lava-currents, great sheets of which may be seen descending to the sea-shore, where they are sometimes thrown up in rugged masses, as though acted on by the sea-water when in a state of fusion, as may now be seen in Sicily.

Next to these most ancient rocks come the lower hills, whose origin we assign to a somewhat later period, when the volcanic action was dying out: these are composed of materials readily acted on by the atmosphere, and are thus shaven into cones. I must now refer to the trap dykes. Every geologist who has studied the Western Highlands well knows the great area which has been subjected to volcanic action at a comparatively late period. In the low grounds, in the beds of rivers, and on the sea shore, we find trap-dykes, from one inch to several feet in width, passing through the more ancient beds, into which various qualities of trap have been injected. This appears to me to have been the subsiding action of the great elevatory force, and it is interesting to find it extending in Scotland up to the Tertiary period, for Skye offers at Broadford most interesting examples of trap-dykes traversing the Lias limestone.

I will only add, that subsequently to the periods referred to, came that universal surface action by which all Scotland and the North of England have been covered with gravel beds—a subject deserving deep and persistent enquiry. In these beds the primeval forest grew, which, in its turn, has been buried beneath peat or soil, the surface of which is now adorned with the flora of our modern time.

Yours,

THOS. C. BROWN.

FURTHER BARTON, CIRENCESTER,
7th September, 1867.

THE ORIGIN OF GRANITE.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I am glad to see "the origin of granite" is likely to crop up as a result of Dr. Sterry Hunt's Lecture "On the Chemistry of the Primeval Earth," which has been so ably commented on in the last number of the GEOLOGICAL MAGAZINE by Mr. David Forbes. There has been so much "Denudation" of late, both marine and atmospheric, that we need not be surprised if a deep-seated rock, like granite, is laid bare, and at last appears on the surface in the field of geological discussion.

At the recent meeting of the British Association in Dundee, Professor Ansted communicated a paper "On the Conversion of Stratified Rock into Granite in the North of Corsica." I took part in the discussion which ensued; but as my remarks, together with those of Sir Charles Lyell and Mr. Geikie, were reported thus—"Some discussion followed the reading of the paper," while those of Professors Phillips and Ramsay were merely noticed, I venture to ask you to have the kindness to permit me to re-state in the pages of the GEOLOGICAL MAGAZINE, as briefly as possible, the substance of what I said on that occasion.

Professor Ansted entered into some wide generalizations favouring the metamorphic origin of granite. I happen to reside in a district where the intrusive character of that rock is particularly well shewn, and I could hardly allow his views to pass unquestioned. There is in this country the largest exposure, and perhaps the greatest variety, of granite in the British Islands, and I trust that a short account of my observations, which have been made with some care, may not be without interest.

There are four large tracts of granite in Ireland—(1) The Leinster district, ranging from Dublin, through Wicklow, into Wexford; (2) the Mourne Mountain district, in the Co. Down; (3) the Donegal district; and (4) the Connaught district. Granite also occurs in smaller masses in other parts of this country.

The Leinster granite (1) is unquestionably intrusive; it penetrates into Lower Silurian Slates, which are everywhere altered into mica-schist as they approach it, and are pierced by numerous granitic dykes. The Mourne granite (2) has a similar character, though the metamorphism of the surrounding rocks is not so extensive as in Leinster: it is supposed to be a newer rock than that of Leinster, being believed to be post-Carboniferous.[1] The Donegal (3) and Connaught (4) granites are of a totally different character. They are essentially of a metamorphic type, being bedded and, in Donegal, interstratified with limestone;[2] they do not intrude into, but form part of the great mass of gneiss, schist, quartz-rock, and limestone among which they occur.[3]

If two geologists were to set to work to investigate the origin of granite, and if one were to locate himself in Leinster and the other in Donegal, the Leinster geologist could bring forward the most convincing proofs of the intrusive character of granite, while the Donegal observer could produce equally conclusive arguments in favour of its metamorphic nature.

I am at a loss to understand how any one could explain the Leinster granite by the metamorphic theory, yet the Donegal rock appears to be but an instance of an advanced or perfected stage of that metamorphic action which is less fully developed in the varieties of gneiss. Any geologist who has examined gneissose districts may

[1] Jukes, "Student's Manual of Geology," pp. 93 and 313. I think, however, further proof is required as to its being of the same age as the rock which alters the Carboniferous Limestone near Carlingford: it rather differs in appearance and mineral composition from the Leinster granite, containing other micas, and notably by the occurrence in some places of albite (Haughton, Quart. Journ. Geol. Soc. vols. xii. and xiv.), though I believe that this feldspar is not so important a constituent as has been supposed.

[2] Brit. Assoc. Report, 1863; Scott, Journ. Geol. Soc. Dublin, vols. ix. and x. See also Haughton, "On Granites of Donegal," Quart. Journ. Geol. Soc., vols. xviii. and xx.

[3] There can be little doubt that some intrusive granites do occur in Donegal and perhaps largely in Connaught: we require further information on this point; a red patch on a map, lettered G for granite, does not teach us much.

["Stratified eruptive rocks." See Forbes, "The Microscope in Geology," in this number, p. 515.—Edit.]

remember to have seen true gneiss which, in a hand specimen, it would be impossible to distinguish from granite.

Now I ask—Are we to suppose that, notwithstanding the vast difference between their modes of occurrence in the field, the granites of Leinster, and the granitoid rocks of Donegal must have had a like origin, merely because they have a *somewhat* similar mineral composition, both containing quartz, feldspar, and mica?

But have these rocks an identical mineral composition? So far as my experience goes, most assuredly not. They vary in appearance, texture, and mode of aggregation of the component minerals; the quartz has a different look, difficult to describe, but once seen and observed, not easily to be forgotten; but above all, they differ widely in their feldspathic constituents, for while the intrusive granites are orthoclasic or, as in Down, sometimes albitic (and, let it be remembered, albite is as highly silicated as orthoclase), and the uncrystallized feldspathic paste is always highly silicated, the granitoid rocks on the other hand contain, notwithstanding the presence of free quartz, a large proportion of basic feldspars, of which oligoclase is the most recognizable, and the feldspathic paste is basic also, approaching oligoclase or anorthosite[1] in composition.

During a recent visit to Scotland I had these views fully confirmed by the facts which I observed there. The intrusive granites of Arran are extremely like those of the Mourne district, while many of the Highland rocks appear to pertain to the metamorphic type. As my visit was very hurried, I cannot now commit myself to details; neither shall I say anything of the intrusive and metamorphic characters of the hornblendic series of rocks, such as greenstones, syenites, and hornblendic schists.

The views now put forward are only suggestive: my field of observation has been too limited to warrant my entering into generalizations, but I trust they will tend to elicit further opinion on this important subject. So long as our knowledge is added to, it matters little whether these views are corroborated or refuted by such investigators as Forbes, Haughton, Hunt, and Sorby, men who combine the highest chemico-mineralogical attainments with great knowledge of physical geology, accomplishments which unfortunately do not often co-exist in the same individual.

In conclusion, I think the last passages of Mr. Forbes's paper (Geol. Mag. Vol. IV. pp. 442—444), deserve the serious attention of every one who may be inclined to go in for the metamorphic origin of *all* granite.

I am, Sir, your obedient servant,

W. H. Stacpoole Westropp.

Blackrock, Dublin, *October 5th*, 1867.

Since writing the above, I have looked into Haughton's Manual of Geology, and find that I have been anticipated in suggesting a two-fold origin for granite. In that work (p. 45) the terms hydro-metamorphic and pyro-metamorphic are proposed. I fear that the

[1] Geol. Report, Canada, 1854; and Bigsby, Geol. Mag. Vol. I. p. 157.

latter word smacks of the old "dry fusion" theory, though, as every one knows, Professor Haughton's speculations are anything but *dry*.

FORBES.—CHEMISTRY OF THE PRIMEVAL EARTH.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—Under this heading, page 434 of your October number, are these words, "Hutton, the propounder of the plutonic theory of the world's origin, which assumed the world to have been at one time a sphere of molten matter solidified by refrigeration."

I think that there must be some great mistake here. I do not think that Hutton would attempt to lift the veil of Isis, or to account for the "*world's origin*" at all, or for the "*origin*" of anything whatever, animate or inanimate; not even for the "*origin*" of the smallest particle of matter. His word is "no sign of a *beginning*, no prospect of an end."

I have, indeed, never had access to Hutton's work; but I have by me Playfair's illustrations of it, Edinburgh, 1802, and he totally repudiates the idea of the original fusion of the globe, either igneous or aqueous, partial or entire. The igneous theory he imputes (while he controverts it) to Buffon. Page 136, section 132, and note XXV. Playfair accounts for the orange shape of the globe by a most beautiful theory of his own, entirely dependent on Hutton's doctrines, and therefore entirely dependent on rain and rivers.

The principles which poise the *universe* are as simple as they are sublime; and it is not only, as Professor Jukes remarks in your last number (p. 144), that "the form of the ground" depends on rain and rivers, but, as Playfair says, the statical figure of the globe itself,—the spheroid of equilibrium depends on rain and rivers, on causes now in operation. Those who have not access to Playfair's work may see his beautiful theory as to this clumsily explained by me in the eleventh chapter of "Rain and Rivers."

I have the honour to be, Sir, your most obedient and most obliged servant,

GEORGE GREENWOOD, Colonel.

BROOKWOOD PARK, ALRESFORD,
4th October, 1867.

THE CHEMISTRY OF THE PRIMEVAL EARTH.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I hope the space at your disposal will admit of the insertion of a few remarks in reply to Dr. Sterry Hunt's letter, on page 478, and in defence of my report of his lecture "On the Chemistry of the Primeval Earth:" (GEOL. MAG., p. 357).

Dr. Sterry Hunt's communication must not be allowed to mislead you or your readers into the belief that I am responsible for the twenty *errata* which have been tabulated in the two published lists, (pages 432 and 478), for, in fact, *only four* of these mistakes have originated with me. Of these four I am perfectly willing to bear the blame. The first occurs in the passage (page 361) relating