From the PHILOSOPHICAL MAGAZINE for July 1855.

NOTES ON MINERALOGY.

No. II.

ON THE CHEMICAL COMPOSITION OF THE GRANITES OF THE SOUTH-EAST OF IRELAND.

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THE granites of the south-east of Ireland occur in the counties of Dublin, Carlow, Kilkenny, Wicklow, and Wexford, and may be divided physically into two distinct groups:—

1st. The chain of granite hills extending from Booterstown and Dalkey, co. Dublin, in a N.N.E., S.S.W. direction, to Poulmounty in the south of the county of Carlow, within five miles of New Ross. This granite chain has a length of 68 miles, and a breadth varying from 8 to 15 miles.

2nd. The series of granite hills occurring at intervals in the slate of the counties of Wicklow and Wexford, isolated from each other, and rising like islands through the slate. This group of granite hills lies between the main chain and the sea, and appears to be arranged in lines parallel more or less to the axis of the main chain. These granite hills are about twenty in number, and extend for a distance of 43 miles from Ballinaclash, county Wicklow, to Camarus Hill, county Wexford.

Hitherto, so far as I am aware, no *decisive* proof of difference of geological age has been discovered between these two groups of granites; they are both newer than the Silurian slates, which they penetrate and metamorphose.

Such being the state of geological knowledge on this subject, it occurred to me that it might be useful to direct attention to a distinction of a chemical character which appears to exist between these two groups of granites,—a distinction to which I have been led in the course of a series of analyses of Irish granites, in which I have been for some time engaged. The distinction to which I have alluded is the following. The granites of the main chain contain more potash than soda; and *vice versâ*, the granites to the east of the chain, which are isolated from it and from each other, contain more soda than potash; showing that the circumstances, unknown to us, under which the isolated granites were formed, were such as to yield to the molten mass a quantity of soda greater than that possessed by the granites of the principl chain.

In illustration of the foregoing generalization, I offer analyses of granites from the following localities:—

Granitic chain.	*Isolated granites.*
1. Dalkey, Co. Dublin.	1. Cushbawn, Co. Wicklow.
2. Foxrock, Co. Dublin.	2. Croghan Kinshela, Co. Wicklow.
3. Three Rock Mountain, Co. Dublin.	3. Ballymotymore, Co. Wexford.
4. Enniskerry, Co. Wicklow.	4. Ballynamuddagh, Co. Wexford.
5. Ballyknocken, Co. Wicklow.	
6. Killballyhugh, Co. Carlow.	
7. Blackstairs, Co. Wexford.	
8. Ballyleigh, Co. Wexford.	

It will be seen, on reference to the Ordnance Map, or any good map of Ireland, that the localities selected extend from the north to the south of both the granite series; and on reference to the geological maps of Wicklow and Wexford, it may be observed by those unacquainted with the geological structure of this part of Ireland, that the granites of the second group examined are taken from the distinct and distant isolated patches of granite.

In order to investigate the relative proportions of quartz, felspar and mica, of which these granites were composed, I used the following method, which appears to be as simple as any that has been proposed for such a purpose.

Let the per-centage of silica in the granite be divided by the atomic weight of silica, and let the quotient be denoted by a.

Let the per-centages of alumina and peroxide of iron be divided by the atomic weights of alumina and peroxide of iron respectively, and let the sum of the quotients so found be denoted by b.

Let the per-centages of lime, magnesia, potash, and soda be divided by the atomic weights of these elements, and the sum of the quotients called c.

Then, on the hypothesis that the granite is composed exclusively of quartz, felspar, and mica (margarodite), since

$$\begin{aligned} \text{Quartz} &= SiO^3 \\ \text{Felspar} &= RO,\ SiO^3 + R^2O^3,\ 3SiO^3 \\ \text{Margarodite} &= RO,\ SiO^3 + 2(R^2O^3,\ SiO^3) + 2HO, \end{aligned}$$

we find, if Q, F, M denote the number of atoms of quartz, felspar, and margarodite present in the granite, the following relations:—

$$\left.\begin{aligned} a &= Q + 4F + 3M \\ b &= F + 2M \\ c &= F + M \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In these equations, a, b, c are given by the analysis; and from these equations, Q, F, M may be found. Having determined Q, F, M, we can obtain the per-centages corresponding to them by multiplying Q, F, M by their respective atomic weights. The atomic weight of quartz is known, and is 46; but the atomic weights of felspar and mica vary with the relative proportions of the ingredients composing these minerals. Assuming the average of the analyses of micas from this granite range already given by me (Phil. Mag. vol. ix. p. 272), it is easy to infer from it an atomic weight of mica equal to 305. This atomic weight of mica has been used by me in the calculations made in this paper, and the per-centages of felspar found by difference.

The calculations just mentioned do not prove that the granites to which they are applied are composed of quartz, felspar and mica, as combinations of other minerals might equally well represent the analyses; but on the hypothesis that the granites are composed of these three minerals, they give their per-centages with a close degree of approximation: and further, if the equations cannot be satisfied with positive values of Q, F, M, it may be considered as proved that the granite under consideration cannot be simply a compound of quartz, felspar and margarodite.

It is to be observed, that if a granite be composed of four or more minerals, it is not possible to find by the process just described, the per-centages of each mineral, because in this case the number of unknown quantities is greater than that of the equations from which they are to be calculated.

The following Table contains the analyses of eight granites taken from north to south along the principal granite chain, and the notes appended contain a few interesting particulars respecting each granite.

Table I.—Analyses of Granites from principal Chain.

Localities.	Silica.	Alumina.	Peroxide of iron.	Lime.	Magnesia.	Potash.	Soda.	Loss by ignition.	Totals.
1. Dalkey	70·38	12·64	3·16	2·84	0·53	5·90	3·13	1·16	99·74
2. Foxrock.........	73·00	13·64	2·44	1·84	0·11	4·21	3·53	1·20	99·97
3. Three Rock ...	70·28	16·44	2·60	2·04	trace	5·79	2·82	......	99·97
4. Enniskerry ...	74 24	13·64	1·40	1·48	trace	3·95	2·72	1·20	98·63
5. Ballyknocken...	70·82	14·08	3·47	2·65	0·31	4·64	2·31	1·39	99·67
6. Killballyhugh...	73·24	15·45	1·60	0·99	trace	4·59	3·08	1·20	100·15
7. Blackstairs ...	73·20	15·48	1·72	0·96	trace	4·80	3·18	......	99·34
8. Ballyleigh	73·28	12·64	2·00	1·72	trace	4·70	2·97	1·04	98·35

No. 1. *Dalkey.*—Specific gravity, 2·647. A fine-grained granite containing black and transparent mica. This granite cannot be a ternary compound of quartz, felspar and margarodite. This granite was used in the construction of Kingstown Harbour.

No. 2. *Foxrock.*—Specific gravity, 2·638. A coarse granite, which strikes fire under the hammer; it forms a durable and strong building stone, and has been employed in the ring stones of Trinity College belfry, and in the construction of the O'Connell monument at Glasnevin.

No. 3. *Three Rock.*—Specific gravity, 2·652. This granite is rather coarse-grained; it was taken from Woodside Quarry, on the slope of the Three Rock Mountain, and like No. 2, has been used in the construction of the O'Connell monument.

No. 4. *Enniskerry.*—Specific gravity, 2·633. A rather coarse-grained granite, containing veins of black tourmaline.

No. 5. *Ballyknocken.*—Specific gravity, 2·636. This granite is the best building stone in the neighbourhood of Dublin, and has been extensively used in the public buildings of this city; it forms the principal part of the granite used in the belfry and museums of Trinity College. The quarries are situated beyond Blessington, in the county of Wicklow.

No. 6. *Killballyhugh.*—Specific gravity, 2·616. This is a fine-grained granite, and works freely; it has been employed in the construction of the Chapel of Ease in the town of Carlow.

No. 7. *Blackstairs.*—Specific gravity, 2·622. A mediumgrained granite from Kiltealy, on the Wexford slope of Blackstairs.

No. 8. *Ballyleigh.*—Specific gravity, 2·627. A fine-grained granite taken from near Poulmounty Bridge, at the south-west extremity of the granite chain.

Calculating the atomic quotients from Table I., we construct the following Table, containing the values of *a*, *b*, *c*, and of Q, F, M, calculated from equations (1).

Table II.—Atoms of Granitic Minerals.

	Atoms of silex $=a$.	Atoms of peroxides $=b$.	Atoms of protoxides $=c$.	Atoms of quartz.	Atoms of felspar.	Atoms of mica.
Dalkey	1·530	0·286	0·353			
Foxrock	1·587	0·296	0·274	0·513	0·252	0·022
Three Rock	1·528	0·352	0·287	0·445	0·222	0 065
Enniskerry	1 613	0·282	0·225	0·770	0 168	0 057
Ballyknocken	1·510	0·317	0·283	0·442	0·249	0·034
Killballyhugh......	1·592	0·321	0·232	0·753	0·143	0·089
Blackstairs	1·587	0·322	0·239	0·714	0·156	0·083
Ballyleigh	1·593	0·271	0·257	0·579	0·243	0·014

Calculating, by the method already described, the per-centages of quartz, felspar and mica, contained in the different granites, we find the following:—

Table III.—Per-centages.

Locality.	Quartz.	Felspar.	Mica.
Dalkey			
Foxrock	23·60	69·66	6·71
Three Rock	20·47	59·68	19·82
Enniskerry	35·42	45·83	17·38
Ballyknocken	20·33	68·97	10·37
Killballyhugh......	34·64	38·37	27·14
Blackstairs	32·84	41·19	25·31
Ballyleigh	26·63	67·45	4·27

From the foregoing calculations, it follows, that, with the exception of the Dalkey granite, the granites of the main chain examined might be represented by combinations of quartz, felspar and mica, in which the quartz is the most regular mineral, considered with reference to its per-centage.

The following Table contains analyses of granites belonging to the second group, and supposed to be newer than the others.

Table IV.—Isolated Granites.

Localities.	Silica.	Alumina.	Peroxide of iron.	Lime.	Magnesia.	Potash.	Soda.	Loss by ignition.	Totals.
1. Cushbawn	70·32	11·24	4·80	3·01	0·73	2·27	3·39	1·62	97·38
2. Croghan Kinshela..	80·24	13 24	0·72	0·89	trace	0·40	5·58	......	101·07
3. Ballymoty	66·60	13·26	7·32	3·36	1·22	2·31	3·60	2·34	100·01
4. Ballynamuddagh...	68·56	14·44	5·04	3·85	0·43	2·78	3·36	1·00	99·46

No. 1. *Cushbawn.*—Specific gravity, 2·671. A fine-grained granite, containing hornblende in addition to mica. Besides the constituents given in the table, the specimen examined by me contained 1·34 per cent. of carbonate of lime.

No. 2. *Croghan Kinshela.*—Specific gravity, 2·629. This granite is composed of quartz, felspar and chlorite; the specimen examined appeared to be composed exclusively of quartz and felspar. From the great quantity of soda, I infer that the felspar of Croghan Kinshela is probably albite. On the northern slope of this mountain are situated the old gold streams of Wicklow.

No. 3. *Ballymoty.*—Specific gravity, 2·659. A very fine-grained granite, but containing distinctly felspar, quartz and black mica.

No. 4. *Ballynamuddagh.*—Specific gravity, 2·670. A coarse-grained granite, with large plates of black mica.

Applying to the preceding granites the method of calculation already employed, we find, excluding the granite from Croghan Kinshela, which contains chlorite in place of mica,—

Table V.—Atoms of Granitic Minerals.

	Atoms of silex $=a$.	Atoms of peroxide $=b$.	Atoms of protoxide $=c$.	Atoms of quartz.	Atoms of felspar.	Atoms of mica.
Cushbawn	1·529	0·278	0·300			
Ballymoty	1·448	0·349	0·346	0·067	0 343	0·003
Ballynamuddagh...	1·490	0·344	0·325	0·209	0·306	0·019

From the foregoing Table, it appears that the granite of Cushbawn cannot be considered as a ternary compound of quartz, felspar and margarodite, and in fact it contains a sensible quantity of a mineral which is either hornblende or chlorite. Calculating the per-centages of quartz, felspar, and mica of the two granites, which may be represented as composed of these minerals, we find,—

Table VI.—Per-centages.

	Quartz.	Felspar.	Mica.
Ballymoty	3·08	96·02	0·91
Ballynamuddagh ...	9·62	84·05	5·79

Whatever doubt may attach to the preceding calculations, owing to the hypothesis on which they are of necessity founded, no such doubt or uncertainty can belong to the results of direct experiment contained in Tables I. and IV., which have a positive value, independent altogether of the inferences which may be deduced from them. From these tables I deduce the following as the average composition of the granites of the main chain and of the isolated granites:—

Table VII.—Average Composition of Granites.

	Main chain.	Isolated.
Silica	72·305	71·430
Alumina	14·251	13·045
Peroxide of iron	2·299	4·470
Lime	1·815	2·778
Magnesia	0·119	0·595
Potash	4·822	1·940
Soda	2·967	3·982
Loss by ignition	0·899	1·240
Totals	99·477	99·480

On examining Tables I. and IV., several interesting differences present themselves in the composition of the two groups of granites, in addition to the important difference to which I have drawn attention with respect to their alkaline constituents; but I content myself at present with establishing this fundamental distinction between the two groups, and thus furnishing an additional proof of the service which may be rendered to geological science by the more exact and experimental sciences.