913). Some uplands above eight thousand feet are thus assigned to the Great Plains Province. The equally high Ocate Plateau (lavas) to the south is part of the same province, the line following, as before, the hogbacks of Mesozoic rocks wherever present on the west of the volcanic plateau south to latitude 35° 30'. Approximately in that latitude the mountains on the west come to an end and the Great Plains are interrupted by a great east-west escarpment from which the Las Vegas Plateau (Cretaceous) on the north overlooks the Pecos Section (Triassic) on the south.

The Pecos Valley, a characteristic portion of the Great Plains, is delimited on the west by the Glorieta Mesa, the "Hills of Pedernal,"\(^3\) and the Mesa Jumanes, which lie within the Basin and Range Province. The scarp used as the boundary line (altitude 6,250 to 6,500 feet) is fairly well shown on Hill's Map of Texas and Parts of Adjoining Territories, accompanying his Physical Geography of the Texas Region.\(^4\)

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\(^4\)Topographical Atlas, U. S. Geol. Surv., Folio No. 3.
Southward from the Mesa Jumanes the topographic break which limits the Pecos Valley on the west is traced at the foot of the following mountain ranges in the order named: the Jicarilla, Capitan, and Sacramento ranges in New Mexico, and the Guadaloupe, Davis, Comanche, Caballos, and Santiago ranges in Texas. This carries the boundary to the Rio Grande at longitude 102° 30' west. North of this river to the Southern Pacific Railroad (about forty miles), the boundary is fairly indicated by San Francisco Creek. The altitude of the foot of the Jicarilla Mountains at the northern end of this line is between 5,000 and 6,000 feet, but the altitude of the boundary declines somewhat uniformly to about 4,000 feet at the southern end. The exact plotting of this line awaits more detailed mapping. In any case the line is not a clear one, for the mountains merge gradually into the plain, but there is no question concerning its rank as a boundary between major divisions.

**Middle Sections of the Great Plains.**—The Great Plains Province embraces ten sections which must be distinguished in the description or explanation of the topography. These sections can best be distinguished and characterized by first considering the three which are represented in eastern Colorado and western Kansas. The middle one of these sections is well known as the High Plains. The other two are here called respectively the Plains Border and the Colorado Piedmont. The threefold division is well recognized both popularly and scientifically, but the names here used for the eastern and western strips are not in popular use.

The essential features of the topography of each of these sections and the nature of their boundaries will be best understood by reference to their origin. Consider these plains to have been a uniform smooth surface stretching from the mountains to eastern Nebraska and Kansas. The central strip or High Plains is what is left of this flat surface, still covered by the late Tertiary beds to which the flatness is due. The Plains Border is the belt on the east from which the Tertiary mantle has in large part been eroded and which is now dissected but not reduced to the low relief which characterizes the Central Lowland. It is in general a hilly country (pp. 311-312). The climate in this portion is slightly more humid than in the High Plains and the headwaters of east-flowing streams are pushing westward and broadening the Plains Border at the expense of the High Plains. The Colorado Piedmont has likewise lost much of its Tertiary cover and all of its
original flatness, but for a different reason. Here the climate is drier than on the High Plains and the bunch grasses which grow here afford poor protection against erosion as compared with the closely matted sods of the High Plains. Original slopes on the Colorado Piedmont were also more favorable to erosion. These three subdivisions may therefore be regarded as (1) a strip of residual plain in the middle, (2) a strip of degraded plains on the west, and (3) a strip of dissected plains on the east.

The High Plains are limited on the north by the Pine Ridge escarpment, a north-facing scarp, locally one thousand feet high, at the northern limit of the later Tertiary formations. It extends east from near the north end of the Laramie Mountains in Wyoming, through the northwestern corner of Nebraska and northeastward into South Dakota about fifty miles south of the Black Hills. Farther east it loses its sharpness and near the 100th meridian it dies out.

The eastern and western boundaries of the High Plains cannot now be drawn with accuracy except for a part of the distance in their southern extensions. Here, in northern Texas and Oklahoma, the typical flat High Plains, under the name of Llano Estacado, are practically coextensive with the later Tertiary formations. As the eroded border in these states and southern Kansas is nowhere wide it is included in the High Plains section. The boundary between this section and the Plains Border is necessarily arbitrary as the degree of dissection diminishes westward. Even the High Plains in the states north of Oklahoma have been eroded and the original flat surface survives only between streams. A good idea of their distribution is conveyed by the map given on the frontispiece in the paper by Johnson. The topographic mapping of the Great Plains has not advanced sufficiently to make possible the accurate delineation of the area within which these remnants are abundant. It is certain that the High Plains as here defined cannot exceed the area covered by the later Tertiary sediments, and it is equally certain that much of the area thus covered is much eroded and belongs to the Plains Border. Two large areas which will need to be distinguished in a more detailed treatment of the area are the Sand Hill country of western

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33 Willard D. Johnson, loc. cit., Pl. CXIII.
Nebraska and Goshen Hole, an extensive denuded tract traversed by Platte River on the Wyoming-Nebraska boundary.

*Northern Sections of the Great Plains.*—North of the High Plains, and separated from them by the north-facing Pine Ridge escarpment, is the Missouri Plateau, so named because it is drained by the upper Missouri and its tributaries. This name is applied to two sections, the one glaciated, the other not. The Missouri Plateau has a topography resulting from profound degradation with extensive Fluvial terraces. Monadnocks or exhumed mountains show that this degradation has been, at places at least, several thousand feet. The Missouri Plateau, therefore, is in a manner analogous to both the Plains Border and the Colorado Piedmont. Erosion in a recent cycle has made extensive badlands which, in a more detailed classification, might be set off as a subsection.

Within the Missouri Plateau are several isolated groups of mountains of which the Black Hills are the largest. The size and physiographic importance of this domed mountain uplift require that it be treated as a separate section of the Great Plains Province. It is surrounded by residual monoclinal ridges. On the accompanying map the section boundary is traced at the outer limit of the exposed Dakota sandstone.

The Glaciated Great Plains, while mentioned here as a section, because of very limited extent in the United States, extend far to the north in Canada. Their extent is probably comparable with that of the unglaciated portion of the province. In the treatment of the continent it will doubtless be found necessary to recognize more than one section in the glaciated portion, which may then, if desired, be treated as a subprovince.

The boundary of the glaciated section is in large part vague. The extreme advance of the ice is not here marked by terminal moraines. A thick sheet of drift may thin out gradually and give way to scattered boulders. The line on the accompanying map represents an attempt to separate the area in which the drift affects the topography from that in which it is absent or represented only by scattered boulders. At the west end a small driftless area lies north of the line.

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*A generalization by W. C. Alden. In the Dakotas it is based on the work of L. H. Wood and older writers.*
Southern Sections of the Great Plains.—South of the Colorado Piedmont is the Raton section, a strongly characterized division in northeastern New Mexico and southern Colorado. It is characterized by high mesas (in part lava flows) and by sharply incised canyons; elsewhere by isolated buttes (chiefly volcanic) rising above the general level of the Plains. The southern edge of this subdivision is a south-facing escarpment overlooking the Canadian and Pecos valleys.

For a distance of four hundred miles in eastern New Mexico and western Texas the Pecos section borders the High Plains. On the east side of the boundary rises the west-facing escarpment of the Llano Estacado (High Plains) 500 to 700 feet high. The Pecos and Raton sections are genetically allied to the Colorado Piedmont; their forms (except volcanic) are due chiefly to erosion of the High Plains which were at one time almost continuous to the Rocky Mountains.

South of the High Plains and continuous with them is the Edwards Plateau which, in the sense here used, includes the Stockton Plateau west of Pecos River. This section is distinguished from the typical High Plains on the north by the absence of a Tertiary cover (see Geologic Map of North America). In place of it is the more or less roughened surface of the strong and very thick Lower Cretaceous limestone. Pecos River crosses it in a narrow valley separating the Edwards Plateau, strictly so called, from the Stockton Plateau on the west. Except where the limestone substratum runs beneath the Tertiary cover on the north, the Edwards Plateau east of Pecos River is almost everywhere terminated by an escarpment. West of that river the plateau continues southward into Mexico and abuts on the west against the mountains of the Basin and Range Province. The edges of the Edwards Plateau are dissecting. On its eastern and northern sides is a broad frayed margin analogous to the Plains Border farther north.

Texas Central Section.—There is a large area in Central Texas which, for a want of a better name, may be called the Central Texas section. The name is not satisfactory and its boundaries are not sharp; it is not itself a unit in topography but comprises five or six subdivisions, each with its own individuality and needing separate treatment in any detailed account. The whole is, however, a dissected and partly denuded tract, bordered on the one hand by residual plateaus and on the other by relatively low plains.
It is more advanced in its erosion cycle than the plateaus on the west and south, and less advanced than the prairies on the north.

The topographic relation of this section to its neighbors is rendered clearer by a consideration of its origin. It should be remembered that the whole of central Texas was once covered by a great eastward-sloping cover of early Cretaceous strata, the Edwards limestone. This was underlain for the most part by weaker rocks, but not everywhere. West and south of the center, this strong cover still persists in the Llano Estacado and the Edwards Plateau. To the east in the Coastal Plain the same formation is buried, and the surface of the country is too near its baselevel to be deeply dissected. On the north, the strong limestone has been entirely stripped away from the locally peneplaned Permian prairies. Only in the center is the work of reducing the strong rocks but half done. We have therefore on the west and south, plateau not yet cut down; on the east, low plains too low to be much cut down; on the north, rolling prairie already denuded; in the center, a hill country in process of down cutting.

The above statement is necessarily the result of generalization. It is not to be expected that an area so defined should have clean-cut boundaries. However, the contrast between this area and its neighbors is sufficiently sharp to have received expression in the language of the people. From this source Hill has appropriated the names Burnet Country, Callahan Divide, Lampasas Country, and others which are applied to districts within this great area.

The western and southern portions of this section are merely the dissected border of the Llano Estacado and the Edwards Plateau. The whole section is, in fact, a greatly expanded and diversified phase of the eroded edge of the Great Plains. Of itself it should not be called "Great Plains," but it belongs in the Great Plains Province. As stated above, the strong limestone which makes the Edwards Plateau lies beneath the surface of the Coastal Plain, its dip being easterly. At the western margin of the Coastal Plain it emerges partly by reason of its easterly dip and partly because of the Balcones fault (p. 291). A considerably eroded north-south strip on the limestone west of this line and north of Colorado River is known as the Grand Prairie. With increasing altitude toward the west the limestone becomes deeply dissected. The rough country thus produced (north of Colorado River) is Hill's "Lampasas Cut Plain." Stretching westward

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from these "cut plains" to the rugged fringe of the High Plains is a line of plateau remnants marking the "Callahan Divide" between the head waters of the Brazos on the north and those of the Colorado on the south. It is a rough country having the same history as the "cut plain" on the east and the dissected border on the west, but in a more advanced stage of erosion than either of these. North of this line of buttes and mesas are the lowland belts and east-facing escarpments of the denuded Permian, drained by the Brazos head waters. To the south also, and hence within the section herein outlined, the headwaters of the Colorado have reduced many areas to lower elevation and gentler relief.

Much of this area, although stripped of its former cover of Lower Cretaceous limestone, has not been reduced even approximately to its local baselevel because the rocks thus exposed are themselves resistant. This applies to the area of pre-Cambrian rocks in the southeast part of the province (Hill's "Burnet Country") and to a strip of Carboniferous rocks in the northeastern part of the section (Hill's "Palo Pinto Country"). These parts of the province are quite as rugged as the "Cut Plain" with its partly-destroyed cap of Edwards limestone, but the styles of relief are different.

On the south this section is not sharply separated from the Edwards Plateau. The latter is itself partly dissected, and progressively more so as its edges are approached. Hence it passes gradually into the semi-denuded basin which is here styled the Central Texas section. The line of separation here used is essentially the edge of the Lower Cretaceous as shown on a Geologic Map of Texas. The area of pre-Cambrian rocks, and that in which Lower Cretaceous outliers are found, are assigned to the Central Texas section.

On the west likewise, this section has been delimited from the Edwards Plateau and the Llano Estacado, largely on the basis of the geologic map. On the north, the topographic sheets of the United States Geological Survey have been used in separating this section of rough surface and outlying plateau remnants from the approximate peneplain of the Central Lowland.

**INTERIOR HIGHLANDS**

**Ozark Plateaus**

The Ozark Province is distinguished from all its neighbors by its greater altitude. While the Ouachita Mountains are equally
high, the part of that province which is adjacent to the Ozark Province, namely the Arkansas Valley, is a lowland.

**Boundaries.**—The most clearly marked boundary of the Ozark Province is on the southeast where it is separated from the Coastal Plain by a distinct topographic break extending from Cape Girardeau on the Mississippi southwest to Arkansas River. For a part of this distance an escarpment may be seen from the St. Louis, Iron Mountain and Southern Railway which follows the inner edge of the Coastal Plain generally five to fifteen miles from the boundary. The escarpment marks the contact of Paleozoic rocks with Tertiary and Quaternary.

Northward from Cape Girardeau the Ozark Province is bounded on the east by the Interior Low Plateau and the Till Plains. Their relatively low altitude and level surface clearly distinguish them from the more elevated and dissected Ozark Province. The characteristics of the latter are due to a dome-like uplift. The limits of this dome are not sharply marked, but the Mississippi flows approximately at its base and likewise marks the western limit of the glacial drift. It is therefore taken as the province boundary as far north as the mouth of Meramec River near St. Louis. In a similar manner the Missouri may be used as the northern boundary, but it is necessary to exclude from the Ozark Province the area of Carboniferous rocks lying west of the Mississippi and south of the Missouri near the mouth of the latter. This inter-stream area (St. Louis and vicinity) is a part of the Dissected Till Plains of the Central Lowlands.

A strip a few miles wide on the north side of Missouri River has a purely erosion topography no longer influenced by the wasted drift, although the position of Missouri River was essentially determined by the edge of the drift. In detailed work this may be considered as part of the Ozark Province since its topography has more in common with the country to the south than to the north.

The western boundary of this province is least definite, but the contact between Lower and Upper Carboniferous rocks has already been used for a part of the distance.\(^{38}\) Some of the distinctive Ozark features are associated with the Lower Carboniferous rocks and there is a similar association of the Upper Carboniferous with the lowlands on the west and north. The boundary, although drawn from topographic sheets, nowhere departs far

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from the contact named. Through much of its extent it is followed by small streams which mark the boundary with sufficient accuracy for general purposes. In this way after leaving Missouri River, Blackwater Creek might be followed and, after an interval, Osage River, Sac River, and Cedar Creek in turn, and, still farther south, Spring and Neosho Rivers.

The southern boundary of the Ozark Province is at the southern base of the Boston Mountains. For most of the distance this is a ragged escarpment not many miles north or south of the parallel of 30° 30'. Locally the south-sloping dissected plateau called Boston Mountains, merges gradually into the Arkansas Valley. The line used in the accompanying map is a generalization from the topographic sheets of the United States Geological Survey.

Sections of the Ozark Province.—The Ozark Province consists of three rock terraces separated by retreating escarpments. The northern ones, embracing most of the province, are sufficiently alike to be included in a single section—the Springfield-Salem Plateaus—though separated by the bold east-facing escarpment of the Mississippian limestone. The foot of the eroded north-facing escarpment of the Boston Mountains is indicated on the geologic map of North America by the edge of the Upper Carboniferous in Northern Arkansas.

Ouachita Province

The topography of the Ouachita Province is dependent on folded rocks—mildly folded in the northern section (Arkansas Valley), and closely folded in the southern section (Ouachita Mountains). On the east and south the topography thus determined is strongly contrasted with that on the flat-lying strata of the adjacent province. The boundary line on these sides is indicated on the geologic map by the edge of the Paleozoic rocks. On the west side the boundary is not accompanied by any geologic contrast. Even on this side the topographic contrast is in general well marked, though for twenty or thirty miles south from Arkansas River the line is indefinite. It has been located by Taff37 between the gently folded rocks and low level-crested ridges of the Arkansas Valley on the one hand and, on the other, the nearly horizontal beds which occasion the benches and low east-facing scarps of the Osage Plains.

The Arbuckle Mountains, west of the Ouachita, consist of deformed strata peneplained and uplifted or given local prominence by circumdenudation. Nowhere do they rise more than four hundred feet above the adjacent prairies; the average for the area is much less. These so-called mountains are mentioned here because they have been treated by some as a part of the Ouachita Province. They are separated by ten or twelve miles of prairie plain whose character is more like that of the Osage Plains than like that of the Arkansas Valley. If the Lehigh Basin between the two mountain ranges be classed with the Ouachita Province, the Arbuckle Mountains become contiguous and should be included by drawing the boundary around them in such a manner as to include all strata older than Devonian. In the accompanying map and classification the Arbuckle Mountains, like the much higher Wichita farther west, are regarded merely as an exceptional feature of the Central Lowland.

The boundary between the Ouachita Mountain section and the Arkansas Valley section is fairly indicated by the Rock Island and Pacific Railway which in general follows the first valley north of the mountain section. It runs a little north of the 35th parallel in Arkansas and a little south of it in Oklahoma. A few miles east of McAlester, Okla., this line intersects the western boundary of the province.

ROCKY MOUNTAIN SYSTEM
Southern Rocky Mountains

Between central Wyoming and northern New Mexico the southern Rocky Mountains form a continuous mountain area, interrupted only by such valleys as belong distinctively to a mountain country.

Except near the south end, the entire eastern boundary of this mountain province is easily traced on the contour map of the United States (scale 40 miles to 1 inch) and may be seen as a mountain front by an observer standing a few miles distant on the Great Plains. In southern Colorado and northern New Mexico, such observations are less satisfactory. This portion of the Great Plains Province is itself very rugged, a high and deeply dissected plateau belonging to the Raton section. Views of the

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mountain front must therefore be had from high points on the plateau.

The eastern boundary of the province is likewise clearly marked on the geologic map. In general the Cretaceous and all younger rocks belong to the Great Plains Province, the exceptions being only a narrow belt of hogback foothills. The very narrow zone of Jura-Trias, where present, belongs to the same foothill belt and therefore to the mountain province, which likewise includes all older rocks. The ranges thus fronting on the Great Plains are the Laramie, chiefly in Wyoming; the Colorado Front Range from near the Wyoming boundary to Arkansas River; the Wet Mountains (*en echelon* with the Front Range) from the Arkansas to Huerfano Park; and the Sangre de Cristo Range (*en echelon* with the Wet Mountains) from Huerfano Park to the southern extremity of the province.

The southern limit of the Sangre de Cristo Range is definite both structurally and topographically. This granite-cored mountain uplift comes to an end at the Glorieta Mesa. The boundary here is essentially at the Santa Fe Railroad. There are other mountains in line with the Rockies farther south, but they are of different type, allied with those of the Great Basin and the Mexican Highland.

For some distance west and north of Santa Fe it is impossible to draw a province boundary which shall include all the related mountains without at the same time including considerable areas of plateau continuous with the Colorado Plateau Province. The Rio Grande Valley west and north of Santa Fe is ten to twenty miles wide, its floor being a dissected plateau. This is continuous at the north with the broad flat plateau (*Mesa de los Viejos*) in which the Rio Chama has cut its canyon. West of the south end of the Sangre de Cristo Range and separated from it by the valley of the Rio Grande are the Jemez Mountains and, on their western edge, the Nacimiento. The Jemez Mountains consist largely of dissected lava flows and tuffs and are thus similar to the San Juan Mountains to the north, the volcanic cover being continuous between them. The Nacimiento Range is a linear uplift similar to the Sangre de Cristo. The character of both would justify their inclusion in the Rocky Mountain Province. It seems on the whole most consistent to include them, although this necessitates including also parts of the broad Rio Grande Valley and the *Mesa de los Viejos* which separate the Jemez Mountains
from the Sangre de Cristo. The line here is much generalized, including in the mountain province the entire lava-covered belt of which the Jemez Mountains are the southern end and, in addition, the Nacimiento. A number of isolated eminences west of the lava-covered belt are apparently mere residual buttes incident to the large amount of erosion which has occurred on the Colorado Plateau.

North of the Rio Chama the province boundary soon becomes clear. For a long distance it is marked by the Dakotà (Cretaceous) hogback which follows closely the edge of the volcanic rocks of the San Juan Mountains.

In southwestern Colorado the mountain province comprises, in the main, all rocks older than Mesozoic, together with contiguous areas of eruptives. A boundary line so located will include in the mountain province south of latitude 38° 45' the following contiguous ranges and groups: San Juan, La Plata, Rico, Uncompahgre, and West Elk. Certain parts of this line are highly irregular by reason of spurs and embayments in the mountain front. Moreover, the agreement of this front with the actual contact of the rocks mentioned is necessarily only approximate because of erosion and minor structural features, such as hogback foothills. The two lines, topographic and geologic, are, however, fundamentally related. The final appeal is, of course, to the topography, the geology being understood to be interpretative rather than definitive. Further refinement in the location of this boundary awaits more detailed work.

North of latitude 38° 45' it is necessary to include in the mountain province all the closely-grouped laccolithic mountains which lie in the reentrant between the Elk Mountains and the West Elk. The boundary may be considered to run tangent to their bases and to continue north along the line of the Huntsman's Hills, a prominent range of monoclinal foothills on the west side of the Elk Mountains. With a break of only a few miles at the valley of Grand River, this strong monoclinal ridge is continuous to the northwest all the way to the Uinta Mountains. It ranges in height from 500 to 1,500 feet. North of Grand River it is called the Grand Hogback. Here it flanks the White River Plateau, a structure of the Uinta type (see below). Throughout its length the west or southwest slope of this great monoclinal range

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40See Topographic Map of the United States, U. S. Geol. Surv., 1913; also Topographic Sheet, Gallina Quadrangle.
merges into the Colorado Plateau. Its east or northeast slope facing the mountain province is generally scarp-like.

The White River Plateau is a true mountain uplift,\(^{41}\) though, like the Uinta Range, its uplift was accomplished without greatly disturbing the horizontality of the strata except on the flanks where they are steeply upturned. Its summit, known locally as the Flat-top Mountains (formed in part of lava flows), rises to levels of 10,000 to 12,000 feet.

The boundary of the Southern Rocky Mountain Province on the north and east sides of the White River Plateau is similar to that already described on the southwest side, but the ridges are less continuous and imposing. A southeasterly extension of the Wyoming Basin east of the White River Plateau reaches south to Grand River. North of that river the Park Range (here the westernmost range of the Southern Rocky Mountain Province) is separated from the Wyoming Basin by a fairly abrupt topographic break. The province boundary is marked by hogback foothills.

In assigning the above described limits to the Southern Rocky Mountain Province, a considerable area of lofty and deeply dissected plateau of nearly-horizontal strata is also included between the White River Plateau on the northwest and the Elk, Holy Cross and Park Ranges on the south and east. The highest plateau remnants in this district are more than eleven thousand feet above the sea. The general aspect of this country is mountainous and its relations to the structurally deformed areas are intricate. In so far as it cannot be called true mountain it is properly treated as an intermontane feature of the mountain province.

The Southern Rocky Mountain Province terminates at the north in three branches or prongs which indent the Wyoming Basin. These are the Sierra Madre or Encampment Mountains (the northern extension of the Park Range), the Medicine Bow Range, and the Laramie Range. All these rise above the plains of the Wyoming Basin. The edge of the mountain province is at most places marked by hogback foothills. Except for a local and narrow belt of Mesozoic foothills, all rocks of that age and younger are excluded from the mountain province.

Wyoming Basin

The Southern and Middle Rocky Mountain provinces are not connected by any continuous range. On the contrary one may

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travel on a plateau surface from the Great Plains on the east to the Colorado Plateau on the south without crossing a mountain range. South and west from central Wyoming, this transverse plateau expands into a basin having an extreme east-west length of 250 miles and an almost equal width. Single ranges from the mountain provinces project finger-like into this basin, and some low isolated mountains rise from its plateau surface. These would be higher if not buried in part by younger horizontal beds. They indicate that structurally the two mountain provinces are continuous.

The small isolated ranges in the Wyoming Basin are mainly in the northeastern part. Their structural trend is more nearly east-west than north-south and is therefore in line with that of the adjacent ranges of the two mountain provinces, the Wind River, and Owl Creek Ranges on the north, and the north end of the Laramie Range on the east. This serves to emphasize the unity of the whole Rocky Mountain system. Topographically, or geographically, it is interrupted, but geologically it is continuous beneath the horizontal sediments which make the Wyoming Basin.

The boundaries between this basin and the Southern Rocky Mountain Province have already been traced (p. 331). The boundary between this province and the Middle Rocky Mountains is described under the head of the latter (p. 333). Both are topographically clear and both lie near the line of contact between the Mesozoic (or younger) rocks and the Paleozoic (or older). For a large part of the distance the boundary is marked by hogback foothills.

For a stretch of forty miles at the northeast there is no prominent barrier between this basin and the Great Plains. They must be separated by a more or less arbitrary line connecting the Big-horn Mountains with the Laramie Hills. By following anticlinal axes more or less marked by lines of hills, the gap to be crossed may be reduced to about fifteen miles. The geologic map of Wyoming (1919) indicates distinct folding along this zone but in the absence of topographic maps the best line for a province boundary is not determined.

The continuity of the Wyoming Basin with the Colorado Plateau on the south is less perfect than with the Great Plains on the east. Between the basin and the Colorado Plateau lies the range of Danforth Hills, a broad, complex, and deeply eroded anticlinal belt 1,000 to 1,500 feet in height. This ridge connects
the Uinta Range of the Middle Rocky Mountain Province with
the White River Plateau of the southern province. The Danforth
Hills are plateau-like rather than mountain-like, and are, there-
fore, included in the Wyoming Basin. Isolated uplifts of similar
structure and topography are found within the basin. White River
flows at the southern base of the Danforth Hills and approxi-
mately marks the province boundary.

Middle Rocky Mountains

The Middle Rocky Mountain Province embraces all contiguous
mountains west of the Wyoming Basin to the headwaters of Yel-
lowstone and Madison rivers. At the divide between these rivers
the Rocky Mountain Province is greatly narrowed. Were the
non-mountainous Yellowstone Plateau excluded the entire width
of the system would be that of the Snowy Range north of the
Park or of the Absaroka Range on the east. The division between
the Northern and the Middle Rocky Mountain Provinces is not
made primarily on account of this constriction but because of
difference in character. The middle province consists of definite
linear ranges whose trend is in agreement with structure which is
generally anticlinal. Monoclinal foothills are common. In the
northern province the individual range is rarely if ever an indi-
vidual uplift. Most of the province is a deeply dissected upland
of resistant intrusive rocks or very ancient sediments. The
"ranges" are for the most part divides unrelated to lines of
uplift. Exceptions to this are mainly on the east side.

The boundary between this province and the Great Plains on
the east has already been traced in discussing the latter. At the
south end of the Bighorn Mountains, where that range curves
to the west under the name of Owl Creek Mountains, the
province boundary nowhere departs very far from the contact of
the Cretaceous and Tertiary rocks on the one hand and the
older rocks on the other. By following this contact the boundary
may be traced with considerable accuracy on the geologic map
of North America. Locally the boundary is marked by hogback
foothills. The valley of Wind River is thus included in the
Wyoming Basin. The Wind River Mountains form a long
peninsula of the mountain province indenting the Wyoming Basin.
Around these, as elsewhere, the boundary line follows hogback
ridges where present, and essentially the edge of the Tertiary
rocks where such ridges are absent. In like manner the line surrounds the upper Green River Basin, following the southern foothills of the Gros Ventre Range and the eastern foothills of the Hoback and Wyoming Ranges. South of latitude 42°, the ranges of western Wyoming decline in altitude and become mere parallel lines of hogbacks, rising to a maximum height of seven hundred feet above the plains which here occupy much more of the area than do the mountains. It seems best, however, to treat this shrunken extension of the large mountain ranges as a part of the mountain province. The boundary line is accordingly extended south at the foot of the easternmost monoclinal ridge of Mesozoic strata.

Near the southwestern corner of Wyoming the line passes to the northern foot of the Uinta Mountains. By the criteria named above, it surrounds this range which overlooks the Wyoming Basin to the north and the Colorado Plateaus to the south. Continuing southward to Mount Nebo at the southern extremity of the Wasatch Range, the line follows the base of the mountains to Salt Creek and Nephi. All rocks older than Mesozoic are plainly in the mountain province.

Going north at the west foot of the Wasatch, the province boundary is marked by a perfectly clear and abrupt topographic break separating the Wasatch Mountains from the Great Basin. This boundary is so located as to leave to the west all the Quaternary filled basins, so highly characteristic of the Great Basin. It follows the valley of Bear River northward to latitude 42° 40'. Thence it continues north along a line somewhat east of Blackfoot River.

At a point south of Idaho Falls the line thus described intersects the boundary of the Snake River Plains. Northeast of that point to latitude 44° 30' the boundary of the mountain province lies close to Snake River and its tributary, Henry's Fork. West and southwest of Yellowstone Park the province boundary separates two lava plateaus, the lower, nearly level and unforested Snake River Plateau on the west, and the higher, forested and rougher plateau of the Yellowstone on the east. The Snake River Plateau consists essentially of basalt; the Yellowstone Plateau, of rhyolite. Disregarding a moderate amount of recent erosion, the relatively level basalt surface may be seen to abut against the edge of the rhyolite. The difference in altitude between the two plateaus ranges from several hundred to several thousand
The character of the Northern Rocky Mountains has already been given in contrasting them with those to the south. The province boundary on the east has been described in speaking of the Great Plains. The southern boundary west of the Yellowstone plateau lies at the foot of the east-west mountain range which here forms the continental divide. The basalt continues on the lower or plains side of the line, while the rhyolite on the north soon gives way to the strong metamorphic rocks of the mountains of southeastern Idaho and later to the granitic rocks of the great Idaho batholith. In a large way the geologic line thus defined is in striking agreement with the foot of the mountains and the edge of the plateau. The altitude of this foot is about six thousand feet in eastern Idaho, but declines westward. The boundary line thus defined continues west to longitude 116° near Boise City, thence nearly north at the contact of the lava flows on the west with the ancient batholith which constitutes the Salmon River Mountains.

Between the parallels of 45° and 45° 30' there lies, west of the great compact mass of mountains, a semi-detached mass called the Seven Devils. This corresponds in a general way to the area shown as Jura-Trias on the geological map of North America. These mountains are separated from the great mountain mass to the east by narrow valleys only and not by a portion of the plateau. They are therefore included in the Northern Rocky Mountain Province. The profound canyon of Snake River borders its western base and is taken as the province boundary at this place. West of the canyon is a narrow strip of the lava plateau, which is here included in the Blue Mountain section of the Columbia Plateau Province.

North of the Seven Devils, the province boundary returns to the contact between the Columbia basalts and the crystalline rocks of the great batholith (Clearwater Mountains). The western front of the mountains is bold though irregular, being indented by lava-filled bays. North of the great batholith, the metamorphic

42 Compare Transcontinental Guidebook, U. S. Geol. Surv., Bull. 611, 1915, Pl. 15C and 15D.
sediements which constitute the Coeur d'Alene Mountains present a similar front to the west, being everywhere limited by the edge of the basalt. The granite hills west of Coeur d'Alene Lake rise above the lava plateau and are included in the mountain province. East of Spokane is a reentrant in the outline of the mountain province, indicated on the geologic map by an eastward extension of the recent lavas. Westward from this locality to the Cascade Mountains the province boundary is well marked by Spokane and Columbia Rivers. Only a small patch of the lava plateau occurs north of the Columbia, east of the mouth of the Okanogan.

Okanogan River is customarily spoken of as the boundary between the Northern Rocky Mountain Province and the Cascade Mountains. Properly speaking, the entire Okanogan Valley, twelve miles in width, should be included in the former province which is, in this part, much lower than the Cascade Mountains. The steep east front of the latter lies about ten miles west of the Okanogan at the International Boundary. At this place Similkameen River marks the boundary sharply. The boundary here used continues the line of Similkameen River southward at an elevation of about 3,000 feet.

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43When the Rocky Mountain provinces are divided into sections the relatively low rounded mountains west of Colville and Columbia Rivers (longitude about 117° 30') must be distinguished from the higher and more rugged mountains to the east. For some purposes geologic rather than physiographic, it is convenient to consider this section as a member of the Intermontane Plateaus which thus become a continuous belt from Mexico to Alaska. Topographically, this great longitudinal belt is interrupted by a narrow transverse belt of low mountains. This mountain section is totally unlike the plateau to the south but it grades into the Interior Plateau of British Columbia which, like much of the Intermontane Plateau Belt in Canada and Alaska, consists of worn down mountains with local remnants of horizontal lava flows. In treating the entire continent the northern and southern halves of the Intermontane Plateau belt should be made divisions of coordinate rank. For purely physiographic and geographic studies, these are separated by the narrow transverse belt of mountains in northern Washington. In studies of another character these low mountains may be included in the northern division.

44J. T. Pardee, Personal communication.

INTERMONTANE PLATEAUS

Columbia Plateau

Included between the Northern Rocky Mountains, the Cascade Range and the Basin and Range Province, is the Columbia Plateau, so named because it lies mainly within the drainage basin of Columbia River. As a plateau of horizontal rocks (with only local exceptions and these not on the border) it is necessarily contrasted with the adjacent mountains. The boundary on the north and east has already been described in connection with the Rocky Mountains.

The province boundary on the west is the foot of the Cascade Mountains. Both structurally and topographically the eastern border of this range in Washington is irregular and the boundary here given is at best an approximation. In Oregon the mountain front follows a more regular line along the west side of the Deschutes Valley.

The southern boundary of the Columbia Plateau is against the Great Basin. The choosing of a boundary on this side is difficult. The characteristics of the two provinces are nevertheless so different that they must be separated by some line however arbitrary. The distinguishing characteristic of the Columbia Plateau is its plateau surface on a substratum of lava. Those of the Great Basin are isolated mountain ranges separated by plains on unconsolidated detritus. In general the drainage of the Great Basin does not reach the sea; but distinctions in drainage (interior and exterior) cannot be used to define provinces. On the accompanying map a line has been drawn which, so far as possible, touches the northern ends of the northernmost Basin Ranges, leaving as little as possible of the lava plateau south of the line. From the geologic map of North America it appears that a considerable lava-covered area, probably in large part plateau and not covered by Quaternary sediment, is thus assigned to the Great Basin in Oregon, Nevada, and California. However, at least a part of this is known to be characterized by newly tilted fault blocks, one of the types of basin ranges.

It also appears that a considerable area in central Oregon, here assigned to the Columbia Plateau (Harney section), is covered by Quaternary sediments which are typical of the desert basin to the south. The extent and thickness of such a covering in this little studied country are uncertain. The subaerial accumulation is certainly insufficient to prevent typical plateau dissection of the
basalt substratum in the basin of Crooked River, the largest eastern tributary of the Deschutes.

The boundary line in southeastern Idaho runs parallel to Snake River and not far from it. As here drawn it follows essentially the northern edge of the Quaternary deposits as shown on the geologic map of North America and runs tangent to the northern ends of the Basin Range. This is not the limit of the Snake River drainage basin, which extends far to the south between the several mountain ranges. Passing southwest into Nevada, the edge of the basalt plateau becomes essentially the divide which limits the Snake River Basin. In northern Nevada this divide turns to the northwest and continues to form the province boundary to the 43d parallel—that is to the north end of Steen’s Mountain. This north-south ridge and others west of it in southern Oregon have been described by Russell as tilted fault blocks and have been used by Davis as his type of young block mountains. Their relations are plainly with the Basin and Range Province. The boundary on the accompanying map is drawn in a rough way tangent to their northern ends. The basin of interior drainage centering in Malheur and Harney Lakes is thus assigned to the Columbia Plateau.

The subdivisions of the Columbia Plateau are as yet imperfectly outlined for want of detailed investigations. Little can be said of their limits except what is contained in their definitions given on page 286, and in the table on page 279.

**Colorado Plateaus**

*Boundaries.*—The Colorado Plateaus Province occupies the greater part of the basin of Colorado River from which it takes its name. Its characteristic topography is determined in the main by greatly elevated, nearly-horizontal, strong strata, locally covered by lava flows. As thus characterized, the province is distinguished from its neighbors on all sides except from the Wyoming Basin. The mountains on the north and east are not only higher but have different topography and structure. In the Great Basin on the west and the Mexican Highlands on the south and southeast, horizontal beds are in general limited to the Quaternary filling of local basins. These beds are not indurated and not relatively elevated and are not, in general, subject at present to

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plateau dissection. They are therefore clearly distinguished topographically from the Colorado Plateaus.

The features here named as characteristic of the Colorado Plateaus fail, however, to distinguish them from the Wyoming Basin. The border land between these provinces is described on page 332. On the accompanying map the boundary follows White River which flows at the south foot of the Danforth Hills, a complex anticlinal swell which forms a structural connection between the Uinta Range and the Southern Rocky Mountain Province. The elevation is not such as to require that this swell be included in the Rocky Mountains. It rises 1,000 to 1,500 feet above the plateau level, but has a plateau-like surface. Its location and its structural relations give it importance both as a connecting link and as a boundary line.

The least satisfactory boundary of the Colorado Plateaus is in New Mexico. That portion which concerns the Southern Rocky Mountain Province between the San Juan and the Nacimiento Ranges has already been discussed. South of these mountains the boundary line separates the Colorado Plateaus on the west from a northern arm of the Mexican Highland on the east. As a part of the Basin and Range Province the latter includes debris-filled basins among its characteristic features. The valley of the Río Grande in this part of New Mexico is typical of such basins except that it is now traversed by a through-flowing stream. Its western boundary is against a typical portion of the Colorado Plateaus. This determines the province boundary about as far south as latitude 34° 30'.

Leaving the Río Grande Valley and turning southwestward in latitude 34° 30', the boundary becomes indefinite, partly for want of sharp distinctions in Nature and partly because of the lack of detailed surveys of the region. As drawn on the accompanying map the line passes west of the Sierra Ladron; thence westward on the south side of the Bear, Gallina, and Datil Mountains. Those mountains appear to be remnants of nearly horizontal strata rising several thousand feet above the adjacent plains. They are therefore features of the Colorado Plateaus rather than of the Basin and Range Province, whose mountains are generally north-south ranges due to deformation. The line so drawn leaves to the south the Plains of San Augustin. This is a typical bolson. The Quaternary deposit which makes its floor is at least several

47D. E. Winchester: Personal communication.
hundred feet deep and may be much deeper. East of it is a small bolson of the same character. The nature of the mountains south of these plains is not well known. Presumably these bolsons occupy structural basins as do the characteristic bolsons of the Basin and Range Province but the nature of these is poorly known. In the absence of more definite knowledge these bolsons are classed in the province of which the type is characteristic. Along the west side of the San Augustin basin the line trends southwestward to the Arizona boundary, following the line of San Francisco River and its headwaters, the Tularosa, excluding from the plateau the Mogollon and Tularosa Ranges.

At the Arizona state line, latitude about 33° 45', the province boundary quadrangle turns abruptly to the northwest. It crosses the Clifton quadrangle (see U. S. Geol. Surv. topographic sheet), leaving all good plateau remnants to the north. Thence northwestward to Fort Apache (longitude 110° W.), the line follows essentially the divide between the Gila River and the Little Colorado. On the north side of this divide the headwaters of the Little Colorado have incised themselves but little and the plateau is in large part preserved. On the other hand the tributaries of the Gila have steep gradients and among them the plateau is in large part destroyed. Continuing westward along the same divide, the line follows the edge of the Mogollon Plateau capped by Coconino sandstone and Kaibab limestone. For a long distance south and west of Flagstaff, Verde River occupies a valley at the foot of the escarpment. The latter at this place is known as the “Verde Breaks.”

It will be observed that from the valley of the Rio Grande westward to the 110th meridian the boundary of the province follows no geologic line shown on available maps. Thence to beyond 112° the plateau is almost coextensive with the Permian strata tho covered at the west with lava. Farther west the agreement between the edge of the plateau and that of the Redwall and related limestones becomes increasingly close. It is these limestones that make the Yampai cliffs which limit the plateau on the southwest and are continuous with the west-facing Grand Wash Cliffs which cross the Colorado at the mouth of the Grand Canyon near the 114th meridian.

48Not to be confused with the Mogollon Mesa of Arizona.
49See Geol. Map of Arizona, 1928.
The Grand Wash (fault) Cliffs continue north of the Colorado to the Virgin River in southwestern Utah, which the province boundary follows for a few miles, thus passing to the Hurricane fault scarp which continues in the same direction (north-northeast) through Cedar Lake (Rush Lake) and Parowan Valleys at least to Beaver.\textsuperscript{50} Thence the province boundary continues in the same general direction at the west foot of the Tushar and Pavant Ranges. These, as stated by Dutton,\textsuperscript{51} are of intermediate character between the High Plateaus and the Basin Ranges. They are, however, considered to be more closely allied with the former. Moreover, the Quaternary valley filling, so highly characteristic of the Great Basin, begins at their western foot. The same line continues north at the west foot of the Gunnison Plateau to Mt. Nebo, the southern extremity of the Wasatch Mountains. Thence around the Wasatch and Uinta Ranges the line has already been described.

Within the great area thus surrounded are many plateaus needing individual description, separated by fault scarps, erosion scarps, and deep canyons. They differ in elevation, degree of dissection, and climate. There are also volcanic mountains and local orogenic uplifts interrupting the general plateau character; but as a distinct physical division of the United States this province has, amid great variety, certain fairly constant characteristics which consistently distinguish it from its neighbors.

\textit{Sections of the Colorado Plateaus}.—While the subdivision of this province into sections is still somewhat tentative, certain parts of it may be pointed out as possessing distinctive characteristics. These demand separate consideration in any detailed treatment of the province. The High Plateaus of Utah are a strongly individualized district. With them should be included, for purposes of rational treatment, the gigantic rock terraces at their southern end. Another well-marked section is the broad, deeply eroded rock terrace lying south of the Uinta Mountains, known in part as the Uinta Basin, and terminated by the great south-facing escarpment which bears in succession the names West Tavaputs Plateau, East Tavaputs Plateau, Roan Cliffs, Book Cliffs, and Grand Mesa. (The Roan Cliffs and Book Cliffs are locally dis-


\textsuperscript{51}Geology of the High Plateaus of Utah, p. 7.
tinct and parallel escarpments.) The series of fault block plateaus north of the Grand Canyon, sometimes collectively known as the Kaibab section, may be combined with the San Francisco Plateau south of the Colorado and Little Colorado. The Grand Canyon section thus formed is well distinguished from its neighbors except on the southeast. Here it may also be bounded with a fair degree of definiteness if a southeastern section be recognized as characterized by volcanic features, and for the most part by an igneous cover. This is the Datil section. The Navajo country in northeastern Arizona and the San Juan Basin in northwestern New Mexico together comprise a vast area of terraced plateaus, characterized by youthful dissection and retreating rock scarps. The “Canyon Lands,” located mainly in southeastern Utah are characterized by more profound and intricate dissection. To the south these pass by degrees into the plateaus of the Navajo section. The eastern margin of this section along the Rocky Mountains has broader valleys cut in softer rocks and includes some excellent irrigable areas.

**Basin and Range Province**

*General Relations.*—West and south of the Colorado Plateaus is a vast area marked by certain dominant characteristics from southern Oregon to the interior of Mexico. This great region is, for the most part, a highland, but even where low, as in southeastern California and southwestern Arizona, the most characteristic features are the same in kind though differing in their development.

No single name is in general use to designate this entire area. Its northern half is the Great Basin. Its southwestern part is the northern continuation of the Sonoran district of Mexico. The southeastern part is the northern continuation of the Mexican Highland. Because of the continuity of essential features throughout the entire region, it is desirable to treat this large region as a single province and to designate it by a single name, the more so because its subdivisions are not in all cases sharply delimited. The fitness of the term Basin and Range Province will appear from the characteristics named below.

The distinctive features of this great area are isolated, nearly parallel mountain ranges (commonly fault blocks) and intervening plains made in the main by subaerial deposits of waste from the mountains. These deposits though locally absent are often very
deep and generally unconsolidated. The consolidated older strata and lavas which make the mountains are only locally horizontal. In general they are deformed, and at places very much so.

With respect to the above-mentioned structural features, and the topographical features resulting from them, this great region is clearly contrasted with the Colorado Plateaus. It is less sharply contrasted with the mountains on its border, notably the Wasatch and Sierra Nevada. The greater size of these ranges makes them exceptional and the contiguity of the Wasatch with other ranges justifies their assignment to the mountain provinces. The Basin Ranges, on the other hand, are smaller and isolated. Aside from these things there is great similarity between the mountains within the Great Basin and those named on its borders.

From the close geographic relations between the Great Basin and the kind of mountains here mentioned, the latter have come to be called Basin Ranges. The larger area characterized by them was therefore called by Powell the Basin Range Province. By this name the impression seems to be conveyed that the region is primarily one of mountains, whereas the area of intervening, nearly-flat basins is in reality much greater. In a large view the local desert basins and the mountain ranges are of coordinate importance in the character of the country; hence the change of name to Basin and Range Province.

**Great Basin Section.**—As already stated, the northern part of this region is roughly coextensive with the area of internal drainage which John C. Fremont named the Great Basin. Its strongly marked and very characteristic structural and topographic features are, however, not quite coextensive with the basin of internal drainage. In geologic and geographic writings the name Great Basin has generally been used with primary reference to these characteristic surface features and without regard to the actual limits of drainage basins. Probably this custom is firmly fixed and will continue.

The boundaries of the Great Basin will depend on which one of its characteristics is regarded as most significant and is therefore made the criterion for its delimitation. A little reflection will serve to show that the difference between internal and external drainage cannot be used as a criterion for the purpose here in hand. It would, in the first place, require that the western boundary be drawn at the crest of the Sierra Nevada and Cascade Mountains instead of at the foot, whereas it is evident that the eastern
slope of that range is just as much a part of the mountain province as the western slope. The physiographic history, features, and classification of the eastern slope of the Sierras are in no way dependent upon what becomes of the water twenty miles farther east. In a similar way some valleys leading outward from the Great Basin may contain through-flowing streams or may, in wet seasons, deliver water to permanent streams in other provinces. Thus the through-flowing Pitt River, a branch of the Sacramento, rises in northeastern California where it and its tributaries (many intermittent) drain a large area which is generally and properly, spoken of as a part of the Great Basin. Other streams of the same character flow through the same kind of country in other directions and do not reach the sea. So far as physiographic character and classification are concerned, the upper basins of such streams cannot be grouped according to the destination of their waters. It is doubtful whether divides and stream courses ever make significant physiographic boundaries except where the location of the divide or stream is merely incidental to some more significant fact, generally one of structure.

The most central and significant feature of the Great Basin seems to be the accumulated waste from its higher parts, building plains in its lower parts. This is related on the one hand to the structure of the province and on the other to its climate. Along streams entering the basin from other provinces, such deposits do not begin until the proper limits of this province are reached. Again, where such deposits are found along stream courses leading outward from this province to through-flowing streams, their presence indicates ineffective drainage in that portion of the stream basin where they are found. This inability of the running waters to forward the waste derived from higher slopes is a much more important fact in the character of the country than the mere fact that the water is, at some remote point, evaporated or that it ultimately reaches the sea. In addition to the above-mentioned considerations, these surficial deposits are very important in the classification of soils, and it is desirable so far as possible that the conventional boundaries of physiographic provinces should agree with those of soil provinces.

For the practical delimitation of the Great Basin it seems best to assign coordinate importance to the characteristic mountains and to the detrital covering of the basin floors. The two are not
quite coextensive, especially on the northern side. Internal drainage is disregarded. It is a characteristic but not a criterion.

The eastern boundary of the Great Basin, against the Rocky Mountains and the Colorado Plateau, has already been traced. Immediately to the west of the boundary already described, Quaternary sediments begin to form the floors of basins between elevations which are for the most part (presumably) block mountains.

The western boundary of the basin is at the foot of the Sierra Nevada and Cascade Mountains. The foot of these mountain ranges, while locally difficult to determine within a few miles, is generally a more consistent line than could be found by following the edge of the Quaternary deposits. These boundaries can best be described under the head of the mountain province (pp. 348-350).

In common usage the application of the name Great Basin in southern California is very indefinite. Powell, in his sketch of physiographic provinces (1896), limited it only by the Pacific Ocean and Colorado River, allowing it an indefinite extension into lower California. Elsewhere the name is limited to its strict hydrographic sense. A much more significant fact in physiographic description is this: North of a line connecting the south end of the Sierra Nevada with the mouth of the Grand Canyon the space occupied by the block mountains is at least half the total area; south of that line it is not more than one-fifth of the total.\textsuperscript{52} North of that line the mountains are not only longer and broader but higher and composed of younger rocks. The mountains appear to be less advanced in the erosion cycle. South of the line mentioned and of Colorado River is the Sonoran Desert. The separation of the Great Basin from the Mexican Highland by Colorado River is purely arbitrary; that is, it is not based on physiographic contrasts. The chief reason for making the division is convenience in geographic treatment.

The description of the Great Basin given above needs qualification for its northwestern part. The part which lies in southern Oregon, with a strip of indefinite width in northwestern Nevada and northeastern California, is the Oregon Lake district, a division of lower order than section. It is an area of young block mountains of simple monoclinal structure, composed of recent volcanic rocks. Correlative with these block mountains are inter-

\textsuperscript{52} Compare the Geologic Map of North America, \textit{U. S. Geol. Surv.}, 1911; also, the Geologic Map of California, 1916.
vening troughs with lake basins. The sediments accumulating in these structural troughs are not yet deep. Further investigations may lead to further subdivisions of the Great Basin. Geographically the drainage basin of former Lake Bonneville may be distinguished from that of former Lake Lahontan, but it does not appear that their difference in character is sufficiently great to justify their recognition as distinct sections.

*Southern Sections of the Basin and Range Province.*—That part of the Sonoran Desert which lies in the United States embraces the Mohave Desert at the northwest, the Gila Desert in the southeast, and the immediate basin of the lower Colorado in the center. The last is a very narrow strip if only that portion be included which actually yields surface water to the river. The Sonoran section differs from the Great Basin not only in its smaller proportion of mountains to plain, but in its lower elevation. It is bounded on the west by the Sierra Nevada and, south of that, by the Los Angeles Ranges and the Salton Basin. The line which separates the mountain provinces from the desert is essentially that which separates the older intrusive rocks from the Quaternary sediments. With the latter are included the small areas of pre-Cambrian which make the old block mountains. The boundary indicated on the accompanying map is located by this criterion but modified in detail by the fault lines shown on the map of the California Earthquake Commission and by topographic maps where available. The boundary of the Sonoran Desert against the Arizona (Mexican) Highland is necessarily much generalized (see below).

A separate section is here made of the great trough most of which is occupied by the Gulf of California, but whose northern end is the desert basin which centers in Salton Sink. It is bounded on the west by the Los Angeles Ranges and the Lower California Province. Its northeastern boundary is here drawn at the foot of the San Bernardino Range and of the other mountains (Chocolate Range, etc.) in line with the San Bernardino southeast to Colorado River. Southeast from Yuma, the boundary is so drawn as to leave the ranges, so far as possible, in the Sonoran section. That it is not possible in all cases to do this is

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53Atlas of California Earthquake Commission, Plate 1, 1908.
See also, Fault Map of the State of California, published by the Seismological Society of America, 1922.
seen from the high islands (mountains) in the Gulf of California in latitude 29°.

The Mexican Highland is in the main a southeastward extension of the Great Basin, though much of it is drained to the sea. In smaller part, it is the eroded margin of the Colorado Plateau stripped of its overlying beds. In the size of its block mountains and in the proportion of mountain to plain, this region resembles the Great Basin rather than the Sonoran Desert. In passing from this section southwest to the Sonoran Desert, the size and proportion of mountains decrease; hence there is gradation rather than a sharp line. However, despite this gradation, the contrast is quite enough to determine very different types of landscape which are well recognized and geographically important.

On the eastern margin of the Basin and Range Province is a narrow strip midway between Pecos River and the Rio Grande whose features suggest transition to the plateau type. This is the Sacramento section. Some of its basins have floors of horizontal sedimentary rocks not very deeply buried (perhaps several hundred feet) by Quaternary detritus. Most of the mountains, like the Sacramento from which the section is named, result from faulting and only moderate tilting, of otherwise horizontal rocks. They are not like those in central Nevada, in which the strata are much deformed, but more like those of southern Oregon in which the tilt that raised the mountain is the only deformation noted. The Sacramento Range is eroded to maturity.

**Pacific Mountain System**

**Sierra-Cascade Province**

The Sierra-Cascade Mountains form a continuous mountain mass from a little north of the Canadian boundary to the Mohave Desert in southern California. They cannot be called a single range if that word is made to imply unity of history or character. The one thousand miles of mountains in this province embrace several distinct types.

*Sierra Nevada.*—The Sierra Nevada may almost be described as a fault block composed of old and much-deformed sedimentaries and intrusives, reduced by erosion to moderate relief at a low level, and then uplifted with a westward tilt. As thus defined, the range terminates in latitude 40° as shown by Diller.\(^5^4\) In

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common usage the name Sierra Nevada is extended farther north, sometimes to the Oregon state line. This usage ignores the only important natural line of distinction.

As here indicated the northern limit of the Sierra Nevada is at the contact of the recent volcanic rocks on the north and the Paleozoics and older intrusives on the south. The eastern limit is marked throughout by fault lines. The line on the accompanying map is drawn from the topographic sheets but it differs little from the line of faulting as shown on the Atlas of the California State Earthquake Commission, Map No. 1. Such maps are necessarily generalized and may represent as a single fault what should be several or many faults en echelon. Their importance here is not as faults but as scars. Presumably the faulting is inferred from topographic evidence throughout most of the distance; hence the fault line as drawn is a good generalization of the mountain front. Beginning at the north end just north of the 40th parallel, the boundary is a bold escarpment southwest of Honey Lake and Susanville. The line turns south along the California-Nevada boundary and follows the east foot of the Carson Range east of Lake Tahoe. Other faults lie west of this one. The basin of Lake Tahoe is in a moat, that is, on a depressed fault block between mountains on the west and east. South of Lake Tahoe the bold front is nearly straight, passing just west of Mono and Owens Lakes. Near the south end it curves to the west and runs at right angles to its upper course until it meets the Coast Ranges. The western boundary of the Sierra Nevada is essentially at the contact of Quaternary with older rocks.

Cascade Mountains.—For the first 150 miles at the south, the Cascade Range does not have that compactness of mass or definiteness of outline which is commonly thought of as belonging to a mountain range, and which is shown in a high degree by the Sierra Nevada and by the Cascade Range farther north. The Southern Cascade Mountains are a line of volcanic cones and plateaus of various sizes and ages, but all so recent that their height above the adjacent provinces is due to accumulation of eruptive material. Local relief is of course complicated with erosion features. The distribution of the volcanic vents is very irregular and the accumulations vary greatly in depth. Huge accumulations like those marked by Shasta and Lassen Peak alternate with sags. By one such sag Pitt River crosses the range.

At their south end for perhaps fifty miles these mountains are
bordered on the west by the Valley of California. Within this distance the volcanic accumulations fail to cover completely an eroded belt of Tertiary strata which here constitute a belt of foothills which are necessarily included in the mountain province. Farther north the volcanic accumulation lies against or upon the Klamath Mountains. Here the western boundary of the Southern Cascade Mountains is at the edge of the volcanic rocks. For sixty miles in northern California this boundary is approximately marked by the valley which is followed by the Southern Pacific Railroad, but both north and south of this stretch the province boundary is farther east.

A conventional western boundary is thus assigned to the Southern Cascades based on geologic contacts. On the eastern side of the range, if range it may be called, such a boundary is not possible because the rocks of the adjacent Great Basin are likewise volcanics not yet distinguished on geologic maps from those which make the mountains. Here the boundary must be fixed by topographic data without relation to geologic lines. The line here used is taken from the United States topographic sheets and is necessarily much generalized.

West of Klamath Lake (latitude about 42° 15') the Cascade Range becomes well defined on both sides and continues so to the north. Evidences of faulting appear, indicating that the range here owes part of its relative altitude to crustal uplift. This portion of the range is the Middle Cascade Mountains. It extends north nearly to latitude 47° 30'. These mountains are completely covered with volcanic rocks and owe their height at least in part to extensive accumulation. Presumably this factor is very large, but of decreasing importance toward the north, for at the northern end of this section the volcanic cover gives out while the height of the range continues undiminished. Where cut across by the Columbia River the component lava sheets are distinctly, though not sharply, folded and indicate uplift along the axis of the range. The northern end of this section is also characterized by a close accordance of summit levels which has been interpreted as evidence of an uplifted peneplain, thus assuming crustal movement as it is not assumed in the Southern Cascades. With respect also to accordance of summit levels it appears that there is gradation between the southern and northern ends of the middle section.

The eastern foot of the Middle Cascade Mountains in Oregon is a fairly definite topographic line. The range overlooks the
valley of Klamath Lake and Williamson River, and, for about 175 miles, the nearly straight valley of Deschutes River. North of the Columbia, the eastern slope of the range is complicated by subordinate transverse folds making low swells which extend east from the range. Some of these are much dissected, but on the whole it seems most consistent to interpret the plateau province somewhat liberally and to exclude these east-west swells from the mountain province. The line on the accompanying map is a generalization from the topographic sheets of the United States Geological Survey.

On the west the Middle Cascade Mountains descend to the Puget trough, including its southern portion, the Willamette Valley. Accurate topographic and geologic maps along much of this boundary are wanting. The line here used is based on available topographic sheets and on the contour map of the United States (40 miles to the inch, 1913). It does not appear that the topographic break follows any one geologic line consistently. Farther south these mountains are bounded by the Oregon Coast Range section and the Klamath Mountains, the Cascade Range being limited to the area of volcanic rocks.

The Northern Cascade Mountains differ from the Middle and Southern in having no cover of recent volcanic rocks. Their accordant crests suggest a maturely dissected peneplain and, in any case, their altitude is necessarily due to crustal movement.

The eastern boundary of this section is not far from the Columbia and Okanogan Rivers. The latter stream is bordered on both sides by a belt of lower mountains and hills which are much more like the adjacent low Rocky Mountains than like the Cascades. On the accompanying map an attempt has been made to throw these in with the Rocky Mountain Province by locating the boundary a few miles west of Okanogan River. (See p. 336.) The boundary on the west against the Puget trough is like the corresponding boundary of the Middle Cascades. Geologic lines are not determinative. The line on the accompanying map is taken from available topographic sheets supplemented by the contour map of the United States. A few miles north of the International Boundary the Cascade Mountains end. Beyond them is the Interior Plateau of British Columbia, the southernmost representative of a plateau belt in Canada and Alaska.
Pacific Border Province

The Puget Trough is an intermontane valley four hundred miles long within the United States and extending far to the north between the coast of British Columbia and the adjacent islands. Its south end is the valley of the Willamette. Its boundary on the east has already been described. The western boundary must in like manner be described empirically for the present. It is not known to coincide with any geologic line. It is drawn at the foot of the Olympic Mountains and the Oregon Coast Range. The altitude of the mountain foot varies from a little more than 100 feet at the north to more than 500 feet at the south. On the map here presented the Puget Trough is limited on the south by the mountain barrier south of Eugene. The relatively small intermittent lowlands farther south are treated as features of the mountain provinces.

The California Trough lies west of the Sierra Nevada and Southern Cascade Mountains. The boundary on this side has already been described. The western boundary of the trough is similar to the eastern, namely, the line of contact between the Quaternary sediments of the valley floor and the older rocks which participate in the structure of the California Coast Ranges. An exception is made by including in the valley section several small areas near the south end which are underlain by late Tertiary (Pliocene) sediments. The relations of these areas are with the valley rather than with the mountains.

The Olympic Mountains of Washington are an isolated group. West of longitude 123° 30' the northern base of the mountains is essentially at the shore of the strait of Juan de Fuca. Farther east and on the east side, the mountain section is bordered by a low margin of Quaternary sediments which belongs to the Puget Trough. On the west side is a dissected coastal plain ten to twenty miles in width which must be included in the same section with the mountains. With more detailed work in the future, this and other parts of the narrow coastal plain, as far south as latitude 43°, may be made divisions of a lower order than those now recognized. A similar plain borders the Olympic section on the south and is included in it, Chehalis River being taken as the boundary.

The Oregon Coast Range can scarcely be called mountainous. It is rather a dissected plateau, but none the less range-like and a distinct uplift above the Puget Trough on the one side and the
narrow coastal plain on the other. The latter is included in this section. The Oregon Coast Range extends from Chehalis River (Olympic section) on the north to the Klamath Mountains on the south. On that side the boundary is at the contact of the Tertiary rocks of the Oregon Coast Range with the older rocks to the Klamath.\textsuperscript{55}

The topographic features of the Klamath Mountains are conditioned by old rocks closely folded, generally metamorphosed and strong. They rise above their neighbors on the north and south, though not above the Cascades on the east. On the south they touch the California Coast Ranges, all rocks younger than Paleozoic being classed with the latter. The Klamath Mountains are thus bordered on all sides by mountains which differ from them in topography because of differences in the rocks which compose them.

The name California Coast Ranges is here used in the sense most commonly understood, namely, to designate the mountains along the coast having a north-south or northwest-southeast trend. This excludes what are called below the Los Angeles Ranges, the most prominent of which have an east-west trend.

The more or less arbitrary boundary between these two sections may be traced along the southwestern base of the San Rafael Mountains (Miocene-Quaternary contact) southeastward to Santa Ynez River which marks the boundary farther east to its head at the line between Santa Barbara and Ventura Counties. From that point the section boundary may be drawn to the westernmost angle of Antelope Valley (Basin and Range province). Without deviating much from straightness such a line may follow important valleys.

The mountains here called Los Angeles Ranges includes not only the Santa Ynez, San Gabriel, and San Bernardino, which have a distinct east-west trend, but other ranges south of them (Santa Ana, San Jacinto, etc.) whose trend is more southeasterly. The latter are blocks in the great granitic area which, farther south, constitutes the Lower Californian Province. South of the east-west ranges are the lowlands sometimes spoken of as the Valley of Southern California. This more or less continuous lowland is in part coastal plain and in part consists of intermontane valleys.

Lower Californian Province

The Lower Californian Province is the great granitic area, at least in part mountainous, which lies mainly in Lower California. It is similar to the Sierra Nevada, being limited on the east by a sharp descent (presumably a fault scarp) to the Salton Trough. As here set off, the section consists of a broad west-sloping upland, not of parallel mountain ridges. The parallel fault ridges at its north end, which are geologically a part of the same province, are classed with the Los Angeles Mountains.
PHYSICAL DIVISIONS OF THE UNITED STATES

Prepared by Nevin M. Fenneman
in cooperation with the Physiographic Committee of the U. S. Geological Survey
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<td></td>
<td>Adirondack province</td>
<td>10. Submaturely dissected and glaciated</td>
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</tbody>
</table>
CHARACTERISTICS

MAJOR DIVISION          PROVINCE

11. Interior Low Plateaus
   a. Highland
   b. Lexington
   c. Nashville
   d. Possible delin
      a. Eastern
      b. Western
   e. Wisconsin

12. Central Lowland
   Interior Plains

13. Great Plains province

14. Ozark Plateaus
   a. Springfi
   b. Boston

15. Ouachita province
   a. Arkansas
   b. Ouachita

16. Southern Rocky Mountains

17. Wyoming Basin

18. Middle Rocky Mountains

19. Northern Rocky Mountains

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*Prepared by N
*Degrees of relief
As used here *h* in hundreds of *f*e
with a wide latitu
## SECTION

<table>
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<tr>
<th>Description</th>
<th>Characteristics</th>
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<td>11a. Young to mature plateau of moderate relief.</td>
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<td>Lexington Plain</td>
<td>11b. Mature to old plain on weak rocks; trenched by main rivers.</td>
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<tr>
<td>Nashville Basin</td>
<td>11c. Mature to old plain on weak rocks; slightly uplifted and moderately dissected.</td>
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<tr>
<td>Possible western section (not delimited)</td>
<td>11d. Low, maturely dissected plateau with silt-filled valleys.</td>
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<tr>
<td>Eastern lake section</td>
<td>12a. Maturely dissected and glaciated cuestas and lowlands; moraines, lakes, and lacustrine plains.</td>
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<tr>
<td>Western lake section</td>
<td>12b. Young glaciated plain; moraines, lakes, and lacustrine plains.</td>
</tr>
<tr>
<td>Wisconsin Driftless section</td>
<td>12c. Maturely dissected plateau and lowland invaded by glacial outwash.</td>
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<tr>
<td>Till Plains</td>
<td>12d. Young till plains; morainic topography rare; no lakes.</td>
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<tr>
<td>Dissected Till Plains</td>
<td>12e. Submaturely to maturely dissected till plains.</td>
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<tr>
<td>Osage Plains</td>
<td>12f. Old scarred plains beveling faintly inclined strata; main streams intertrenched.</td>
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<tr>
<td>Missouri Plateau, glaciated</td>
<td>13a. Glaciated old plateaus; isolated mountains.</td>
</tr>
<tr>
<td>Missouri Plateau, unglaciated</td>
<td>13b. Old plateau; terrace lands; local badlands; isolated mountains.</td>
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<tr>
<td>Black Hills</td>
<td>13c. Maturely dissected domed mountains.</td>
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<td>High Plains</td>
<td>13d. Broad intervalley remnants of smooth fluviatile plains.</td>
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<td>Plains Border</td>
<td>13e. Submaturely to maturely dissected plateau.</td>
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<td>Colorado Piedmont</td>
<td>13f. Late mature to old elevated plain.</td>
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<td>Raton section</td>
<td>13g. Trenched peneplain surmounted by dissected, lava-capped plateaus and buttes.</td>
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<td>Pecos Valley</td>
<td>13h. Late mature to old plain.</td>
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<td>Edwards Plateau</td>
<td>13i. Young plateau with mature margin of moderate to strong relief.</td>
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<td>Central Texas section</td>
<td>13k. Plateau in maturity and later stages of erosion.</td>
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<td>Springfield-Salem plateaus</td>
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<td>Arkansas Valley</td>
<td>15a. Gently folded strong and weak strata; peneplain with residual ridges.</td>
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<td>Ouachita Mountains</td>
<td>15b. Second-cycle mountains of folded strong and weak strata.</td>
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<td>17. Elevated plains in various stages of erosion; isolated low mountains.</td>
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<td></td>
<td>18. Complex mountains, mainly antiflormal ranges; intermont basins.</td>
</tr>
<tr>
<td></td>
<td>19. Deeply dissected mountain uplands, not antiflormal ranges; intermont basins.</td>
</tr>
</tbody>
</table>

*Used by Nevin M. Fenneman and Douglas W. Johnson.*

Reliefs of relief are herein spoken of as low, moderate, strong, and high. Here *high* relief is measured in thousands of feet; *moderate* relief in hundreds of feet. *Strong* relief may be anything approaching 1,000 feet. Low relief is but rarely measured. **Low** latitude on both sides.
<table>
<thead>
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<td>a. Walla Walla Plateau</td>
<td>20a. Rolling plateau with young incis</td>
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<td>Intermontane</td>
<td>Columbia Plateaus</td>
<td>b. Blue Mountain section</td>
<td>20b. Complex mountains and dissecte</td>
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<td>Plateaus</td>
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<td>c. Payette section</td>
<td>20c. Young plateaus of prevailingly</td>
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<td></td>
<td>d. Snake River Plain</td>
<td>(Applies to northern part only;</td>
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<td></td>
<td></td>
<td>e. Harney section</td>
<td>20d. Young lava plateau.</td>
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<td>a. High Plateaus of Utah</td>
<td>20e. Young lava plateau; features of i</td>
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<td>b. Uinta Basin</td>
<td>21a. High block plateaus, in part lava</td>
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<td>d. Navajo section</td>
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<td>e. Grand Canyon section</td>
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<td>21e. High block plateaus, trenched by</td>
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<td>e. Grand Canyon section</td>
<td>22d. Isolated ranges (largely dissected</td>
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<td>f. Datil section</td>
<td>22e. Mature block mountains of gently</td>
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<td>23b. Generally accordant summits; hi</td>
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<td>c. Canyon Lands</td>
<td>23c. Volcanic mountains variously ero</td>
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<td>d. Navajo section</td>
<td>23d. Block mountain range tilted we</td>
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<td>e. Grand Canyon section</td>
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<td>f. Datil section</td>
<td>23d. Block mountain range tilted we</td>
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NOTE.—Major divisions of Provinces: Provinces are divided by number. Broken lines indicate poorly known or poorly defined regions.
ARACTERISTICS

Incised valleys.
Dissected volcanic plateaus.
Vailingly weak rocks; broad alluvial terraces. Part only.)

Tures of recent volcanism; ineffective drainage.
Part lava-capped; terraced plateaus on south side. Relief.
Ed plateaus; high relief. Relief than 21c, into which it grades.
Nched by Grand Canyon.
Mnants; volcanic necks.
Dissected block mountains) separated by aggraded Anges in desert plains.
1 delta plain; Gulf of California.
Dissected block mountains) separated by aggraded Of gently tilted strata; block plateaus; bolsons. Accordant height; higher volcanic cones.
Mits; higher volcanic cones.
Usly eroded; no very distinct range.
Tilted west; accordant crests; alpine peaks near acter; in part submerged.
Ts; local alpine peaks.
Ak rocks, dissected; monadnocks of igneous rock.
Eneplain on strong rocks; extensive monadnock

Ys on folded, faulted, and metamorphosed strata; Equal height.
Fault blocks; alluviated lowlands.
Ung granite upland (in northern part).

ajor divisions are separated by the heaviest lines. Ovines are named on map and also distinguished numbers. Sections are indicated by letters. Open lines indicate boundaries much generalized poorly known.