



HOW TO BEGIN THE STUDY OF GEOLOGY.



THERE are two ways of commencing to learn any of the natural history sciences, of which the study of rocks and fossils is one, or rather several combined. The first is to buy a text-book, and begin at the first page, following the teacher step

by step, and from time to time examining in a museum the specimens described or figured in the pages of the volume. If the young student live in a large city he may follow out this method, or if he seek the aid of a teacher he will undoubtedly be compelled to adopt the routine indicated. And in its way it is not unadvisable. But it has just this drawback: that very frequently the learner is discouraged at the beginning by hearing of objects and of phenomena which he cannot by any possibility see; while, if he live in the country, or in a small town, he may read about scores of fossils, rocks, and minerals which he may never have the remotest chance of seeing. Of course, I do not take into account the very probable contingency of the youthful tyro, after the first flush of enthusiasm is over, contenting himself with looking simply at the pictures, and not taking the trouble of going to examine their prototypes in the cabinets of the public or private collections to which he has access. Nothing is more common than for an examiner to find a "student" describing with surprising glibness some object on

paper, and then staring in dumb despair when the specimen itself is put before him. Such an individual will never become a geologist, for it is evident he does not possess the necessary enthusiasm, nor is endowed with that genius which "consists in the capacity for taking pains." We may, therefore, at once put him out of the field, in discussing how best to begin learning of what the ground we tread on is made.

The other method, though not commended to those who have to face an examination, is the better, the more frequent, and the natural way. In brief, without any serious intention of ever going very far, one often begins to be a geologist before he hardly knows the meaning of the term. The student who starts under the docile guidance of a text-book, be it Lyell, Page, Bonney, Skertchley, Davies, Geikie, Jukes, Green, or any of the numerous others—which, it makes really very little difference—goes through a regularly graduated course of lessons. He is taught, first of all, that geology is "derived from two Greek words signifying the earth, and a discourse;" and, this awe-inspiring bit of etymology mastered, that its scope is so-and-so—information not at all calculated to animate the timorous adventurer into a new intellectual world. The later chapters will initiate him into the classification of rocks—the figure of the earth—the theories as to its primitive condition and its internal fluidity. Stratified and unstratified beds will, or ought to, become familiar to him; while "faults," "dykes," "dip," "strike," "cleavage," "foliation," "synclinals" and "anticlinals," "conformability" and "unconformability," will all assert their right to be understood. Before he is permitted to know anything about the rocks themselves, he will be shown in an off-hand patronising way how they were made. Denudation, and all the forces at work illustrative of geological change, including metamorphism, allotropism, and isomorphism, will be discussed in many chapters or lectures, before he even puts his foot on the lowest rung of the geological ladder which begins with the Laurentian

Rocks of the Palæozoic Epoch, and ends with the surface deposits of the Quaternian period, or that in which we ourselves are living. Now undoubtedly, if the beginner survive this programme, he will have run the chance of imbibing a very large amount of cut-and-dried knowledge at second hand; and if he have, in addition, taken care not only to read about these things but also to have seen them and handled them, and, if possible, dug some of the objects out for himself, he will be a better-informed and presumably a more useful member of society by the time he finishes the volume than when he bought it.

But for one person who has the resolution to undergo this course of intellectual treatment, or not to break down before he is half-way through it, there are scores who know a great deal about rocks before—as was the case with a man afterwards eminent in the science—knowing that there are books describing all that he has laboriously, if crudely, found out for himself. A railway is being made in his neighbourhood, and in examining one of the cuttings his curiosity is excited by the alternations of the beds of rock laid bare—coal, dark slaty-looking layers of shale, sandstone, and limestone. He picks up bits of the refuse, and finds impressed on the rocks the loveliest sculptured ferns, the glistening agate-like scales of what are undoubtedly armoured fishes, or the broken stems of the stalked starfishes of former days, known as encrinites. He is anxious to know more about them, and very soon finds his way into a bookseller's shop, which ends in his buying a text-book.

He eagerly searches for the required information—at first like a man groping in the dark—or, rather, like a person listening to a strange tongue of which he has only acquired a few words. But the book puts him in the way of still more information, and teaches him to look for things which his untrained eye would have passed over. He returns to his cutting, and examines everything with fresh interest, and soon he begins examining, and perhaps roughly sketching what he sees in the note-book which should be the inseparable companion of every one who would gain accurate knowledge, or practise himself in the art of observing narrowly. In the course of the day he will learn much about bedding—he will notice that some of the rocks which he has seen in the quarry or cutting are tilted up, or even bent, or so disturbed by some agent acting on them from below, that they lie to each other like the two sides of a sloping roof; or, he may notice that through the centre of the beds there shoots a spur of some darker and harder rock without any trace of bedding, which has evidently once been molten, and has indurated or altered the softer bedded rock on either side of it. All this he jots down in his note-book, and he transfers to his bag specimens of each of the rocks. On his way home he will doubtless puzzle out for himself much of what he has seen, and the more he tries to do so the better it will be, as a mental gymnastic, and for his future progress in the science. Of course, on referring his conjectures to some one able to solve them, or going

to his book to see what he can learn about them, he will find that in many cases he has been entirely wrong—though it does not always follow that the *littera scripta* are correct, for geology is a progressive science. However, for the present, the tyro may safely follow the words of his book with implicit confidence. Before he takes his next excursion, he will find that without knowing it he has learned, in a manner he will never forget, a great deal about “stratification” and “stratified rocks,” about “plutonic” and “eruptive” rocks, “trap,” “metamorphosis,” “synclinal” and “anticlinal,” “dip,” “strike,” and perhaps “foliation,” and “faults.” And here, at once, let me say that the student, so far from being frightened by what at first looked like hard words, will speedily be almost too fond of using them; for he will discover that they are easier to remember than the cumbrous English equivalents, and that in precision, euphony, and “handiness,” they meet all the purposes for which they were devised. The learner will also find that he has to deal with many objects which have no “common name,” for the simple reason that they never struck the eye of those who use common words. Our ordinary vocabulary was devised to express ideas or to describe facts and objects with which we daily come in contact, but when we begin to deal with science we meet with principles and appearances for which we require to devise new words, just as when the traveller goes into a new country he does not apply to the rivers, mountains, and lakes he finds the same names that were appropriated to those in the land which he left.

Thus, the beginner having acquired these facts finds the acquisition of others greatly simplified, and though the case-hardened writers of books may scorn the suggestion of such ignorance, is animated with a personal interest in the new science, as he daily learns that he can discover in the great book of the earth what he hitherto half believed was only confined to the pages of the printed ones on his shelves at home. Take another case: if the young student live in the north, he will not long have learned to spell out first lessons in the reading-book of the rock before he notices on the surface of some hard, exposed knoll, most probably of whinstone, a number of longitudinal or confused grooves or scratches. These he will most likely find repeated on many other rocks in the same district, and most generally following a certain determinate plan. Working out the problem for himself, he may be long before he strikes on anything like the real explanation. But when he finally refers to his books for information, and finds that ancient ice passing over these rocks, or icebergs depositing the great scattered or “perched blocks” of stone, entirely different from any in the immediate neighbourhood, have been the cause of these scratches, he will be in a better position to understand the soundness of the theory, and able to read with an interest and intelligence the account of the “glacial period,” and the “glacial deposits” with their arctic shells, which will naturally form the next part of his geological study at home. Such examples

of how the beginner may gradually obtain an elementary knowledge of the geology of his own neighbourhood, and of the general principles of the science, might be multiplied to any extent, but these instances may suffice as samples. In short, there is not a rock, a quarry, a sand-pit, a sinking for a coal-pit or a well, a railway cutting, a sea-cliff, a mountain glen, a river-bed, a wall, the stone of a house, the "metal" for the road, the gravel of the garden walk, or the endless strange fossils, with their strange history, which might not, to the intelligent and moderately persevering student, convey such lessons in the science as those which Canon Kingsley has so charmingly told in his "Town Geology." The great thing is, to use a familiar phrase, not to "put the cart before the horse." Don't be able to talk fluently of what you have only read about. Always try to see the object itself, and go gradually from the familiar to the less familiar, until you are brought up—we shall not say standing, but modestly diffident before the unknown. Throw nothing aside until everything knowable about it is known, and never be sparing of your legs, for if you gain little knowledge by a long walk, you have at least fortified your body while endeavouring to strengthen your mind. Above all, as Charles Dickens used to impress on his younger literary brethren, "don't be condescending," for you will find that, after all, the meanest bit of rock, the most seemingly insignificant sea-worn pebble, embodies within or upon it problems, the solution of which requires sager heads and more learning than even that of the most persevering beginner in geological science.

Patience is requisite, and it is also well not to be too ambitious. First let the beginner know his own neighbourhood thoroughly, and then he will find that the acquaintance of another comes to him very easily; just as the traveller who makes himself familiar with one province of an empire, finds that he sooner masters the peculiarities of the others than if he had visited them with only a smattering knowledge of any part of the country. To attain the local knowledge is now much less difficult than it once was. Not only are good geological text-books far more plentiful than publishers desire, but the researches of local geologists, and above all of the officers of the Government Geological Survey, have provided excellent maps and descriptions of nearly every part of the kingdom. The beginner ought early in his studies to provide himself with the sheet and accompanying "memoir" relating to his district, and after he has once become fairly familiar with the language of the science, to try and follow out all the facts mentioned in it. The works of the local geologist will of course be easily ascertained on the spot, and the local bookseller

can, no doubt, also obtain the publications of the Geological Survey, which, it may be added, though not expensive, are somewhat dear. If, however, there is any difficulty, the agent in London (Stanford, Charing Cross) can supply them. On the map the limits of each "formation" will be shown by colours, and "sections," or more or less problematical cuttings across country will also be engraved on it. The student should, first of all, by examining the "out-crop" of rocks at the surface, and availing himself of the glimpses which quarries, sea-cliffs, railway cuttings, river-banks, borings, and such like under-the-surface peeps afford, make a "section" for himself, and then test the exactitude of it by comparing it with that on the Survey map. To collect is intuitive to mankind, and accordingly it is needless to counsel the student about collecting, or how best to form a museum, as his text-book will doubtless contain sufficient hints to start him into this department of his new hobby. A cabinet, which may be a press or a box with shelves, is always much too soon filled, but it is also easy enough to throw or give away the bad specimens as better ones are found, and so long as it is not filled simply by purchases, or by specimens about which the learner does not trouble himself to learn anything, the collecting mania is a valuable and even an indispensable adjunct to the course of study which has been all too briefly sketched out. It ought perhaps to be added that, while abjuring the silver hammer and chisel, an exception must be made in favour of one of the little typical collections of rocks, fossils, and minerals which are sold by dealers whose names can be found in the advertisement pages of the scientific journals. To a student at a distance from a museum these are especially valuable, and are indeed essential if an accurate knowledge of minerals is to be acquired. The only danger of such a collection is that the student, having once learned this easy way of making a museum, is apt to travel the royal road much too frequently. The "philosophical instrument makers" have devised endless more or less useless apparatus, which will soon enough be brought to the beginner's notice; but, at first, a text-book, a hammer, a chisel, a stout bag, and perhaps, in addition to a note-book and pencil, a little bottle of acid, to determine whether a rock has lime in it or not, are all that is necessary; while the beginner who has an earnest desire to learn, is gifted with a fair intellect and a reasonably stout resolution, and is not afflicted with more than the average laziness of the species, may be certain before many months have passed to have acquired a large amount of geological knowledge, and experienced a corresponding degree of the loftiest enjoyment.

