ROCK-FORMING MINERALS

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PREFACE.

STUDENTS on the Continent are well supplied with text-books

Page 219. Fig. 115. For a read c, and for c read a.

there is a constant demand for a book to which they can refer for information enabling them to determine the chief rock-forming minerals. Yet, although many of the works now published supply them with much that is useful, this want seems still to remain unsatisfied.

It is essentially a student's want. Whether this book will in any way meet it, at least for the time being, is a question best answered by the book itself.

Text-books of mineralogy and petrology are, to a great extent, necessarily compilations from others bearing upon these or upon collateral branches of science. In the present case

the Author has referred largely for information to the following works:—

Bauerman, H., "Text-book of Systematic Mineralogy" 1881.
" " " "Descriptive Mineralogy" 1884.
De Lapparent, A., "Cours de Minéralogie" . . . . 1884.
Groth, P., "Physikalische Krystallographie" . . . 1885.
Rosenbusch, H., "Mikroskopische Physiographie," Bd. i. . . . . 1885.
Tschermak, G., "Lehrbuch der Mineralogie" . . . 1884.

To the writings of Profs. Des Cloizeaux, Dana, Zirkel, Fouqué, and Lévy, the Author is, of course, also greatly indebted, as well as to those of the late Profs. Naumann and A. von Lasaulx. Numerous books by other authors have also been consulted; and the most grateful acknowledgments are tendered to several friends who have given important help in the correction and revision of the work.

Save in a very few instances, no references to original sources of information have been given, as they would have expanded the book far beyond its present limits. The more advanced student will find a copious bibliography in the work of Prof. Rosenbusch, already cited, and numerous references to the European and American literature of the subject in Mr. Teall's "British Petrography."

F. R.

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PART I.

I. Apparatus, Methods of Preparation, Examination, etc.

Before attempting the microscopic examination of a mineral or a rock, it is well to consider the kind of apparatus which will have to be employed.

We may, in the first place, deal with what is absolutely necessary for the simplest class of observations; in the next, with the means employed in the prosecution of the somewhat more advanced class of research; but the elaborate and costly instruments now used in the highest branches of petrological investigation will not be described, as they are beyond the reach of the majority of students. An account of such instruments and of the methods of using them will be found in Groth's "Physikalische Krystallographie" (2nd edition), in Rosenbusch's "Mikroskopische Physiographie der petrographisch wichtigen Mineralien" (2nd edition), and in other works devoted to this subject.

For the successful examination of a rock, an acquaintance with various branches of science is necessary, namely, chemistry, physics (especially optics), mineralogy, and geology.

Geology, indeed, may be regarded as the first essential, for, without it, we can find no real interest in rocks; and it is this science which gives us an insight,—often, however, only a rough or approximately true one, into the conditions under which a rock has been formed. Mode of occurrence is, there-

fore, a matter of immense importance in all petrological questions; and the eyes which see a rock only through a microscope will see but dimly where this first vision has been denied to them.

The general mode of occurrence of rocks will be found described in any good text-book of geology, and it is therefore needless to encumber these pages with an account of the principles, or of the more detailed explanations, relating to this branch of the subject. Suffice it to say, that the beginner going into the field should take with him a trustworthy geological map; while the experienced geologist will at least need a well-constructed topographical guide, preferably a map of large scale, cut into small pieces for the sake of portability and ready reference. With this, a strong hammer, a compass, clinometer, protractor, and collecting-bag, he will be able to do his work.

We shall also say but little about chemical reactions conducted under the microscope, since a practical acquaintance with the ordinary methods of analysis adopted in the laboratory is indispensable to the successful prosecution of this branch of research. Those, however, who wish for information upon the subject should consult Klement and Renard's "Réactions Microchimiques," Brussels, 1886, Bořický's "Elemente einer neuen chemisch-mikroskopischen Mineral- und Gesteins-analyse" (Prag, 1877), Fouqué and Lévy's "Minéralogie Micrographique" (Paris, 1879), etc.

A certain knowledge of mineralogy should also be possessed by any one who wishes to study petrology. For this purpose, however, after the general principles of the science have been learnt, an acquaintance with a comparatively small number of rock-forming minerals will suffice for the beginner; and, for information concerning minerals not given in the following pages, he is referred to the more recently published text-books mentioned in the Appendix.

From the foregoing observations, it will be seen that the student must have had some amount of preliminary training before he finds himself in a position to investigate the genesis, the changes, the chemical composition, and the mineralogical constitution of rocks.

The pocket-lens. When the observer has examined a chip of rock, and has seen all that he can see with his unassisted eyes, he should next have recourse to a lens; and it may here be remarked, that those who have had no practice in the use of this simple instrument, seldom hold it in a manner calculated to give it the requisite steadiness. To do this, hold the specimen in the left hand and the lens between the thumb and fore-finger of the right. Rest the tips of one or more of the remaining fingers of the right hand upon the specimen, and while keeping them in this position raise or lower the lens until the proper focus is gained. If the specimen be too small to afford a support to the fingers of the right hand, rest the disengaged fingers of the right upon those of the left hand. When a Coddington lens or one of very high power is employed, this precaution becomes additionally needful. Should it be necessary to scratch a minute crystal in order to test its hardness or streak, it will be found difficult to manipulate a knife and a magnifier at the same time. This difficulty can be obviated by employing a watch-maker's lens, held in the eye; but it is less fatiguing to use a small lens attached to a spring-clip which can be placed on the nose. The hands are thus left free.

The same end may be attained by adopting the contrivance used by engravers; namely, by fixing one end of a stout brass wire round a watchmaker's lens of suitable focus. The other end is turned into a small loop, and the wire is then bent to about two-thirds of a circle, so as to fit comfortably round the head. There is thus sufficient spring in the wire to keep the

lens in position without any muscular effort whatever; and it can be shifted on to the forehead and replaced over the eye without trouble.

Specific Gravity.—The determination of the specific gravity of a rock, or of any of its component minerals, may be effected in the ordinary way by means of a suitable balance; but larger masses may be employed when Mohr's apparatus is used, a considerable advantage when rocks composed of more than one kind of mineral are being examined. The latter consists of a burette with its usual support. Beneath the lower end of this a tall glass cylindrical vessel 3½ to 4 inches in diameter is placed, and across its mouth is laid a strip of wood through which a large needle is driven, fitting so that it can be easily slid up or down. A piece of india-rubber tubing is then attached to the superior extremity of the burette, water at a temperature of 60° F. is poured into the glass cylinder beneath it, and the needle so adjusted that its point barely touches the surface of the water, the reflection of its point appearing to touch the actual point of the needle. The specimen, having been accurately weighed in air, is now immersed in the water, which rises in the cylinder. The operator next applies his mouth to the tubing connected with the upper end of the burette, the lower end being adjusted so as to be well below the level of the water in the larger vessel, opens the tap on the nozzle and draws up into the burette a slightly greater quantity of water than the specimen displaced, so that the water stands a little below the point of the needle, and closes the tap. He next opens the tap cautiously, allowing the water in the burette to drip back into the cylinder until the original level (*i.e.*, up to the needle-point) is restored. The amount of water displaced by the stone, is now in the burette, and can be ascertained by means of the graduation. If then we divide the weight of the mineral in air by the weight of the displaced water in the