

condemnation is hinted of collegiate education for our Indian engineers. Engineering degrees meet neither favour nor contempt; the gods of the profession seem to live far removed from all this turmoil, and do not deign even to nod approval.

Seriously, it seems impossible that the Council of the Institution can rest satisfied with such a contribution to the cause of education as this barren pamphlet. It is their duty to take action; their recommendations would have no legal force, but great moral weight. Let them say whether they desire great Polytechnic Schools on the continental model. Not improbably public money will ere long be granted for some such. Let them approve or condemn the Indian College. Let them recommend engineers to compel the attendance of their pupils at suitable classes, and to refuse all students as apprentices who cannot show that they have received proper preliminary training. If proper classes do not now exist for the students, let them tell us where they are wanted and what they ought to be. Let them declare what the preliminary training of a pupil must be. Let them fix a practical value on the engineering degrees of those colleges which deserve such encouragement; or finally, if they will do none of these things, let them say, if they dare, that they are perfectly well satisfied with things as they are.

RECENT PETROGRAPHICAL LITERATURE

II.

Untersuchungen über die Mikroskopische Zusammensetzung und Structur der Basalt-Gesteine. Von Dr. F. Zirkel. (Bonn, 1870.)

Mikromineralogische Mittheilungen. Von Dr. F. Zirkel. Pp. 801. (Neues Jahrbuch für Mineralogie, 1870.)

Beiträge zur Petrographie der plutonischen Gesteine. Von Justus Roth. (Reprinted from the Transactions of the Royal Academy of Sciences of Berlin.)

Sur les Crystallites, études crystallogéniques. Par H. Vogelsang. (Archives Néerlandaises, 1870.)

Kritische Mikroskopisch-mineralogische Studien. Von H. Fischer. (Freiburg.)

Mikroskopische Unterscheidung der Mineralien aus der Augit, Amphibole und Biotit-gruppe. Von G. Tschermak. (Proceedings of the Vienna Academy of Sciences, 1869.)

AMONG the Continental petrographers who have led the way in the recent reform and extension of this branch of science, none can claim a more prominent place than Dr. Zirkel. Although still a young man, he has held professorships successively at Lemberg and at Kiel, and we rejoice to hear from him that he has been selected to succeed the venerable Dr. Naumann at Leipzig. He is the author of many excellent mineralogical and petrographical papers, and of the best text-book of petrography which has yet been published. Especially has he distinguished himself by the zeal with which he has followed out the ideas first broadly sketched by Mr. Sorby, and has shown how absolutely indispensable is the application of the microscope to the study of the composition and history of rocks. His researches, while extending over the length and breadth of Germany, have not been confined to the Continent, but have been carried with cha-

racteristic enthusiasm even as far as the peaks of Arran, and the cliffs and glens of our north-western isles.

A few years ago he resolved to devote himself to a comprehensive study of the rocks to which the general name of basalt has been given. Though abundant chemical analyses had made the ultimate chemical constitution of these rocks well known, the mineralogical composition of them still remained rather vaguely defined. Their compactness and dark opaque hue made it difficult to investigate the separate mineral ingredients of which they consisted, and men were still speculating about the mineralogical nature of that part of basalt which is soluble in acid, when Dr. Zirkel set to work to collect specimens of basalt from every available locality, and to prepare thin transparent sections of them for examination with transmitted light under the microscope. The result of these investigations appears in the little volume now before us, which is appropriately dedicated to Mr. Sorby. In a brief introduction the author recounts the state of the question when he took it up. Having collected and prepared upwards of 300 sections of basalt from the most varied localities, he believes that he has obtained samples of at least the chief types of composition and structure among the basalts, and he now gives us this first instalment of his labour.

The first section of the volume treats of the microscopic structure and peculiarities of the minerals which enter as chief ingredients into the composition of basalt—augite, feldspar, nepheline, leucite, olivine, magnetic iron, &c. This is an especially valuable part of the book, seeing that it furnishes materials for speculating both upon the conditions under which basalt was erupted, and on the various metamorphic changes which the rock as a whole and its component minerals in particular, undergo under the influence of percolating water and atmospheric weathering.

The second part deals with the general microscopic structure of basalt-rocks. The common notion regarding that structure has hitherto been that down to its minutest particles basalt is a crystalline rock, that its individual microscopic ingredients mutually impinge on each other, and that the difference between the structure, for example, of granite and basalt consists in little more than in the varying relative size of their component minerals. Prof. Zirkel, however, shows that this notion, which has been founded on mere deduction and not on direct observation, must be changed. He finds that in the majority of the specimens examined by him, there exists between the most minute ingredients a more or less abundant substance, not individualised into crystals, but amorphous, acting like a cement, sometimes glassy in character, sometimes half-glassy, owing to the appearance of hair-like particles, and sometimes completely dentrified so as to present a confused aggregate of darker or lighter minute granules, needles, hair, and crystals. He regards it as hardly possible to doubt that this glassy base in basalt is the residuum of the original *magma* out of which the recognisable minerals in the rock crystallised, and that it furnishes us with a new proof of the igneous origin of basalt.

In the next section the author proceeds to offer a new subdivision, and detailed descriptions of the basalts. He bases his classification upon the mineralogical composition

of the rocks, as made known by microscopic analysis; and taking the non-ferruginous, colourless silicate as his guide, finds that the rocks hitherto classed under the general term basalt, group themselves naturally in three divisions: (1) the Felspar-basalts; (2) the Leucite-basalts; and (3) the Nepheline-basalts. All the three groups always contain augite and magnetic or titaniferous iron, and almost always olivine. So far as Dr. Zirkel's researches go, it appears that all our British basalt-rocks belong to the first or felspar group.

In the last few pages of his memoir the author adds some pertinent remarks on the hitherto vaguely defined series of rocks, which, as he remarks, under the various names of greenstone, trap, melaphyre, &c., play among the secondary and palæozoic formations a part like that which is performed by the basalts in the tertiary formations. And here let us remark that in the chronological separation of igneous rocks made use of by our German fellow-workers, there is something eminently unsatisfactory. The term basalt is restricted by them to tertiary and post-tertiary rocks. But by what methods has the age of each rock been determined? No geologist who has ever had any experience in mapping a district of igneous rocks, can fail to realise how exceedingly difficult it sometimes is to decide upon the true age of such rocks. It is of course easy to say that all basalt is of tertiary or post-tertiary date, and, regarding this as an axiom, to look on every mass of basalt as of later origin than the secondary formations. But the axiom seems to us exceedingly doubtful. In Dr. Zirkel's memoir itself, we have basaltic rocks described which are not only certainly not tertiary, but are probably palæozoic. That igneous rocks have varied in the geological past is highly probable, but geologists are hardly yet in a position dogmatically to assert that no basalt was ever erupted before tertiary times. We cordially wish that our excellent friend Dr. Zirkel will take up the so-called melaphyres; and from what we have ourselves seen of the microscopic structure of the British examples, we shall be greatly surprised if he does not find that from these rocks to true basalt there is such an insensible gradation that no sharp line can be drawn between them. In the meanwhile he deserves the thanks and congratulations of all lovers of mineralogical geology for this admirable memoir on the basalts.

That Prof. Zirkel is still busy with his researches, is shown by the paper (second in the list at the head of this article) which appeared in a recent part of the *Neues Jahrbuch*, and in which he investigates the peculiarities in the minute structure of rock-forming minerals, and also of artificially-fused basalt and syenite.

If the limits of this journal and the patience of its readers permitted, a good deal ought to be said about Roth's most laborious work on the Petrography of the Plutonic Rocks. It is based on the analyses published from 1861 to 1868, which, given in full as an appendix, form half of the book. The word plutonic is used by the author in the sense of originating from igneous fusion, and he includes under it, not only igneous rocks commonly so called, but also gneiss, schist, and clay-slate. These, according to his view, are "the first crusts formed by the cooling of the earth's mass, not metamorphic, that is, not altered in various ways by dark, strange processes which

appeared but once and never afterwards; although, indeed, these gneisses and schists, like other rocks, and even more than other rocks, by virtue of their antiquity and position, have undergone chemical changes." From this extract one may judge of Herr Roth's geology. He is a chemist rather than a geologist, and has gained deserved distinction for the great labour he has expended in the collection and discussion of analyses. In his present work, read as a memoir before the Berlin Academy of Sciences, he has amassed all the analyses he could find, which have appeared since the publication in 1861 of his *Gesteinsanalysen*, and has prefixed to them a discussion of the chemical composition of the various rock-species. As a work of reference in the chemical part of petrography, the book is of great value. Two important features are the analyses of decomposed rocks, and the account given of weathering.

Herr Voglesang is another ardent student of the microscopic structure of rocks. A few years ago he published a little work containing the most beautiful coloured illustrations of that structure which have yet appeared. In the present paper he describes under the name of *crystallites* the non-crystallised but yet more or less regularly grouped inorganic bodies which are found in crystals and rocks. As the paper, however, is to be followed by others, we reserve our notice of it for the present.

Professor Fischer's little pamphlet is a modest production, but one which could not have been prepared without a great deal of hard work. Finding that minerals, which to all outward appearance are simple and homogeneous, can yet be resolved by microscopic examination into as many as sometimes four distinct minerals, he has analysed by this method some sixty minerals, and publishes his results in the present paper, which should be in the hands of every petrographer.

Professor Tschermak's essay shows how by microscopic examination with polarised light, it is possible to distinguish augite and hornblende, even when minutely diffused through a rock. The paper is too important to be noticed at the end of this article, and we propose to return to it on a future occasion.

ARCH. GEIKIE

GODMAN'S NATURAL HISTORY OF THE AZORES

Natural History of the Azores or Western Islands.

By Frederick Ducane Godman, F.L.S., F.Z.S. (Van Voorst, 1870.)

SINCE the time when Mr. Darwin called attention to the peculiarities of the fauna and flora of the Galapagos in his "Journal of Researches," and showed in his "Origin of Species" how important were the lessons to be learnt from oceanic islands in general, the subject has had great attractions for naturalists, and much material has been collected for its elucidation. Mr. Wollaston's bulky volumes on the Coleoptera of Madeira, the Canaries, and the Cape de Verdes, are models of careful research; but Mr. Godman appears to be the first who has, after a personal exploration of one of these oceanic groups, endeavoured to collect all that is known of its natural productions, and published the result in a condensed and convenient form; and for so doing he deserves the thanks of all naturalists.