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AGRICULTURAL GEOLOGY

DURING reconstruction, as the present period is frequently termed, many new applications of the principles of pure science to special fields of endeavor are being made. The principles of geology thus applied during recent years have given rise to economic geology, mining geology, engineering geology, oil geology and perhaps to that branch of the subject indicated by the above title for it is not entirely new. The application of the principles of the science to the solution of the geological problems that are met in agricultural enterprises and pursuits, in brief, the relation of geology to rural welfare may appropriately be considered as agricultural geology.

Such a problem is that of securing an abundant supply of pure water. In regions of copious rainfall it is essential, in those of average to minimum rainfall it is absolutely necessary to consider the properties and the structure of the substrata in their relation to water in order to obtain such a supply. Pursuant to the requirement of this necessity, the United States Geological Survey maintains a branch of service whose work is concerned with the water resources of the entire country. The purity of subsurface water depends chiefly on the filtering power of the yielding rocks. One of the best natural filters consists of residual material of considerable depth. Some rocks below this mantle are sufficiently pervious to hold, transmit, filter and consequently to yield pure water. Certain others are impervious. Another condition is found where the rocks contain joints or cracks along which water moves freely without filtration, conveying to wells or springs contamination from distant sources. This condition is a strong possibility in limestone regions. Artesian water which, in some localities, flows from wells may be found where the properties and structure of the containing rock bears such a relation to a supply of water as will produce it. Under one combination of these conditions, as in areas of jointed igneous or metamorphic rocks in the Piedmont belt, an artesian well may yield a few hundred gallons daily; under another, that of a pervious sedimentary rock overlaid by impervious ones which outcrop in a moist region of higher elevation, as in the Great Plains, the yield may be several hundred gallons per minute.

Among the minerals most useful in agricultural pursuits are coal and other mineral fuels, the mineral oils (kerosene and gasoline), iron, salt, gypsum, lime, the minerals of the soil, and the fertilizer minerals yielding potash, phosphates and nitrates. The nature, quality, distribution and availability of most of these substances bear direct relations to their respective geological occurrences. In order that careful discriminations may be made in their purchase and use, those who have need for them should be familiar with their distinguishing properties and with their relative values.

In numerous localities natural gas is obtained from considerable depth. Gas provides fuel and light for use in buildings and power for machinery. Examples of such uses are common in agricultural districts in the gas-producing regions from Pennsylvania and West Virginia via Illinois southwestward to Texas and in other places, where many farmers depend almost wholly on the gas wells for these services. Gasoline for the auto and the tractor is now being extensively made from natural gas. At Anaconda, Montana, the tallest smokestack in the world, 585 feet, was erected to protect vegetation from destruction by smelter gases and soil from ruin by erosion due to this loss of its vegetative cover. Ducktown, Tennessee, and other mining districts afford additional illustrations of these principles. The gases and dust from the smelters, from the blast furnaces of the steel industry and from the flues of the cement mills, through skillfully devised systems of careful collection and concentration, are soon to yield a large proportion of the potash used as fertilizer.

In road building the adaptation of various materials even when only sand and clay are needed is determined by the properties of the minerals and rocks considered for this purpose and by the nature of the base on which the road is to be constructed. In locating a road along or near a slope or in any topographic position where strata outcrop, the drainage and therefore the safety and permanence of the road, or its failure, depend on the kinds of rock involved and on their structural relation. The rapidly growing use of motor vehicles emphasizes the importance of details in regard to road materials and road locations.

From the rocks at the surface or below it, suitable material is obtained for buildings and other structures necessary in agricultural enterprises. Such materials are used in making brick, cement and concrete, in building roads, bridges, dams and retaining walls and in the erection of dwellings and other buildings. A knowledge of the properties and adaptations of structural materials is essential to the intelligent selection of them and to their efficient use. It is also necessary in many localities to understand thoroughly the relations of the substrata to the surface in order to choose safe locations for permanent structures.

The way in which undrained areas were formed has much to do with the solution of the problems that arise when drainage is undertaken and with the kinds of soil reclaimed when the project is completed. Whether an area must be drained by means of surface ditches or whether an exit may be found through a pervious layer of rock below depends wholly on the elevation and on the nature and structure of the substrata. In arid and semi-arid regions the possibility of irrigation as well as the permanence of the aqueduct is dependent also on geologic and topographic factors. Of the sewage disposal plants which are needed on all farms most types can be located with safety in regard to water supply only by considering fully the conditions of geologic structure and materials in the vicinity.

The losses of soil by erosion due to the action of wind or of water and in some localities due to the additional influence of improper tillage and pasturage bear definite relations to the topography of the area affected. Unfortunately the rich, black humas of the top soil, which is the best part of it, is the first to be removed—a fact that makes early prevention imperative. If the losses are permitted to continue a great succession of gullies and barren ravines soon develops and a worthless area is formed where valuable land could have been retained. The water table is perceptibly lowered over large areas by increased depth of drainage channels or removal of protective cover and this is another serious loss. On the other hand proper drainage may change an alkali soil to a fertile one. The chief processes that cause these losses involve the principle that the transporting power of water various as the sixth power of its velocity. This means that a current whose velocity is three miles per hour can carry more than eleven times as much sediment as one whose velocity is two miles per hour and that a current of three miles per hour loaded to its capacity will, on being reduced to two miles per hour or less, deposit more than 90 per cent. of its load. When a flood current subsides or is checked, an area of rich soil may be covered to a depth of several feet with sand or other worthless material. Prevention and partial restoration of losses may be accomplished as follows: Meandering channels may be replaced by large drainage ditches and with the aid of catchment basins in regions having high rate of rainfall, prevent flooding and erosion of river bottom land. Other losses may be wholly or partly prevented by constructing retaining walls, by the use of tiling or of lined open drains, by contour tillage, by limited pasturage, or by planting trees, shrubs or grasses. Restoration may be partially made by constructing dams or by other means of ponding to check the current and arrest the moving sediment thereby changing the area from one of erosion to one of deposition.

Soil origin finds its explanation chiefly in the field of geology; soil distribution, largely in that of physiography. Different kinds of soils are produced from different kinds of rock or from the same kind of rock when subjected to different processes during the course of origin. For example, soils originating from a given kind of rock in a warm, wet climate will be very unlike those derived from the same kind of rock in a cool, arid region. A third kind of soil will result if the materials from the same kind of rock are transported and sorted by water before forming the final soil; a fourth kind, if transported by glaciation; and a fifth, if deposited by the wind. The various kinds of soil may differ from each other in number of mineral constituents or in the different proportions of each. The development of hills and valleys and other topographic forms by erosion gives rise to a different kind of soil in each topographic location. Kinds of soil arise also in numerous other ways each of which is a response either directly or indirectly to geologic or physiographic processes and conditions.

Classification of soils that they may be subjected to treatment conducive to the greatest production depends chiefly on the accurate use of the principles of soil origin and distribution. The changes recently made by the United States Bureau of Soils in the revision of classification units that were used in mapping a number of years ago afford excellent illustrations of this fact and of its recognition by the Soil Survey. The new divisions formed are based almost wholly on genetic and topographic relations—the principles of geology and physiography being applied to a much greater extent and in greater detail than in the earlier work.

The distribution of vegetation in so far as it is controlled by topography, kind of rock and geologic structure constitutes an important phase of agricultural geology. The distribution of soils, of rainfall, of temperature and of plant and animal life, the location of water courses, of valleys and uplands, of railways, highways and of markets as well as the adaptability of various areas to their respective agricultural uses are, to a remarkable extent, arranged in accordance with the topography and with the kinds and relations of the underlying rocks.

The principles of improvement in domestic plants and animals are found in a diligent study of the geological history of their respective races and are fully illustrated in the development of the present forms of life from the ancient ones. These great changes in form, stature and intelligence make some of the useful stories in the earth's history as they are revealed by the record that is written in the rocks. By the study of this history man is encouraged in self improvement and in the realization of his responsibility to the world about him; he is inspired to higher ideals in his relations with his fellow man and in the field of intellectual achievement; he is stimulated to a more intelligent understanding of the powerful forces in nature and of their influence on the origin and on the destination of the human family.

In view of the present awakening to the needs of people in agricultural vocations and of the many relations of this science to rural welfare, it seems reasonable to expect that the study of agricultural geology in colleges and elsewhere will be extended until it is shared by all who are preparing to do work in rural improvement and that each will continue this study long enough to be able to apply the subject with intelligence.

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THE NOMENCLATURE OF FAMILIES AND SUBFAMILIES IN ZOOLOGY

Recent years have seen gratifying progress in the establishment of permanent rules of zoological nomenclature. Through the Stricklandian Code, the American Ornithologists' Union Code (commonly known as the A. O. U. Code), and, most recently, the International Code, greater uniformity of usage has been achieved than was ever before thought possible.

Family names, however, are still in very much the same state of nomenclatural chaos as were generic and specific names before the adoption of the Stricklandian Code in 1842. Zoological family and subfamily names have come and continued in use by a sort of *auctorum plurimorum* principle; and though current usage is more or less satisfactory so long as every one is agreed, any serious difference immediately causes trouble. Rules by which workers will agree to be bound, therefore, become necessary; and this, it were trite to say, is the reason for any code of nomenclature. Certain authors, however, have recently begun, for reasons other than zoological, to change many family names long in use, and it is, therefore, pertinent now to inquire into the desirability of such changes, and of the formulation of some principles for guidance. Since family and subfamily designations must depend on generic names, they are more in need of definite rules than are the names of still higher groups.

Latreille, in his "Précis des Caractères Générique des Insectes," published in 1796, was the real originator of the family concept in zoology, but he first designated these groups by number, though in a later work adopted plural Latin names with differing terminations. William Kirby, an English naturalist, in a paper on a new order of insects,[1] was the first to advocate the adoption of uniform patronymic endings in "*idæ*." The idea was soon afterwards adopted and elaborated by W. E. Leach, and subsequently by other authors, so that it was brought into general use during the succeeding decade. In 1825, N. E. Vigors, in a paper on the classification of birds, provided an entire set of family names with the ending *idæ*. It is of interest to note, in this connection, that German authors were far behind the English in adopting this improvement in terminology. Subfamily names in "*inæ*" did not come into general use until about the year 1830.

The first definite formulation of the principle of patronymic endings for family and subfamily names was in the Stricklandian

[1] *Trans. Linn. Soc. London,* XI., 1813, p. 88, footnote.