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SCIENTIFIC BOOKS.

Quantitative Classification of Igneous Rocks, based on chemical and mineral characters with a Systematic Nomenclature. By WHITMAN CROSS, JOSEPH P. IDDINGS, LOUIS V. PIRSSON and HENRY S. WASHINGTON; with an introductory review of the development of Systematic Petrography in the nineteenth century, by WHITMAN CROSS. The University of Chicago Press. 1903. Pp. 286.

During the past year there have appeared in the *Journal of Geology* a series of papers dealing with the various aspects of petrographical classification. These, which really form parts of a continuous treatise, have been gathered together in the present volume. A series of tables and a glossary have been added, the whole forming one of the most valuable contributions to systematic petrography which has as yet appeared.

Few sciences have shown a more rapid development than the science of petrography. One hundred years ago the distinction had not been drawn between a rock and a geological formation, and many very fine-grained rocks were regarded as minerals and were described as such. Thus basalt was supposed to be a mineral species and its columnar

structure was thought to be a peculiar type of hexagonal crystallization. During the early years of the last century progress, it is true, was comparatively slow, but with the introduction of the microscope the science received a tremendous impetus and a great number of enthusiastic workers were attracted to it, so that during the past thirty years or more an immense store of facts has been collected. The system of petrographical classification, however, which has been gradually elaborated, while never wholly satisfactory, is now proving inadequate and unwieldy. It fails, moreover, to express the chemical relationship of rocks. Every year a host of new names, having in themselves nothing to indicate the character of the rocks which they designate, are being introduced and applied to new types or varieties, and the confusion promises to increase with the advance of our petrographical knowledge.

An able historical summary of the development of petrographical classification is given by Cross in the introduction to the volume under consideration, and a new system of classification for the igneous rocks is then presented, based on thoroughly scientific principles and capable of indefinite expansion so as to meet all requirements of the science as it develops. There is no attempt made in the new system to remodel any existing system of classification so as to meet present needs. As the authors state, it would be impossible to do this satisfactorily. An entirely new classification is presented with an entirely new nomenclature—a nomenclature, however, based on mnemonic principles so that it can be grasped and remembered with comparatively little effort.

Before passing to the examination of this new classification, however, it must be pointed out that the authors really present two systems of classification for the use of geologists—a simple or general classification for use in the field, based altogether on the megascopic characters of rocks—and a second much more elaborate and detailed classification which is to be employed after a more complete study of the rock has been made. These two systems are in agreement with each other, the second forming in a way an extension or elaboration of the first. The classification for field purposes retains the common names now in general use, granite, syenite, diorite, basalt, melaphyre, etc., although in some cases giving the terms a rather more comprehensive meaning than they have at present. Thus syenite is made to include all coarse-grained igneous rocks, rich in feldspar, the feldspar, however, being either orthoclase or plagioclase. The term thus embraces, in addition to the normal syenites, the anorthosites, as well as the more feldspathic monozonites, diorites and gabbros of the present classification. However, it may be said that, so far as the field geologists are concerned, the general classification proposed will not differ from that at present in use to such an extent as to cause any inconvenience in applying it. For them, in fact, petrographic classification is made distinctly easier.

The more detailed classification is based on the chemical composition of the rocks, all rocks of a like chemical composition being grouped together. The rock is thus classified according to the composition of the magma from which it solidified. The classification is, furthermore, *quantitative,* and is thus admirably adapted for purposes of comparison and for studies in rock differentiation, which are playing so important a part in modern petrographical work. A chemical analysis or a microscopical examination of the rock is required before its place in this classification can be determined—except in a very general way.

The chemical composition of the rock being known, its mineral composition is first calculated. This is readily and quickly done by the aid of the valuable tables appended to the book. Since, however, the same magma may, under different conditions, crystallize out in different mineral combinations, a certain clearly defined method is followed in these calculations, giving that grouping of minerals which the magmas on cooling usually develop. This percentage mineral composition of the rock expressed in these standard minerals is called the *norm,* a mineral composition which the magma would normally

assume. If for any purpose we wish to calculate the percentage mineral composition of the rock, giving the exact proportion of minerals actually present, full explanations as to the method to be followed are also given, this constituting the *mode* of the rock, or the manner in which the chemical elements have actually arranged themselves. As a general rule, the *norm* and the *mode* of a rock agree closely.

No classification, however, which requires a chemical analysis of a rock before the position of the rock can be determined and a name given to it, would be susceptible of general use. Consequently a method is indicated by which it is possible to determine the chemical composition of a rock without the aid of such an analysis. Rosival has recently shown that if a few thin sections of a rock are taken, the relative proportions of the various minerals constituting the rock may be determined by measuring under the microscope the diameters of each crystal in lines running arbitrarily across the thin sections in question, care being taken to measure a distance at least 100 times as great as the average diameter of the constituent grains. The values obtained will correspond to those of the volumes of the several minerals present. The relative weights of the several minerals may be deduced from these volumes by multiplying each by the specific gravity of the mineral and reducing the whole to 100 parts.

The approximate chemical composition of the several minerals can be determined from the known composition of these species in similar rocks, and from these data the composition of the rock as a whole can be easily calculated. From this, in its turn, the *norm* may be obtained.

In the case of glassy rocks or those containing a large amount of unindividualized material, a chemical analysis is necessary, just as it is for that matter in many cases in the system of classification now employed.

The *norminative* mineral composition and the chemical composition of the rock being thus ascertained, its position in the classification can be readily determined. For this purpose the rock-making minerals are divided into two groups, namely, those which are characterized by a high content in silica, aluminium and alkalis, and those characterized by a high content of iron and magnesia. The first group is known mnemonically as the *salic* (silica-alumina) group and the second as the *femic* (ferro-magnesian) group. On the relative proportion of the minerals of these two groups present, rocks are divided into five *classes,* according to whether one or other of these groups is *extremely abundant* or merely *dominant,* or whether the minerals of the two groups are present in about equal proportions. These five classes are thus characterized (commencing with the most *salic*) as the persalane, dosalane, salfemane, dofemane and perfemane. These classes are subdivided into *orders* according to the relative proportions of minerals forming the predominant group in each case. Thus in the preponderatingly salic classes the order will be based on the relative amount of quartz, feldspars and feldspathoids. The orders in their turn are subdivided into *rangs* (an archaic equivalent of *ranks* used to avoid confusion with this latter term), on the ground of the chemical character of the bases in the minerals of the preponderant group in each case; thus, if these were feldspathic, the fivefold division would be made according to the proportion of alkalis to lime in the feldspars. The lowest division, known as a *grad* (an archaic form of *grade*), is based on the relative amounts of the minerals composing the subordinate group in the rocks. In addition to these, further subdivisions are provided for, when necessary, by *subclasses, suborders, subrangs* and *subgrads.*

The system demands an entirely new nomenclature; in fact any attempt to adapt the old nomenclature to the new system would result in the direst confusion. A new nomenclature in its entirety has accordingly been elaborated, but, being based upon a definite plan, is easily grasped after a little practice. Each name consists of a root derived from some geographical name, the name of some locality where the rock in question is typically developed, the localities being chosen impartially from all countries, thus giving an inter-

national complection to the scheme. To this root is added a suffix which varies in a definite way so as to indicate class, order, rang and grad. For these respective divisions, the letters *n, r, s, t* are employed, in conjunction with the vowel *a,* thus giving in English, *ane, are, ase* and *ate.* In *subclass, suborder,* etc., the vowel is changed to *o,* thus giving *one, ore, ose* and *ote.* An example of the working of the system may prove of interest.

In many parts of the world in recent years occurrences of a peculiar syenite have been found, the rocks being rich in alkalis and usually light in color. They sometimes contain a little nepheline; in other cases this mineral is absent. A number of names have been given to local varieties of this rock, pulaskite, nordmarkite, lauvikite, etc. When any new occurrence is described an attempt is made to bring it under one or other of these terms, or perhaps a new varietal name is suggested. How many of these varieties, often more or less overlapping one another in their characters may eventually be named, it is at present difficult to say.

Now, under the proposed system, the *norm* of any new occurrence having been ascertained, it would at once be seen that the rock belonged to the class *persalane,* for the feldspars would form almost the entire rock. Then it would be found that the quartz or nepheline present occurs in very small amount, less than one seventh of the feldspar. This would bring the rock into the fifth *order* of the *persalanes,* namely, the *canadares.* The question as to the proportion of the alkalis and the lime in the rock would then present itself. If this proportion be more than seven to one, the rock belongs to the first *rang* of the *canadares* and is a *nordmarkase.* If, further, the soda is dominant over the potass, being present in the proportion of between three fifths and one seventh, the rock belongs to subrang 4 and is a *nordmarkose.* If the relative proportion of lime to alkalis be greater than one to seven, the rock falls into rang 2 and is a *pulaskase*—and, the relative proporton of soda and potass remaining as above, into the *subrang lauvikose.*

It will thus be seen that it is possible to compare accurately the newly described variety with those types already established and to classify it with that with which it is most nearly identical. The name assigned to it, moreover, shows at once just how and to what extent it differs in composition from any and each of the varieties already known.

As will be seen, the volcanic or plutonic character of the rock (so important in the schemes of classification employed by Rosenbusch or Zirkel) has not been taken into consideration in naming the rock. A qualifying adjective, however, is prefixed to indicate the texture of the rock, which is, as a general rule, determined by its solidification at the surface or in the depths of the earth's crust. The qualifying adjectives employed are those now in general use, viz., granitic, trachytic, ophitic, porphyritic, etc. This, added to the magmatic name, will give a compound name which accurately describes not only the composition, but the texture of the rock.

It is impossible to refer to more than the main outlines of this new scheme of classification, but, as will be found by perusal of the book, the whole question has been most carefully thought out, every possible case considered and the scheme tested by applying it to thousands of rock analyses. It, further, has the merit of being presented in clear and idiomatic English, so that it can be readily understood. It is the result of some ten years' work on the part of four of the ablest petrographers in America, during which time many different methods of classification have been successively drawn up and tested, only to be found to break down in some important particular. The present scheme is thus the result of a long course of investigation and very mature deliberation. With a little experience the calculations required for the application of the system can be quickly made, especially with the aid of the tables given in the book for that purpose. By such calculations, furthermore, it is possible to check the accuracy of the chemical analysis of the rock and in many cases to point out the nature of errors, if any have been made. A higher degree of accuracy is thus secured in petrographical investigation.

It is hardly to be expected that an entirely new classification such as that proposed will at once be universally adopted, but it is believed that as time goes on it will recommend itself more and more to petrographers as a *quantitative* system of classification, much more precise and definite than any that has been hitherto proposed, and having the further advantage of being based on thoroughly scientific principles and capable of indefinite expansion, if necessary, to meet the growing needs of the science.

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Ueber das Hirngewicht des Menschen. By F. MARCHAND. Abh. d. math.-phys. Classe d. Königl. Sächsischen Ges. d. Wissensch., Bd. XXVII., 1902, No. IV., pp. 393–482.

Professor Marchand, of Marburg, has accumulated the largest number of human brain-weights ever published, and in a large series of tables, containing 1,169 cases, he gives a thorough analysis of these data. Marchand discusses the influences affecting the weight of the brain, such as the cause of death, bodily stature, sex and age. He finds a notable increase in the brain-weight of persons dying of diphtheria and other acute diseases, owing, no doubt, to the hyperæmia and œdema of this organ. In new-born children the average weight is 380 grams for males and 353 grams for females. Combining with these the infants less than one week old, the averages are 371 grams for males and 361 grams for females. These weights are doubled by the end of the first year, and tripled at the end of the third. After the fifth year the increase in the weight of the brain is more gradual. The figures show that in most persons the maximum brain-weight is attained at about the twentieth year in males, the average being about 1,400 grams, and at about the seventeenth year in females, the average being 1,275 grams. The reduction of the average brain-weight due to senile atrophy occurs in the eighth decade in men and in the seventh decade in women. The maximum absolute weight in Marchand's series was 1,705 grams in a male. Many high brain-weights were omitted from the tabulations on account of hydrocephalus, brain-tumor, meningitis and other brain affections. Low brain-weights, less than 1,200 grams in males and less than 1,100 grams in females, constituted about five and seven per cent., respectively, of all the cases, usually in phthisical subjects or in those dying of wasting diseases. The tables show a certain relation existing between the stature and brain-weight, but the ratio of increase is a very inconstant one. Finally Marchand discusses the relation of the sexes as to their brain-weight, and concludes that the lesser weight of the brain in women is not alone dependent upon her smaller stature, for a comparison of both sexes of the same stature shows the male brain to be invariably the heavier. In the growing child, until a stature of seventy centimeters is attained, the brain-weight increases proportionately to the increase in body-length, irrespective of age or sex; thereafter, however, the male brain begins to outstrip that of the female. Woman's lesser brain-weight, like her lesser head-circumference, as compared with males of the same stature, seems to be an expression of the different organization of the female body.

E. A. S.

SCIENTIFIC JOURNALS AND ARTICLES.

The Popular Science Monthly for February has for frontispiece a portrait of Carroll D. Wright, president of the American Association. Asaph Hall has an article on 'The Science of Astronomy,' in which attention is called to the influence of science in promoting harmony among nations. Bradley M. Davis discusses 'The Evolution of Sex in Plants,' as illustrated by the Algæ. Alverton W. Price shows 'The Economic Importance of Forestry,' and Frederick A. Woods gives the seventh of his papers on 'Mental and Moral Heredity in Royalty,' this one dealing with the house of Nassau and Brunswick. An account of 'The Smithsonian Institution' is reprinted from its last report. Roger Mitchell discusses 'Jewish Immigration,' showing that it presents a somewhat serious problem in New York. Wesley Mills treats of 'The Behavior of Blind Animals,' adducing instances to show how great