The Old Red Sandstone

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New Walks in an Old Field

Hugh Miller

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AMERICAN PUBLISHERS' NOTICE

TO THE

NEW AND ENLARGED EDITION.

"HUGH MILLER'S 'Old Red Sandstone,' to a beginner, is worth a thousand didactic treatises," said Sir Roderick Impey Murchison in his Address before the British Geological Society. "No geologist can peruse it without instruction and delight," said Professor Benjamin Silliman in his American Journal of Science. Of the work thus commended by the highest authorities on both sides of the Atlantic, the American publishers now have the pleasure of presenting to the public a new and greatly improved edition.

Geology is emphatically a growing science, and in the hands of no master did it ever grow more rapidly, or to better purpose, than in Hugh Miller's. It thus happened that as edition after edition of his work was called for, he had new facts, new arguments, and new conclusions, wherewith to enrich its pages. Some of these were presented in the prefaces to the successive editions, others were incorporated with the text, and others took the form of notes. Since Mr. Miller's death, a new edition has been given to the public by Mrs. Miller, with a preface from her own pen, notes by other hands, additional plates, and a large amount of new matter selected from Mr. Miller's unpublished writings. The present American edition is re-printed from that; but, to avoid encumbering the volume, the

substance of what is important in the several prefaces alluded to is incorporated with this.

"The Old Red Sandstone" was Hugh Miller's first geological work, and was first published in 1841. In 1842, a second edition was called for. This contained about fifteen pages of new matter, referring chiefly to the least known portion of the Old Red system — that middle formation to which the organisms of Balruddery and Carmyle belong. A print (Plate XI.) illustrative of this portion of the work was also added, and one or two conjectures were made to give place to the facts at which they pointed.

A third edition was issued in 1846. In the preface to that edition, Mr. Miller announced that the bold prediction made by him in the first, — that the ichthyolites of the Old Red Sandstone would be found at least equal to those of all the geological formations united, at the death of Cuvier, — was already more than fulfilled. For, while Cuvier had enumerated but ninety-two species of fossil fishes in all, Agassiz had already, in 1846, enumerated one hundred and five in the Old Red Sandstone alone, — a formation which had been regarded as poorer in organisms than any other. The catalogue of species in that formation, as determined and arranged by Agassiz, was given in this edition. Many additions to the volume in the form of notes were also made, and in several instances the text was modified. It had been stated in the first two editions that a gradual increase of size was observable in the progress of ichthyolitic life, and that the Old Red System exhibited, in its successive formations, this gradation of bulk, beginning with an age of dwarfs, and ending with an age of giants. When the third edition was issued, it had been ascertained that there were giants among the dwarfs; the remains of one of the largest fishes found anywhere in the system had

been discovered in its lowest formation. By the positive proof thus furnished, Mr. Miller was convinced that the theory of a gradual progression in size, from the earlier to the later Palæozoic formations, though based originally on no inconsiderable amount of negative evidence, must be permitted to drop.

The fourth, fifth, and sixth editions were mainly if not wholly reprints of the third. The *seventh*, which has just been issued under the supervision of Mrs. Miller, and is re-printed in the present volume, contains large and interesting additions. While the text and notes of Mr. Miller are preserved without the slightest change or revision, some notes have been appended by a friend of Mrs. Miller, with the view of drawing attention to whatever modifications of opinion he may himself have recorded in his later works, or may have been known to express verbally in conversation with his friends. In addition to these, three or four notes have been furnished by the Rev. W. S. Symonds, who is described as a well-known geologist intimately acquainted with the Silurian and Old Red of his own neighborhood in the south-west of England. Several new figures have also been added, taken either from specimens in Mr. Miller's own unique collection, or from those in the possession of others, which it is known he had asked permission to copy. These present the fossils to which they relate in new and striking aspects. They are those on Plates ix., x., xii., and xiv., and on pages 54 and 267.

But the most important additions to the volume are from the pen of Hugh Miller himself. They consist of the Geological Papers read by him before the Royal Physical Society of Edinburgh. These papers have been selected by Mrs. Miller from the mass of her husband's unpublished writings; and, while they add greatly to

the size of the volume, they add to its value no less. In each and all, the characteristics of their author's genius are abundantly displayed. The first paper presents a succinct summary of those evidences drawn from geology in favor of *revealed* religion, which it formed the chief portion of his peculiar mission to originate and establish. In the second is given a sketch of the early progress of general geologic knowledge in Scotland, together with a delightful account of his exploration of the valley of the Girvan. It is germane to the subject of the twelfth chapter of "The Old Red Sandstone." The paper on the Marbles of Assynt furnishes fine illustrations of Mr. Miller's sagacity as a geologist, and of his unrivalled powers of description. The concluding paper presents a comprehensive survey of the Fossiliferous Deposits of Scotland.

In preparing this volume for the press, the publishers have varied in some few instances from the arrangement of the Edinburgh edition. The four new plates which in that edition were appended to the Notes, have, with a view to convenience in this, been distributed through the body of the work at the points where they seemed most properly to belong. This arrangement made it necessary to renumber the old plates. One of the new cuts has been connected with a note in which it is specifically mentioned; and several footnotes, most of them by Mr. Symonds, have been transferred from the body of the work to the "Notes" at the end. These changes, it is believed, constitute a decided improvement. With the exception of these, and the abridgment of the multiplied prefaces, the present edition is a reprint of the new Edinburgh edition.

BOSTON, April, 1858.

TO

RODERICK IMPEY MURCHISON, Esq., F. R. S., Etc

PRESIDENT OF THE GEOLOGICAL SOCIETY.

In the autumn of last year, I sat down to write a few geological sketches for a newspaper; the accumulated facts of twenty years crowded upon me as I wrote, and the few sketches have expanded into a volume. Permit me, honored Sir, to dedicate this volume to you. Its imperfections are doubtless many, for it has been produced under many disadvantages; but it is not the men best qualified to decide regarding it whose criticisms I fear most; and I am especially desirous to bring it under your notice, as of all geologists the most thoroughly acquainted with those ancient formations which it professes partially to describe. I am, besides, desirous it should be known, and this, I trust, from other motives than those of vanity, that, when prosecuting my humble researches in obscurity and solitude, the present President of the Geological Society did not deem it beneath him to evince an interest in the results to which they led, and to encourage and assist the inquirer with his advice. Accept, honored Sir, my sincere thanks for your kindness.

Smith, the father of English Geology, loved to remark that he had been born upon the Oolite — the formation whose various deposits he was the first to distinguish and describe, and from which, as from the meridian line of the geographer the geological scale has been graduated on both sides. I

have thought of the circumstance when, on visiting in my native district the birthplace of the author of the *Silurian System*, I found it situated among the more ancient fossiliferous rocks of the north of Scotland — the Lower Formation of the Old Red Sandstone spreading out beneath and around it, and the first-formed deposit of the system, the Great Conglomerate, rising high on the neighboring hills. It is unquestionably no slight advantage to be placed, at that early stage of life, when the mind collects its facts with greatest avidity, and the curiosity is most active, in localities where there is much to attract observation that has escaped the notice of others. Like the gentleman whom I have now the honor of addressing, I too was born on the Old Red Sandstone, and first broke ground as an inquirer into geological fact in a formation scarce at all known to the geologist, and in which there still remains much for future discoverers to examine and describe. Hence an acquaintance, I am afraid all too slight, with phenomena which, if intrinsically of interest, may be found to have also the interest of novelty to recommend them, and with organisms which, though among the most ancient of things in their relation to the world's history, will be pronounced new by the geological reader in their relation to human knowledge. Hence, too, my present opportunity of subscribing myself, as the writer of a volume on the Old Red Sandstone,

Honored Sir,

With sincere gratitude and respect,

Your obedient humble Servant,

HUGH MILLER.

EDINBURGH, *May* 1, 1841.

AUTHOR'S PREFACE.

NEARLY one third of the present volume appeared a few months ago in the form of a series of sketches in the *Witness* newspaper. A portion of the first chapter was submitted to the public a year or two earlier, in *Chambers's Edinburgh Journal.* The rest, amounting to about two thirds of the whole, appears for the first time.

Every such work has its defects. The faults of the present volume — faults all too obvious, I am afraid — would have been probably fewer had the writer enjoyed greater leisure Some of them, however, seem scarce separable from the nature of the subject: there are others for which, from their opposite character, I shall have to apologize in turn to opposite classes of readers. My facts would, in most instances, have lain closer had I written for geologists exclusively, and there would have been less reference to familiar phenomena. And had I written for only general readers, my descriptions of hitherto undescribed organisms, and the deposits of little

known localities, would have occupied fewer pages, and would have been thrown off with, perhaps, less regard to minute detail than to pictorial effect. May I crave, while addressing myself, now to the one class, and now to the other, the alternate forbearance of each?

Such is the state of progression in geological science, that the geologist who stands still for but a very little, must be content to find himself left behind. Nay, so rapid is the progress, that scarce a geological work passes through the press in which some of the statements of the earlier pages have not to be modified, restricted, or extended in the concluding ones. The present volume shares, in this respect, in what seems the common lot. In describing the *Coccosteus*, the reader will find it stated that the creature, unlike its contemporary the *Pterichthys*, was unfurnished with arms. Ere arriving at such a conclusion, I had carefully examined at least a hundred different *Coccostei*; but the positive evidence of one specimen outweighs the negative evidence of a hundred; and I have just learned from a friend in the north, (Mr. Patrick Duff, of Elgin,) that a *Coccosteus* lately found at Lethen-bar, and now in the possession of Lady Gordon Cumming, of Altyre, is furnished with what seem uncouth, paddle-shaped arms, that project from the head.* All that I

* As these paddle-shaped arms have not been introduced by Agassiz into his restoration of the *Coccosteus*, their existence, at least *as arms*, must still be regarded as problematical. There can be no doubt,

have given of the creature, however, will be found true to the actual type; and that parts should have been omitted will surprise no one who remembers that many hundred belemnites had been figured and described ere a specimen turned up in which the horny prolongation, with its enclosed ink-bag was found attached to the calcareous spindle; and that even yet, after many thousand trilobites have been carefully examined, it remains a question with the oryctologist, whether this crustacean of the earliest periods was furnished with legs, or creeped on an abdominal foot, like the snail.

I owe to the kindness of Mr. Robertson, Inverugie, the specimen figured in Plate V., fig. 7, containing shells of the only species yet discovered in the Old Red Sandstone of Scotland. They occur in the Lower Formation of the system, in a quarry near Kirkwald, in which the specimen figured, with several others of the same kind, was found by Mr Robertson, in the year 1834. In referring to this shell, page 90, I have spoken of it as a delicate bivalve, much resembling a *Venus;* drawing my illustration, naturally enough, when describing the shell of an ocean deposit, rather from among marine, than fluviatile testacea. I have since submitted it to Mr. Murchison, who has obligingly written me that he "can find no one to say more regarding it than that it is

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however, that they existed *as plates* of very peculiar form, and greatly resembling paddles, and that they served in the economy of the animal some still unaccounted for purpose.

very like a *Cyclas*." He adds, however, that it must be an ocean production notwithstanding, seeing that all its contemporaries in England, Scotland, and Russia, whether shells or fish, are unequivocally marine.

With the exception of two of the figures in Plate X., the figures of the *Cephalaspis* and the *Holoptychius*, and one of the sections in the Frontispiece, section 2, all the prints of the volume are originals. To Mr. Daniel Alexander, of Edinburgh, — a gentleman, who to the skill and taste of the superior artist, adds no small portion of the knowledge of the practical geologist, — I am indebted for several of the drawings; that of fig. 2 in Plate V., fig. 1 in Plate VI., fig. 2 in Plate VIII., and figs. 3 and 4 in plate X. I am indebted to another friend for fig. 1, in Plate VII. Whatever defects may be discovered in any of the others, must be attributed to the untaught efforts of the writer, all unfamiliar, hitherto, with the pencil, and with by much too little leisure to acquaint himself with it now.

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REPRESENTS the Old Red System of Scotland from its upper beds of Yellow Quartzose Sandstone to its Great Conglomerate base. *a.* Quartzose Yellow Sandstone. *b.* Impure concretionary limestone enclosing masses of chert. *c.* Red and variegated sandstones and conglomerate. These three deposits constitute an upper formation of the system, characterized by its peculiar group of fossils. (See Chapter IX.) *d.* Deposit of gray fissile sandstone which constitutes the middle formation of the system, characterized also by its peculiar organic group. (See Chapter VIII.) *e.* Red and variegated sandstones, undistinguishable often in their mineral character from the upper sandstones, *c*, but in general less gritty, and containing fewer pebbles. *f.* Bituminous schists. *g.* Coarse gritty sandstone. *h.* Great Conglomerate. These four beds compose a lower formation of the system, more strikingly marked by its peculiar organisms than even the other two. (See Chapters II. III. IV. and V.) In the section this lower formation is represented as we find it developed in Caithness and Orkney. In fig. 5 it is represented as developed in Cromarty, where, though the fossils are identical with those of the more northern localities, at least one of the deposits, *f*, is mineralogically differ-

ent — alternating beds of sandstone and clay, these last enclosing limestone nodules, taking the place of the bituminous schists.

SECTION II.

The Old Red System of England and Wales, as given in the general Section of Mr. Murchison, with the Silurian Rocks beneath and the carboniferous limestone above *i*. The point in the geological scale at which vertebrated existences first appear. The three Old Red Sandstone formations of this section correspond in their characteristic fossils with those of Scotland, but the proportions in which they are developed are widely different. The tilestones seem a comparatively narrow stripe in the system in England; the answering formation in Scotland, *e*, *f*, *g*, *h*, is of such enormous thickness, that it has been held by very superior geologists to contain three distinct formations — *e*, the New Red Sandstone, *f*, a representative of the Coal Measures, and *g*, *h*, the Old Red Sandstone.

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NEW WALKS IN AN OLD FIELD;

OR,

THE OLD RED SANDSTONE.

CHAPTER I.

The Working-man's True Policy. — His only Mode of acquiring Power. — The Exercise of the Faculties essential to Enjoyment. — No necessary Connection between Labor and Unhappiness. — Narrative. — Scenes in a Quarry. — The two dead Birds. — Landscape. — Ripple Markings on a Sandstone Slab. — Boulder Stones. — Inference derived from their water-worn Appearance. — Sea-coast Section. — My first discovered Fossil. — Lias Deposit on the Shores of the Moray Frith. — Belemnite. — Result of the Experience of half a Lifetime of Toil. — Advantages of a Wandering Profession in Connection with the Geology of a Country. — Geological Opportunities of the Stone-Mason. — Design of the present Work.

My advice to young working-men, desirous of bettering their circumstances, and adding to the amount of their enjoyment, is a very simple one. Do not seek happiness in what is misnamed pleasure; seek it rather in what is termed study. Keep your consciences clear, your curiosity fresh, and embrace every opportunity of cultivating your minds. You will gain nothing by attending Chartist meetings. The fellows who speak nonsense with fluency at these assemblies, and deem their nonsense eloquence, are totally unable to help either you or themselves; or, if they do succeed in helping

themselves, it will be all at your expense. Leave them to harangue unheeded, and set yourselves to occupy your leisure hours in making yourselves wiser men. Learn to make a right use of your eyes: the commonest things are worth looking at — even stones and weeds, and the most familiar animals. Read good books, not forgetting the best of all: there is more true philosophy in the Bible than in every work of every sceptic that ever wrote; and we would be all miserable creatures without it, and none more miserable than you. You are jealous of the upper classes; and perhaps it is too true that, with some good, you have received much evil at their hands. It must be confessed they have hitherto been doing comparatively little for you, and a great deal for themselves. But upper and lower classes there must be, so long as the world lasts; and there is only one way in which your jealousy of them can be well directed. Do not let them get ahead of you in intelligence. It would be alike unwise and unjust to attempt casting them down to your own level, and no class would suffer more in the attempt than yourselves; for you would only be clearing the way, at an immense expense of blood, and under a tremendous pressure of misery, for another and perhaps worse aristocracy, with some second Cromwell or Napoleon at their head. Society, however, is in a state of continual flux: some in the upper classes are from time to time going down, and some of you from time to time mounting up to take their places — always the more steady and intelligent among you, remember; and if all your minds were cultivated, not merely intellectually, but morally also, you would find yourselves, as a body, in the possession of a power which every charter in the world could not confer upon you, and which all the tyranny or injustice of the world could not withstand.

I intended, however, to speak rather of the pleasure to be derived, by even the humblest, in the pursuit of knowledge, than of the power with which knowledge in the masses is invariably accompanied For it is surely of greater importance that men should receive accessions to their own happiness, than to the influence which they exert over other men. There is none of the intellectual, and none of the moral faculties, the exercise of which does not lead to enjoyment. nay, it is chiefly in the active employment of these that all enjoyment consists; and hence it is that happiness bears so little reference to station. It is a truth which has been often told, but very little heeded or little calculated upon, that though one nobleman may be happier than another, and one laborer happier than another, yet it cannot be at all premised of their respective orders, that the one is in any degree happier than the other. Simple as the fact may seem, if universally recognized, it would save a great deal of useless discontent, and a great deal of envy. Will my humbler readers permit me at once to illustrate this subject, and to introduce the chapters which follow, by a piece of simple narrative? I wish to show them how possible it is to enjoy much happiness in very mean employments. Cowper tells us that labor, though the primal curse, "has been softened into mercy;" and I think that, even had he not done so I would have found out the fact for myself.

It was twenty years, last February, since I set out a little before sunrise to make my first acquaintance with a life of labor and restraint, and I have rarely had a heavier heart than on that morning. I was but a slim, loose-jointed boy at the time — fond of the pretty intangibilities of romance, and of dreaming when broad awake; and, woful change! I was now going to work at what Burns has instanced in his "Twa

Dogs" as one of the most disagreeable of all employments — to work in a quarry. Bating the passing uneasiness occasioned by a few gloomy anticipations, the portion of my life which had already gone by had been happy beyond the common lot. I had been a wanderer among rocks and woods — a reader of curious books when I could get them — a gleaner of old traditionary stories; and now I was going to exchange all my day-dreams, and all my amusements, for the kind of life in which men toil every day that they may be enabled to eat, and eat every day that they may be enabled to toil!

The quarry in which I wrought lay on the southern shore of a noble inland bay, or frith, rather, with a little clear stream on the one side, and a thick fir wood on the other. It had been opened in the Old Red Sandstone of the district, and was overtopped by a huge bank of diluvial clay, which rose over it in some places to the height of nearly thirty feet, and which at this time was rent and shivered, wherever it presented an open front to the weather, by a recent frost. A heap of loose fragments, which had fallen from above, blocked up the face of the quarry, and my first employment was to clear them away. The friction of the shovel soon blistered my hands; but the pain was by no means very severe, and I wrought hard and willingly, that I might see how the huge strata below, which presented so firm and unbroken a frontage, were to be torn up and removed. Picks, and wedges, and levers were applied by my brother-workmen; and simple and rude as I had been accustomed to regard these implements, I found I had much to learn in the way of using them. They all proved inefficient, however; and the workmen had to bore into one of the inferior strata, and employ gunpowder. The process was new to me, and I deemed it a highly amusing one: it had the merit, too, of

being attended with some such degree of danger as a boating or rock excursion, and had thus an interest independent of its novelty. We had a few capital shots: the fragments flew in every direction; and an immense mass of the diluvium came toppling down, bearing with it two dead birds, that in a recent storm had crept into one of the deeper fissures, to die in the shelter. I felt a new interest in examining them. The one was a pretty cock goldfinch, with its hood of vermilion, and its wings inlaid with the gold to which it owes its name, as unsoiled and smooth as if it had been preserved for a museum. The other, a somewhat rarer bird, of the woodpecker tribe, was variegated with light blue and a grayish yellow. I was engaged in admiring the poor little things, more disposed to be sentimental, perhaps, than if I had been ten years older, and thinking of the contrast between the warmth and jollity of their green summer haunts, and the cold and darkness of their last retreat, when I heard our employer bidding the workmen lay by their tools. I looked up, and saw the sun sinking behind the thick fir wood beside us, and the long, dark shadows of the trees stretching downwards towards the shore.

This was no very formidable beginning of the course of life I had so much dreaded. To be sure, my hands were a little sore, and I felt nearly as much fatigued as if I had been climbing among the rocks; but I had wrought and been useful, and had yet enjoyed the day fully as much as usual. It was no small matter, too, that the evening, converted, by a rare transmutation, into the delicious "blink of rest" which Burns so truthfully describes, was all my own. I was as light of heart next morning as any of my brother-workmen. There had been a smart frost during the night, and the rime lay white on the grass as we passed onwards through the

fields; but the sun rose in a clear atmosphere, and the day mellowed, as it advanced, into one of those delightful days of early spring, which give so pleasing an earnest of whatever is mild and genial in the better half of the year. All the workmen rested at midday, and I went to enjoy my half-hour alone on a mossy knoll in the neighboring wood, which commands through the trees a wide prospect of the bay and the opposite shore. There was not a wrinkle on the water, nor a cloud in the sky, and the branches were as moveless in the calm as if they had been traced on canvas. From a wooded promontory that stretched half way across the frith, there ascended a thin column of smoke. It rose straight as the line of a plummet for more than a thousand yards, and then, on reaching a thinner stratum of air, spread out equally on every side, like the foliage of a stately tree. Ben Wevis rose to the west, white with the yet unwasted snows of winter, and as sharply defined in the clear atmosphere, as if all its sunny slopes and blue retiring hollows had been chiselled in marble. A line of snow ran along the opposite hills; all above was white, and all below was purple. They reminded me of the pretty French story, in which an old artist is described as tasking the ingenuity of his future son-in-law, by giving him, as a subject for his pencil, a flower-piece composed of only white flowers, of which the one half were to bear their proper color, the other half a deep purple hue, and yet all be perfectly natural; and how the young man resolved the riddle, and gained his mistress, by introducing a transparent purple vase into the picture, and making the light pass through it on the flowers that were drooping over the edge. I returned to the quarry, convinced that a very exquisite pleasure may be a very cheap one, and that the busiest employments may afford leisure enough to enjoy it.

The gunpowder had loosened a large mass in one of the inferior strata, and our first employment, on resuming our labors, was to raise it from its bed. I assisted the other workmen in placing it on edge, and was much struck by the appearance of the platform on which it had rested. The entire surface was ridged and furrowed like a bank of sand that had been left by the tide an hour before. I could trace every bend and curvature, every cross hollow and counter ridge of the corresponding phenomena; for the resemblance was no half resemblance — it was the thing itself; and I had observed it a hundred and a hundred times, when sailing my little schooner in the shallows left by the ebb. But what had become of the waves that had thus fretted the solid rock, or of what element had they been composed? I felt as completely at fault as Robinson Crusoe did on his discovering the print of the man's foot on the sand. The evening furnished me with still further cause of wonder. We raised another block in a different part of the quarry, and found that the area of a circular depression in the stratum below was broken and flawed in every direction, as if it had been the bottom of a pool recently dried up, which had shrunk and split in the hardening. Several large stones came rolling down from the diluvium in the course of the afternoon. They were of different qualities from the Sandstone below, and from one another; and, what was more wonderful still, they were all rounded and water-worn, as if they had been tossed about in the sea, or the bed of a river, for hundreds of years. There could not, surely, be a more conclusive proof that the bank which had enclosed them so long could not have been created on the rock on which it rested. No workman ever manufactures a half-worn article, and the stones were all half-worn! And if not the bank, why then the sandstone underneath? I was lost in conjecture,

and found I had food enough for thought that evening, without once thinking of the unhappiness of a life of labor.

The immense masses of diluvium which we had to clear away rendered the working of the quarry laborious and expensive, and all the party quitted it in a few days, to make trial of another that seemed to promise better. The one we left is situated, as I have said, on the southern shore of an inland bay — the Bay of Cromarty; the one to which we removed has been opened in a lofty wall of cliffs that overhangs the northern shore of the Moray Frith. I soon found I was to be no loser by the change. Not the united labors of a thousand men for more than a thousand years could have furnished a better section of the geology of the district than this range of cliffs. It may be regarded as a sort of chance dissection on the earth's crust. We see in one place the primary rock, with its veins of granite and quartz, its dizzy precipices of gneiss, and its huge masses of hornblende; we find the secondary rock in another, with its beds of sandstone and shale, its spars, its clays, and its nodular limestones. We discover the still little known but highly interesting fossils of the Old Red Sandstone in one deposition; we find the beautifully preserved shells and lignites of the Lias in another. There are the remains of two several creations at once before us. The shore, too, is heaped with rolled fragments of almost every variety of rock, — basalts, ironstones, hypersthenes, porphyries, bituminous shales, and micaceous schists. In short the young geologist, had he all Europe before him, could hardly choose for himself a better field. I had, however, no one to tell me so at the time, for geology had not yet travelled so far north; and so, without guide or vocabulary, I had to grope my way as I best might, and find out all its wonders for myself. But so slow was the process, and so much was I

a seeker in the dark, that the facts contained in these few sentences were the patient gatherings of years.

In the course of the first day's employment, I picked up a nodular mass of blue limestone, and laid it open by a stroke of the hammer. Wonderful to relate, it contained inside a beautifully finished piece of sculpture — one of the volutes apparently of an Ionic capital; and not the far-famed walnut of the fairy tale, had I broken the shell and found the little dog lying within, could have surprised me more. Was there another such curiosity in the whole world? I broke open a few other nodules of similar appearance, — for they lay pretty thickly on the shore, — and found that there might. In one of these there were what seemed to be the scales of fishes, and the impressions of a few minute bivalves, prettily striated; in the centre of another there was actually a piece of decayed wood. Of all Nature's riddles these seemed to me to be at once the most interesting, and the most difficult to expound. I treasured them carefully up, and was told by one of the workmen to whom I showed them, that there was a part of the shore about two miles farther to the west, where curiously shaped stones, somewhat like the heads of boarding-pikes, were occasionally picked up; and that in his father's days the country people called them thunderbolts, and deemed them of sovereign efficacy in curing bewitched cattle. Our employer, on quitting the quarry for the building on which we were to be engaged, gave all the workmen a half-holiday. I employed it in visiting the place where the thunderbolts had fallen so thickly, and found it a richer scene of wonder than I could have fancied in even my dreams.

What first attracted my notice was a detached group of low lying skerries, wholly different in form and color from the sandstone cliffs above, or the primary rocks a little farther to

the west. I found them composed of thin strata of limestone, alternating with thicker beds of a black slaty substance, which as I ascertained in the course of the evening, burns with a powerful flame, and emits a strong bituminous odor. The layers into which the beds readily separate are hardly an eighth part of an inch in thickness, and yet on every layer there are the impressions of thousands and tens of thousands of the various fossils peculiar to the Lias. We may turn over these wonderful leaves one after one, like the leaves of a herbarium, and find the pictorial records of a former creation in every page. Scallops, and gryphites, and ammonites, of almost every variety peculiar to the formation, and at least some eight or ten varieties of belemnite; twigs of wood, leaves of plants, cones of an extinct species of pine, bits of charcoal, and the scales of fishes; and, as if to render their pictorial appearance more striking, though the leaves of this interesting volume are of a deep black, most of the impressions are of a chalky whiteness. I was lost in admiration and astonishment, and found my very imagination paralyzed by an assemblage of wonders, that seemed to outrival, in the fantastic and the extravagant, even its wildest conceptions. I passed on from ledge to ledge, like the traveller of the tale through the city of statues, and at length found one of the supposed aerolites I had come in quest of, firmly imbedded in a mass of shale. But I had skill enough to determine that it was other than what it had been deemed. A very near relative, who had been a sailor in his time on almost every ocean, and had visited almost every quarter of the globe, had brought home one of these meteoric stones with him from the coast of Java. It was of a cylindrical shape and vitreous texture, and it seemed to have parted in the middle when in a half-molten state, and to have united again, somewhat awry, ere it had cooled enough

to have lost the adhesive quality. But there was nothing organic in its structure, whereas the stone I had now found was organized very curiously indeed. It was of a conical form and filamentary texture, the filaments radiating in straight lines from the centre to the circumference. Finely-marked veins like white threads ran transversely through these in its upper half to the point, while the space below was occupied by an internal cone, formed of plates that lay parallel to the base, and which, like watch-glasses, were concave on the under side, and convex on the upper. I learned in time to call this stone a belemnite, and became acquainted with enough of its history to know that it once formed part of a variety of cuttle-fish, long since extinct.

My first year of labor came to a close, and I found that the amount of my happiness had not been less than in the last of my boyhood. My knowledge, too, had increased in more than the ratio of former seasons; and as I had acquired the skill of at least the common mechanic, I had fitted myself for independence. The additional experience of twenty years has not shown me that there is any necessary connection between a life of toil and a life of wretchedness; and when I have found good men anticipating a better and a happier time than either the present or the past, the conviction that in every period of the world's history the great bulk of mankind must pass their days in labor, has not in the least inclined me to scepticism.

My curiosity, once fully awakened, remained awake, and my opportunities of gratifying it have been tolerably ample. I have been an explorer of caves and ravines — a loiterer along sea-shores — a climber among rocks — a laborer in quarries. My profession was a wandering one. I remember passing direct, on one occasion, from the wild western coast

of Ross-shire, where the Old Red Sandstone leans at a high angle against the prevailing Quartz Rock of the district, to where, on the southern skirts of Mid-Lothian, the Mountain Limestone rises amid the coal. I have resided one season on a raised beach of the Moray Frith. I have spent the season immediately following amid the ancient granites and contorted schists of the central Highlands. In the north I have laid open by thousands the shells and lignites of the Oolite; in the south I have disinterred from their matrices of stone or of shale the huge reeds and tree ferns of the Carboniferous period. I have been taught by experience, too, how necessary an acquaintance with geology of both extremes of the kingdom is to the right understanding of the formations of either. In the north, there occurs a vast gap in the scale. The Lias leans unconformably against the Old Red Sandstone; there is no Mountain Limestone, no Coal Measures, none of the New Red Marls or Sandstones, Under or Upper. There are at least three entire systems omitted. But the upper portion of the scale is well nigh complete. In one locality we may pass from the Lower to the Upper Lias, in another from the Inferior to the Great Oolite, and onward to the Oxford Clay and the Coral Rag. We may explore, in a third locality, beds identical in their organisms with the Wealden of Sussex. In a fourth we find the flints and fossils of the Chalk. The lower part of the scale is also well nigh complete. The Old Red Sandstone is amply developed in Moray Caithness, and Ross; and the Grauwacke, in its more ancient unfossiliferous type, rather extensively in Banffshire. But to acquaint one's self with the three missing formations, — to complete one's knowledge of the entire scale by filling up the hiatus, — it is necessary to remove to the south. The geology of the Lothians is the geology of at least two thirds

of the gap, and perhaps a little more;—the geology of Arran wants, it is supposed, only the Upper New Red Sandstone to fill it entirely.

One important truth I would fain press on the attention of my lowlier readers. There are few professions, however humble, that do not present their peculiar advantages of observation; there are none, I repeat, in which the exercise of the faculties does not lead to enjoyment. I advise the stonemason, for instance, to acquaint himself with Geology. Much of his time must be spent amid the rocks and quarries of widely separated localities. The bridge or harbor is no sooner completed in one district, than he has to remove to where the gentleman's seat, or farm-steading is to be erected in another; and so, in the course of a few years, he may pass over the whole geological scale, even when restricted to Scotland, from the Grauwacke of the Lammermuirs, to the Wealden of Moray, or the Chalk-flints of Banffshire and Aberdeen; and this, too, with opportunities of observation, at every stage, which can be shared with him by only the gentleman of fortune, who devotes his whole time to the study. Nay, in some respects, his advantages are superior to those of the amateur himself. The latter must often pronounce a formation unfossiliferous when, after the examination of at most a few days, he discovers in it nothing organic; and it will be found that half the mistakes of geologists have arisen from conclusions thus hastily formed. But the working-man whose employments have to be carried on in the same formation for months, perhaps years, together, enjoys better opportunities for arriving at just decisions. There are, besides, a thousand varieties of accident which lead to discovery—floods, storms, landslips, tides of unusual height, ebbs of extraordinary fall: and the man who plies his labor at all sea

sons in the open air has by much the best chance of profiting by these. There are formations which yield their organisms slowly to the discoverer, and the proofs which establish their place in the geological scale more tardily still. I was acquainted with the Old Red Sandstone of Ross and Cromarty for nearly ten years ere I had ascertained that it is richly fossiliferous — a discovery which, in exploring this formation in those localities, some of our first geologists had failed to anticipate. I was acquainted with it for nearly ten years more ere I could assign to its fossils their exact place in the scale.

In the following chapters I shall confine my observations chiefly to this system and its organisms. To none of the others, perhaps, excepting the Lias of the north of Scotland, have I devoted an equal degree of attention; nor is there a formation among them which, up to the present time, has remained so much a *terra incognita* to the geologist. The space on both sides has been carefully explored to its upper and lower boundary; the space between has been suffered to remain well nigh a chasm. Should my facts regarding it — facts constituting the slow gatherings of years — serve as stepping-stones laid across, until such time as geologists of greater skill, and more extended research, shall have bridged over the gap, I shall have completed half my design. Should the working-man be encouraged by my modicum of success to improve his opportunities of observation, I shall have accomplished the whole of it. It cannot be too extensively known, that nature is vast and knowledge limited; and that no individual, however humble in place or acquirement, need despair of adding to the general fund.

CHAPTER II.

The Old Red Sandstone. — Till very lately its Existence as a distinct Formation disputed. — Still little known. — Its great Importance in the Geological Scale. — Illustration. — The North of Scotland girdled by an immense Belt of Old Red Sandstone. — Line of the Girdle along the Coast. — Marks of vast Denudation. — Its Extent partially indicated by Hills on the Western Coast of Ross-shire. — The System of Great Depth in the North of Scotland. — Difficulties in the way of estimating the Thickness of Deposits. — Peculiar Formation of Hill. — Illustrated by Ben Nevis. — Caution to the Geological Critic. — Lower Old Red Sandstone immensely developed in Caithness. — Sketch of the Geology of that County. — Its strange Group of Fossils. — Their present place of Sepulture. — Their ancient Habitat. — Agassiz. — Amazing Progress of Fossil Ichthyology during the last few Years. — Its Nomenclature. — Learned Names repel unlearned Readers. — Not a great deal in them.

"THE Old Red Sandstone," says a Scottish geologist, in a digest of some recent geological discoveries, which appeared a short time ago in an Edinburgh newspaper, "has been hitherto considered as remarkably barren of fossils." The remark is expressive of a pretty general opinion among geologists of even the present time, and I quote it on this account. Only a few years have gone by since men of no low standing in the science disputed the very existence of this formation — system rather, for it contains at least three distinct formations and but for the influence of one accomplished geologist, the celebrated author of the *Silurian System*, it would have been probably degraded from its place in the scale altogether. "You must inevitably give up the Old Red Sandstone," said an ingenious foreigner to Mr. Murchison, when on a visit to England about four years ago, and whose celebrity among his

own countrymen rested chiefly on his researches in the more ancient formations, — "you must inevitably give up the Old Red Sandstone: it is a mere local deposit, a doubtful accumulation huddled up in a corner, and has no type or representative abroad." "I would willingly give it up if nature would," was the reply; "but it assuredly exists, and I cannot." In a recently published tabular exhibition of the geological scale by a continental geologist, I could not distinguish this system at all. There are some of our British geologists, too, who still regard it as a sort of debatable tract, entitled to no independent status. They find, in what they deem its upper beds, the fossils of the Coal Measures, and the lower graduating apparently into the Silurian System; and regard the whole as a sort of common, which should be divided as proprietors used to divide commons in Scotland half a century ago, by giving a portion to each of the bordering territories. Even the better informed geologists, who assign to it its proper place as an independent formation, furnished with its own organisms, contrive to say all they know regarding it in a very few paragraphs. Lyell, in the first edition of his admirable elementary work, published only two years ago, devotes more than thirty pages to his description of the Coal Measures, and but two and a half to his notice of the Old Red Sandstone. *

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* As the succinct notice of this distinguished geologist may serve as a sort of pocket map to the reader in indicating the position of the system, its three great deposits, and its extent, I take the liberty of transferring it entire.

"OLD RED SANDSTONE.

"It was stated that the Carboniferous formation was surmounted by one called the 'New Red Sandstone,' and underlaid by another called the Old Red, which last was formerly merged in the Carboniferous System but is now found to be distinguishable by its fossils. The

It will be found, however, that this hitherto neglected system yields in importance to none of the others, whether we take into account its amazing depth, the great extent to which it is developed both at home and abroad, the interesting links which it furnishes in the zoölogical scale, or the vast period of time which it represents. There are localities in which the depth of the Old Red Sandstone fully equals the elevation of Mount Ætna over the level of the sea, and in which it contains three distinct groups of organic remains,

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Old Red Sandstone is of enormous thickness in Herefordshire Worcestershire, Shropshire, and South Wales, where it is seen to crop out beneath the Coal Measures, and to repose on the Siluriar Rocks. In that region, its thickness has been estimated by Mr. Murchison at no less than ten thousand feet. It consists there of —

"1st. A quartzose conglomerate, passing downwards into chocolate-red and green sandstone and marl.

"2d. Cornstone and marl, (red and green argillaceous spotted marls, with irregular courses of impure concretionary limestone, provincially called Cornstone, mottled red and green; remains of fishes.)

"3d. Tilestone, (finely laminated hard reddish or green micaceous or quartzose sandstones, which split into tiles; remains of mollusca and fishes.)

"I have already observed that fossils are rare in marls and sandstones in which the red oxide of iron prevails. In the Cornstone, however, of the counties above mentioned, fishes of the genera Cephalaspis and Onchus have been discovered. In the Tilestone, also, Ichthyodorulites of the genus Onchus have been obtained, and a species of Dipterus, with mollusca of the genera Avicula, Arca, Cucullæa, Terebratula, Lingula, Turbo, Trochus, Turritella, Bellerophon, Orthoceras, and others.

"By consulting geological maps, the reader will perceive that, from Wales to the north of Scotland, the Old Red Sandstone appears in patches, and often in large tracts. Many fishes have been found in it at Caithness, and various organic remains in the northern part of