CHEMICAL DATA FOR THE ROCKS OF THE ENGLISH LAKE DISTRICT.

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The following notes are intended to give a complete record of chemical work to the present date on the rocks of the English Lake District, that name being employed in an extended sense to include the Lake District proper, together with the Lower Palæozoic inliers of Edenside, Sedbergh, and Ingleton, which belong to the same natural district. This compilation should have accompanied the Petrographical Notes prepared for the Keswick excursion; and published in the last number of these Proceedings (Vol. XIV., pp. 487-496), but it was not completed in time to be included there. Most of the items have appeared in an article published in "The Naturalist" for 1899, but I have now added a number of supplementary references to bring the list down to date, and have rearranged the whole to correspond with the notes already published in these Proceedings.

I give first a summary of the literature of the subject. Then follows the list of analyses, partial analyses, and silica determinations, the silica percentage being quoted in each case as the readiest means of identification. To each record is appended the name of the analyst and, in parenthesis, the reference to the original publication. In the case of a number of silica determinations made by students of Owens College and the Yorkshire College, under the superintendence of Dr. A. Harden and Dr. J. B. Cohen respectively, these latter names are cited as the authorities.

REFERENCES.

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- (III.) Ward, *ibid.*, p. 597.
- (IV.) Ward, *ibid.* (1876), Vol. XXXII., pp. 5, 7, 22-24.
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- (XII.) Stock, Naturalist (1889), p. 304.
- (XIII.) Harker and Marr, Quart. Journ. Geol. Soc. (1891), Vol. XLVII., pp. 275-302.
- (XIV.) Hutchings, Geol. Mag. (1891), pp. 536-544.
- (XV.) Hutchings, *ibid.* (1892), pp. 154-161, 218-228.
- (XVI.) Harker and Marr., Quart. Journ. Geol. Soc. (1893), Vol. XLIX., p. 361.
- (XVII.) Postlethwaite, *ibid.*, p. 533.
- (XVIII.) Hutchings, Geol. Mag. (1894), p. 42.
- (XIX.) Harker, Quart. Journ. Geol. Soc. (1894), Vol. L., pp. 321, 323.
- (XX.) Harker, *ibid.* (1895), Vol. LI., pp. 129-131, 140, 141.
- (XXI.) Hutchings, Geol. Mag. (1895), p. 316.
- (XXII.) Thomas, Journ. Roy. Inst. Brit. Architects (1896), Ser. 3, Vol. III., p. 196.
- (XXIII.) Harker, Naturalist (1899), pp. 53-58, 149-154.
- (XXIV.) Reade and Holland, Proc. Liverp. Geol. Soc. (1900), Vol. VIII., table p. 478.
- (XXV.) Reade and Holland, *ibid.* (1901), Vol. IX., table p. 127.

- {XXVI.) Rutley, Quart. Journ. Geol. Soc. (1901), Vol. LVII.,
p. 36.
{XXVII.) Harker, Geol. Mag. (1894), p. 553.

SKIDDAW SLATE SERIES.

- {1). 54.480 (anal.). Altered Skiddaw Slate, summit of Red
Pike, near the Buttermere granophyre : Hughes (IV.).
{2). 65.725 (anal.). Chiastolite-slate, How Gill, Skiddaw :
Hughes (IV.).
{3). 54.448 (anal.). Spotted schist, Skiddaw Forest : Hughes
(IV.).
{4). 53.174 (anal.). Mica-schist, close to Skiddaw granite,
Sinen Gill : Hughes (IV.).
{5). 56.76 (anal.). Skiddaw slate, ? locality : Kendall (VIII.).
{6). 79.92 (anal.). Grit in Skiddaw Slates, Robin Hood,
Bassenthwaite : Hellon (XVII.).
{7). 54.9 and 54.8 (silica). Lava in Skiddaw Slates, Scale
Force, Crummock : MacFarlane and Thomas (XXIII.).

FALCON CRAG ANDESITE GROUP.

- {8). 54.5 and 54.2 (silica). Lava with porphyritic augite,
base of No. 5 of Ward's section, E. of summit of Falcon
Crag, Borrowdale : MacFarlane and Thomas (XXIII.).
{9). 60.718 (anal.). Pyroxene-andesite, No. 6 of section,
Brown Knotts : Hughes (II.).
{10). 59.511 (anal.). Pyroxene-andesite, No. 12 of section,
Iron Crag : Hughes (II.).
{11). 61.2 and 61.5 (silica). Pyroxene-andesite, base of No. 10
of section, above Falcon Crag : MacFarlane and Thomas
(XXIII.).
{12). 54.6 (silica). Cleaved agglomerate (slate), Borrowdale
quarries : Garwood (XXIII.).
{13). 58.65 (silica). Pyroxene-andesite, Pooley, Ullswater :
Garwood (XXIII.).

Also, doubtfully assigned to this group :—

- {14). 59.87 (anal.). Andesite, "Greystone" boulder, Manfield
near Darlington : Stock (XII.).

EYCOTT AND ULLSWATER BASALT GROUP.

- (15). 53.40 and 52.73 (silica). Hypersthene-basalt, with large porphyritic feldspars, No. 4 of Ward's section, Eycott Hill : Cooksey (IX.).
- (16). 53.300 (anal.). Hypersthene-basalt, microporphyritic, No. 12 of section : Eycott Hill, Hughes (VI.).
- (17). 52.600 (anal.). Hypersthene-basalt, very compact, No. 13 of section, Eycott Hill : Hughes (VI.).
- (18). 51.100 (anal.). Hypersthene-basalt, No. 15 of section, Eycott Hill : Hughes (VI.).
- (19). 54.3 and 54.9 (silica). Lava with porphyritic augite, Mousegill quarry, Wilton Fell, near Egremont : MacFarlane and Thomas (XXIII.).
- (20). 48.68 (silica). Porphyritic basalt of Eycott type, near Devil's Slidegate, Illgill Head, Wastwater : Harden (XXIII.).
- (21). 52.95 (silica). Porphyritic basalt, Brimfull Beck, Overbeck, Wastwater : Garwood (XXIII.).
- (22). 51.35 (silica). Vesicular basalt with porphyritic augite, Scarth Gap, near summit of pass : Hutchings (XIV.).
- (23). 56.2 (silica). Highly-metamorphosed lava resting on Eskdale granite, Great Barrow, Boot : Harden (XXIII.).
- (24). 55.7 and 55.9 (silica). From same locality : MacFarlane and Thomas (XXIII.).
- (25). 52.6 (silica). Basalt, Galleny Force, Greenup Gill : Garwood (XXIII.).
- (26). 57.4 and 57.1 (silica). Compact lava, about $\frac{1}{4}$ mile N.W. of Castle Crag, Borrowdale : MacFarlane and Thomas (XXIII.).
- (27). 53.45 (silica). Cleaved tuff, slate, Honister quarries : Garwood (XXIII.).
- (28). 52.34 (anal.). Cleaved tuff, green slate, Honister Pass : Holland (XXV.).
- (29). 53.50 (anal.). Cleaved tuff, green slate, Honister Pass : Holland (XXV.).

- (30). 54.02 (anal.). Cleaved tuff, olive-green slate, Honister Pass : Holland (XXV.).
- (31). 53.45 (silica). Porphyritic basalt of Eycott type, Randal Beck, Mardale : Garwood (XXIII.).
- (32). 54.6 (silica). Porphyritic basalt, Gatescarth Pass, near Mardale : Garwood (XXIII.).
- (33). 56.95 (silica). Crushed and cleaved porphyritic lava, Fordingdale Force, Measand Beck, Haweswater : Garwood (XXIII.).
- (34). 50.75 (silica and lime). Basalt, Low Fell, Shap : Garwood (XIII.).
- (35). 50.90 (silica and lime). Basic tuff, Low Fell, Shap : Garwood (XIII.).
- (36). 27.88 (anal.). Cleaved calcareous tuff, green slate, Buttermere : Holland (XXIV.).

The next thirteen rocks, though apparently belonging to this group, seem to present andesitic rather than basaltic characters.

- (37). 59.151 (anal.). Andesite, Lingmell Beck, Wastdale : Hughes (III.).
- (38). 57.55 (silica). Augite-andesite, above Nan Bield : Hutchings (XIV.).
- (39). 52.45 (silica). Much altered andesite, Easedale Tarn, right side : Hutchings (XIV.).
- (40). 60.75 (silica). Andesite, Easedale Tarn, left side : Hutchings (XIV.).
- (41). 51.6 (silica). Much altered andesite, roadside quarry between Seatoller and Seathwaite : Hutchings (XIV.).
- (42). 53.55 (silica). "Andesitic basalt," Seatoller Fell : Hutchings, (XIV.).
- (43). 62.43 (silica). Andesite, near Ullswater, on road to Matterdale : Hutchings (XIV.).
- (44). 61.45 (silica). Andesite, N. slope of Stoneside Fell, Bootle : Garwood (XXIII.).
- (45). 62.95 (silica). Porphyritic andesite (possibly intrusive), Whiteside Bank, Helvellyn : Garwood (XXIII.).

- (46). 69.673 (anal.). Tuff, partly metamorphosed, Base Brown, near Borrowdale: Hughes (III.).
- (47). 68.421 (anal.). Metamorphosed breccia, Slight Side, near Eskdale: Hughes (III.).
- (48). 69.48 (silica). Compact rock with lenticular streaky structure, N.E. slope of Illgill Head, Wastwater: Harden (XXIII.).
- (49). 66.95 (silica). Crushed garnetiferous lava, Frith Wood, Rosthwaite, Borrowdale: Garwood (XXIII.).

The three rocks next following are of acid composition, though intercalated in the basaltic group.

- (50). 73.45. Rhyolite, upper part of Measand Beck, Haweswater: Garwood (XXIII.).
- (51). 82.25. Rhyolite, somewhat altered, $\frac{1}{4}$ mile S.E. of Walla Crag, Haweswater: Garwood (XXIII.).
- (52). 76.95. Breccia, Frith Wood, Rosthwaite: Garwood (XXIII.).

SCAWFELL TUFF AND BRECCIA GROUP, WITH THE KENTMERE-CONISTON SLATE-BAND.

- (53). 56.60 (silica). Hornstone (altered fine tuff), Hanging Knott, Bow Fell: Garwood (XXIII.).
- (54). 63.1 (silica). Hornstone (altered fine tuff), upper part of Eskdale: Harden (XXIII.).
- (55). 58.69 (anal.). Andesite, Thornthwaite Crag: Cohen (XIV.).
- (56). 66.59 (silica). Dark garnetiferous rock, a little south of summit of Scawfell: Harden (XXIII.).
- (57). 69.22 (anal.). Cleaved tuff (ash-slate), insoluble portion, Mosedale, near Shap: Patterson (XV.).
- (58). 74.88 (anal.). Cleaved tuff (ash-slate), insoluble portion, below reservoir, Kentmere: Patterson (XV.).
- (59). 61.75 (silica). Cleaved tuff (ash-slate), Grasmere, quarry: Patterson (XV.).
- (60). 77.40 (silica). Insoluble portion of the same rock: Patterson (XV.).

- (61). 50.88 (anal.). Cleaved tuff, "green Westmoreland slate," probably from Tilberthwaite : Vogt (XXII.).
- (62). 61.25 (silica). Cleaved tuff, slate, Tilberthwaite quarries : Garwood (XXIII.).
- (63). 50.16 (anal.). Cleaved tuff, dark green slate, Tilberthwaite : Holland (XXV.).
- (64). 52.67 (anal.). Cleaved tuff, green slate, Elterwater : Holland (XXV.).
- (65). 80.52 (anal.). Insoluble portion of the same rock : Holland (XXV.).

SHAP ANDESITE GROUP.

- (66). 59.95 (silica and lime). Amygdaloidal augite-andesite, between Wasdale Pike and Great Yarlside : Garwood (XIII., XVI.).
- (67). 65.80 (anal.). Andesite, "near Coniston" : Cohen (X.).
Also two rocks doubtfully referred to this group :—
- (68). 63.60 (anal.). Andesite, boulder, Oxford Street, Manchester : Cohen (X.).
- (69). 61.95 (silica). Crushed and cleaved porphyritic lava, Craggs Mill, Shap : Garwood (XXIII.).

SHAP RHYOLITE GROUP.

- (70). 53.10 (anal.). Basic tuff, highly metamorphosed, close to Shap granite, Wasdale Pike : Hutchings (XXI.).
- (71). 75.95 (partial anal.). Spherulitic rhyolite, Stockdale : Garwood (XIII.).
- (72). 76.95 (partial anal.). Nodular rhyolite, metamorphosed, close to Shap granite, Wasdale Head Farm : Garwood (XIII.).
- (73). 83.8 (silica). Rhyolite, probably with secondary quartz, locality not specified : Tate (XXIII.).
- (74). 69.00 (anal.). Soda-rhyolite, north end of Dufton Pike, Eden Valley : Holland (XXVI.).
- (75). 71.05 (anal.). Rhyolite, Dufton Pike : Holland (XXVI.).

CONISTON FLAGS.

- (76). 58.55 (anal.). Lower Coniston (or Brathay) Flags, Wasdale Beck, near Shap Wells : Hutchings (XVIII.).
- (77). 61.05 (anal.). The same rocks highly metamorphosed, near the Shap granite, Wasdale Beck, $\frac{3}{4}$ mile above Shap Wells : Hutchings (XVIII.).

INTRUSIVE ROCKS : OLDER SUITE.

- (78). 71.442 (anal.). Granophyre of Buttermere mass, Scale Force : Hughes (IV.).
- (79). 67.180 (anal.). Microgranite of St. John's Vale intrusion, Threlkeld : Hughes (IV.).
- (80). 60.45 (silica). Quartz-porphyrite ("quartz-andesite or dacite"), between Greenburn and Wythburn : Hutchings (XIV.).
- (81). 61.15 (silica). Porphyry ("trachyte"), Shap Wells plantation : Hutchings (XIV.).
- (82). 64.5 and 63.9 (silica). Garnetiferous porphyrite (?), doubtfully assigned to this place, near Dock Tarn, E.N.E. of Stonethwaite Church, Borrowdale : MacFarlane and Thomas (XXIII.).
- (83). 48.42 (anal.). Diabase, Robin Hood, Bassenthwaite : Hellon (XVII.).
- (84). 45.65 (silica). Diabase, above Easedale Tarn, towards Langdale : Hutchings (XIV.).
- (85). 45.54 (anal.). Diabase, Gleaston, Low Furness : Roscoe (I.).
- (86). 50.96 (anal.). Another specimen of the same : Roscoe (I.).
- (87). 51.10 (anal.). Another specimen of the same : Roscoe (I.).

The age and geological relations of these last three rocks are doubtful.

INTRUSIVE ROCKS : YOUNGER SUITE.

- (88). 73.573 (anal.). Eskdale granite, S. of Great How : Hughes (III.).

- (89). 75.223 (anal.). Skiddaw granite, White Gill : Hughes (IV.).
- (90). 77.26 (silica). Skiddaw granite, bed of Caldew, 300 yards above Grainsgill : Brend and Craig (XX.).
- (91). 78.13 (silica). Greisen, near foot of Brandy Gill : Harden (XX.).
- (92). 80.36 (anal.). Greisen, Combe Height, 250 yards S. of Grainsgill : Spencer (XX.).
- (93). 68.55 (anal.). Shap granite : Cohen (XIII.).
- (94). 65.41 (anal.). Large porphyritic felspars of the same rock : Cohen (XIII.).
- (95). 68.89 (anal.). Ground-mass of the same : Cohen (XIII.).
- (96). 69.78 (silica). Shap granite : Garwood (XIII.).
- (97). 56.95 (silica). Dark, relatively basic patch in the same rock : Garwood (XIII.).
- (98). 44.44 (anal.). Mica-lamprophyre ("minette-felsite"), dyke, $\frac{3}{4}$ mile from Windermere Station : Houghton (VII.).
- (99). 46.17 (anal.). Hornblende-mica-lamprophyre ("diorite, micaceous"), dyke, Gill Bank, $1\frac{1}{4}$ miles N.N.E. of Staveley : Houghton (VII.).
- (100). 49.52 (anal.). Hornblende - lamprophyre ("diorite, micaceous"), Stile-end Farm, between Kentmere and Long Sleddale : Houghton (VII.).
- (101). 61.12 (anal.). Mica-lamprophyre ("minette-felsite"), Kendal road, 250 yards from third milestone : Houghton (VII.).
- (102). 48.57 (anal.). Mica-lamprophyre ("minette-felsite"), dyke on railway, W. of Docker Garth : Houghton (VII.).
- (103). 58.34 (anal.). Mica-lamprophyre ("minette-felsite"), dyke S. of Haygarth, Docker Fell, No. I. : Houghton (VII.).
- (104). 47.88 (anal.). Mica-lamprophyre ("minette-felsite"), dyke S. of Haygarth, Docker Fell, No. II. : Houghton (VII.).

- (105). 32.31 (anal.). Mica-lamprophyre ("minette-felsite"), lowest dyke, Helm Gill, near Sedbergh : Houghton (VII.)
- (106). 47.2 (anal.). Mica-lamprophyre, the most southerly dyke, Helm Gill : Tate (XXIII.).
- (107). 47.1 (anal.). Duplicate analysis of the preceding : Tate (XXIII.).
- (108). 46.34 (anal.). Another specimen from the same dyke : Tate (XXIII.).
- (109). 58.99 (anal.). Mica-lamprophyre, E. bank of Doe, Storrs, Ingleton ("Phillips' dyke") : Tait (XXIII.).
- (110). 59.46 (silica). Carrock Fell gabbro (quartz-gabbro), White Craggs : Brend and Craig (XIX.).
- (111). 57.7 (silica). Carrock Fell gabbro (quartz-gabbro), 350 yards S. of White Craggs : Brend and Craig (XIX.).
- (112). 56.656 (anal.). Carrock Fell gabbro (quartz-gabbro), White Craggs : Hughes (IV.).
- (113). 53.9 (silica). Carrock Fell gabbro (quartz-gabbro), precise locality not specified : Tate (XXIII.).
- (114). 53.50 (anal.). Carrock Fell gabbro (quartz-gabbro), roadside, 150 yards N.N.W. of Chapel Stone : Barrow (XIX.).
- (115). 50.22 (silica). Carrock Fell gabbro, 600 yards S.W. by S. of White Craggs : Brend and Craig (XIX.).
- (116). 50.0 (silica). Carrock Fell gabbro (quartz-gabbro), same locality as (114) : Cohen (XIX.).
- (117). 47.11 (silica). Carrock Fell gabbro, 120 yards N. of summit of White Craggs : Brend and Craig (XIX.).
- (118). 44.14 (silica). Carrock Fell gabbro, basic variety, top of cliff above Mosedale, S. edge of mass : Brend and Craig (XIX.).
- (119). 43.4 (silica). Carrock Fell gabbro, basic variety, gill $\frac{3}{8}$ mile N.W. of Swineside, S. edge of mass : Cohen (XIX.).
- (120). 33.4 (silica). Carrock Fell gabbro, highly basic variety, lowest part of Furthergill, N. edge of mass : Cohen (XIX.).

- (121). 32.53 (anal.). Carrock Fell gabbro, highly basic variety, upper part of Furthergill, N. edge of mass : Barrow (XIX. and XXIII.).
- (122). 77.38 (silica). Carrock Fell granophyre, below Scurth and 500 yards W.N.W. of Stone Ends : Brend and Craig (XX.).
- (123). 75.3 (silica). Carrock Fell granophyre, in peat-moss S. of Drygill Head : Cohen (XX.).
- (124). 71.60 (anal.). Carrock Fell granophyre, 100 yards E. of summit : Barrow (XX.).
- (125). 69.044 (anal.). Carrock Fell granophyre, summit of Carrock Fell : Hughes (IV.).
- (126). 60.0 (silica). Carrock Fell granophyre, modified by admixture of gabbro material, close to gabbro contact, Furthergill Sike : Cohen (XX.).
- (127). 58.26 (silica). Carrock Fell granophyre, same locality as the preceding : Brend and Craig (XX.).
- (128). 53.63 (anal.). Spherulitic tachylyte, vein cutting the Carrock Fell gabbro : Adie (XI.).
- (129). 59.8 (silica). Variolitic andesite, dyke cutting Carrock Fell granophyre : Cohen (XXVII.).

[*Note added in the proof.* A paper by the late E. E. Walker, read before the Geological Society of London, December 2nd, 1903, and not yet published, contains eleven analyses and sixteen silica-determinations.]