phenomenon must be referred to some peculiarity in the disturbances to which the rocks have been subjected.

To explain it, we must go to North Devon, a district, like North Wales and the Ardenne, deeply affected by great lateral pressures operating on the solid rocks. At various points of the coast east of Ilfracombe we find among the slates beds of limestone exhibiting a succession of swellings and constrictions analogous to those already described; and we see that this disposition is due to the welding together of the adjacent limbs of sigmoid folds under a powerful thrust. The stages of the process are clearly exhibited. After the formation of a series of S-shaped flexures in the ordinary manner (Fig. 1), the direction of the pressure relatively to the bed has

changed, and the folds have been pressed upon themselves in the fashion indicated in Figs. 2 and 3. A node corresponds to the attenuated middle limb of a fold, while a ventral segment represents the union of the complementary parts of two adjacent folds.

It appears probable that the process indicated is also that by which the varying thickness of the greenstone dykes and the quartzite beds has been brought about. It is also seen in various stages in thin bands of grit in the Ilfracombe district. It is not necessary, however, to suppose that the sharp sigmoid folds must be actually formed as a preliminary stage. A series of slight undulations, as in Fig. 4, affected by a shearing motion in the direction shown by the arrows, might equally give rise to the alternate nodes and swellings of Fig. 3.

V.—ON THE OCCURRENCE OF SODA-FELSITES (KERATOPHYRES) IN CO. WICKLOW, IRELAND.

By FREDERICK H. HATCH, PH.D., F.G.S.

(Communicated by permission of the Director-General of the Geological Survey.)

IN an Appendix to the Explanatory Memoir on Sheets 138 and 139 of the Map of the Geological Survey of Ireland (Dublin, 1888), I have given some notes on the petrographical characters of the igneous rocks of Co. Wicklow. One or two of the facts elicited by an examination of these rocks are sufficiently interesting to deserve a wider circulation.

Associated with various types of greenstone, which will form the subject of another communication, there occur in the Lower Palæozoic strata of this district (Bala) numerous beds of felsite. These are

frequently accompanied by felspathic tuffs; and there is no doubt that they are the product of contemporaneous extrusion during the deposition of the sedimentary rocks in which they occur.

Microscopical examination and chemical analysis show that these rocks consist, in part at least, of soda-felsites or keratophyres. The keratophyres (so named from their resemblance to hornstone¹) were first described by Gümbel;² but it is to K. A. Lossen³ that we are mainly indebted for the investigation of the characters of these peculiar rocks and the vindication of their claim to consideration as a definite rock-type. They are characterized by a remarkably high percentage of felspar, especially of soda-felspar, which in some cases appears to be soda-orthoclase or soda-microcline, in others, albite. In consequence, splinters of the rocks fuse more readily before the blow-pipe than the normal quartz-orthoclase-felsites.

Normally constituted felsite, that is to say, rocks composed of a cryptocrystalline aggregate of quartz and felspar (in great part orthoclase), with or without porphyritic quartz, also occur in the Wicklow District;⁴ but there is little doubt that the two types graduate into one another.

Some specimens, collected from a rocky eminence a quarter of a mile west of Brittas Bridge, seven and a half miles west of Rathdrum (Sheet 130), will serve to illustrate the characters of the keratophyres of this district. The rock cropping out at this place is a compact felsite, having, when weathered, a curious mottled appearance, due to the presence of numerous greyish-brown spots of about a quarter of an inch diameter. These spots are crowded closely together, being only separated by a small quantity of a dark grey interstitial substance. Where still more exposed to the action of the weather, the rock is coated with an opaque white crust. When fresh it is of a dark bluish gray to black colour and splinters readily under the hammer.

Under the microscope it is seen to be composed almost entirely of felspar and quartz, the former being in excess. The few porphyritic crystals are invariably felspar, the quartz being confined entirely to the ground-mass. The texture of the latter is extremely variable. In general it is microcrystalline, consisting then of square and lath-shaped sections of felspar, between which are entangled irregular grains of quartz; in places, however, the texture sinks almost to cryptocrystalline, the individual granules becoming so small as to be scarcely distinguishable; but even then, by the use of a higher power, the microcrystalline structure can generally be made out, and there is no evidence of the presence of any "micro-felsitic" (isotropic) matter.

Scattered sparingly through the sections are scales of chlorite,

¹ Gr. *κέρας*, a horn.

² Die paläolithischen Eruptivgesteine des Fichtelgebirges. Munich, 1874, p. 45.

³ Zeitsch. deutsch. Geol. Ges. xxxiv. (1882), pp. 199 and 445; xxxv. (1883), p. 215; Jahrb. k. preuss. Geol. Landesanst. für 1884 (1885), p. 21.

⁴ See Explan. Mem. on Sheets 138 and 139 of the Map of the Geol. Survey of Ireland, 1888, p. 50.

and isolated granules of sphene; occasionally also a few tiny specks of iron-ore.

The porphyritic structure is not well defined, there being but little difference in point of size between the "porphyritic" felspar and the crystals of that mineral in the more evenly crystalline portions of the ground-mass. It is only the occurrence of an isolated large crystal in a cryptocrystalline part that gives the porphyritic appearance. These large felspars form broad rectangular crystals, which are sometimes slightly rounded. In some cases they present a fine twin-lineation either on one (the albite) or two (albite and pericline) types. In other cases the crystals show no trace of twinning. Such crystals, however, are characterized by another and somewhat remarkable structure. They appear, namely, between crossed Nicols to be divided up into a number of rectangular patches by narrow partitions, which have an extinction-angle differing slightly from that of the main portion. In other cases the central portion extinguishes uniformly, while a marginal layer goes out at a slightly different angle. The latter case can sometimes be made out without the use of the Nicols; the rim of the felspar-section being clear, while the central portion is speckled over with minute opaque particles, giving it a somewhat cloudy appearance. Have these phenomena, more especially the first-mentioned, anything in common with the "felderweise mikropertitische" structure mentioned by Lossen and Rosenbusch as characteristic for the felspar of the keratophyres? The smaller felspars of the ground-mass are mostly striated.

A chemical analysis of this rock gave me the following result:—

SiO ₂	...	...	...	...	...	...	...	...	...	=	77.29
Al ₂ O ₃	...	...	...	...	...	...	...	...	...	=	14.62
Fe ₂ O ₃ (a trace)	...	...	...	...	...	...	...	...	...	=	—
CaO (a trace)	...	...	...	...	...	...	...	...	...	=	—
MgO	...	...	...	...	...	...	...	...	...	=	.38
K ₂ O	...	...	...	...	...	...	...	...	...	=	.16
Na ₂ O	...	...	...	...	...	...	...	...	...	=	7.60
Loss on ignition	...	...	...	...	...	...	...	...	...	=	.57
											100.62
Sp. G.	...	...	...	...	...	...	...	...	...	=	2.64

From this analysis the mineral composition of the rock was calculated to be the following:—

Free quartz	...	...	...	...	...	...	...	...	...	=	32.49
Orthoclase	...	...	...	...	...	...	...	...	...	=	.95 }
Albite...	...	...	...	...	...	...	...	...	...	=	64.33 }
Felspar	...	...	...	...	...	...	...	...	...	=	65.28
Other substances	...	...	...	...	...	...	...	...	...	=	2.23
											100.00

This analysis shows that the rock consists almost entirely of quartz and a soda-felspar (albite).

During two visits to Counties Wicklow and Waterford in June and November of last year I collected, among other rocks, a large series of felsites. It is exceedingly probable that a petrographical

examination of these specimens will demonstrate the wide distribution of soda-felsites in these districts. Felsites bearing a strong resemblance in age, association and mode of occurrence, to the Irish rocks occur in Wales. We may confidently expect to find keratophyres among them; indeed, Prof. Rosenbusch has already predicted their occurrence among the Welsh rocks.¹ They appear also to occur in Arran. An analysis of a felsite from this island by Mr. J. A. Phillips is almost identical as regards the alkalies with the one given above.²

It is interesting to correlate with the facts given above Prof. Haughton's researches on the Wicklow granites.³ As far back as 1859 he showed that in many of these granites there is a dominant soda-felspar; and for these he introduced the name "soda-granite." An interesting relation has thus been established between the granites and felsites of Co. Wicklow. What bearing this has upon their mode of origin remains still to be seen.

VI.—AN ANALYSIS OF THE KENTISH RAG.

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IN May last I visited the Preston Hill Quarry, near Maidstone, in the company of the "Geological Field Class," conducted by Professor Seeley, F.R.S., and took from it the specimen, the analysis of which is given below. In appearance the rock was a hard, grey, sandstone, containing fine quartz grains disseminated throughout its mass; its sp. gr. = 2.685; on the addition of an acid sulphuretted hydrogen was evolved, from the decomposition of calcium sulphide. The sample contained:—

Insoluble Residue	...	...	72.190	per cent =	{Silica 72.051 % Fe ₂ O ₃ + Al ₂ O ₃ = 0.137
Alumina	...	...	1.331	"	} = 2.068
Ferric Oxide	...	...	0.682	"	
Phosphoric acid, P ₂ O ₅	...	...	0.055	"	72.188
Lime, CaO	...	...	12.523	"	
Magnesia, MgO	...	...	0.054	"	
Alkalies as K ₂ O	...	...	0.122	"	
Carbonic acid	...	...	9.984	"	
Sulphuric acid, SO ₃	...	...	0.647	"	as insoluble Ca SO ₄ , no soluble sul-
Calcium sulphide, CaS	...	...	1.334	"	[phates.
Moisture, at 100°C.	...	...	0.995	"	
			99.917		

¹ Die Massigen Gesteine, Stuttgart, 1887, p. 418.

² This MAGAZINE, Vol. IX. 1872, p. 540. I give the analysis for comparison:—

SiO ₂	...	...	...	...	...	78.32
Al ₂ O ₃	...	...	...	...	...	11.39
FeO	...	...	...	...	...	1.67
CaO	...	...	...	...	...	13
MgO (a trace)	...	...	...	...	...	—
K ₂ O	...	...	...	...	...	20
Na ₂ O	...	...	...	...	...	7.62
H ₂ O	...	...	...	...	...	1.47
						100.80

³ Trans. Roy. Irish Acad. vol. xxiv. (1859), p. 608.