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## Figures and plates

(Front cover)

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(Figure 1) Map of inferred original Tertiary drainage system (shown in heavy dots) Shatter-belts guide Loch Linnhe, Loch Leven and Lairig Gartain [NN 200 544]. Contour-interval 250 ft, with change of ornament every thousand feet. W, Secondary Watersheds. R, west end of Rannoch Moor

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(Figure 3) Sketch of Appin Fold sectioned in S.W. wall of Glen Nevis 5, Baked Ballachulish Slates (youngest); 6, Marble of Ballachulish Limestone; 6', Calc-silicate-hornfels of Ballachulish Limestone

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(Figure 9) Section across (Figure 8) showing the relation of the Ballachulish Slide to the Tom Meadhoin Antiform 4, Appin Quartzite (youngest); 5, Ballachulish Slates; 6, Ballachulish Limestone; 7, Leven Schists; 8, Glen Coe Quartzite

(Figure 10) Map of Lower Glen Coe

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(Figure 12) View across Upper Glen Nevis, looking south. 7, Leven Schists (youngest); 8, Glen Coe Quartzite; 9, Binnein Schists; 10, Binnein Quartzite; 11, Eilde Schist; 12, Eilde Quartzite. For slides, see Sheet 53 and (Figure 14), (Figure 16)

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(Figure 14) Sections: mostly north of Loch Leven A [NN 166 783] to [NN 280 678]; B [NN 168 707] to [NN 250 621]; C [NN 085 700] to [NN 245 614]; D [NN 080 584] to [NN 250 621].

(Figure 15) (West above, east below). Formations, dip and current-bedding west and east of Caolasnacon.

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(Plate 11) Photomicrographs of Kentallenite, Appinite and rocks connected with the Fault-Intrusion of Glen Coe. x 10 Dia. Explanation of (Plate 11) 1. Kentallenite, type quarry ([S7053](#)) [NN 009 577]. Olivine, with black cracks; augite, idiomorphic, grey; feldspar, clear; biotite, pale or dark. (photo M.2436; p. 212). 2. Appinite, N. of Leacantuim [NN 117 577], Glen Coe ([S11036](#)) [NN 1152 5810]. Hornblende, mainly dark; feldspar and quartz, clear. (M.2441; p. 215). 3. Junction of flinty crush-rock (left) with chilled Fault-Intrusion (right) at Boundary-Fault, Stob Mhic Mhartuin ([S13403](#)) [NN 207 575]. The minute clear grains in the flinty crush-rock are quartz. The four larger crystals in the same are xenocrysts of feldspar derived from the Fault-Intrusion. The four crystals in the Fault-Intrusion are feldspar phenocrysts, one showing dark.

(M.2444; p. 162). 4. Junction of pelitic hornfels (upper third of photo) with *lit par lit* vein (remainder) in xenolith in Fault-Intrusion, taken from quenched zone at Boundary-Fault, An t-Sròn ([S10311](#)) [NN 136 558]. Due to quenching the vein has completed its crystallisation by developing spherulites — right at bottom corner and left at margin against hornfels. (M.2445; p. 216). 5. Fault-Intrusion (felspar shows grey) detaching quartz xenocrysts (clear) from quartzite xenolith. Permeation area north of Glen Coe ([S11517b](#)) [NN 1592 5970]. (M.2440; p. 219). 6. Greatly sheared xenolith of basic lava (right), recrystallised with much minute hornblende. It is enclosed in chilled Fault-Intrusion (left), loaded with clear xenocrysts of quartz, and has been carried just inside Cauldron-Subsidence of Glen Coe at An t-Sròn ([S11905](#)) [NN 1362 5502]. (M.2439; p. 217).

(Plate 12) Photomicrographs of Leven Schists before and after contact-alteration. × 21 Dia. A. Not contact-altered, Glen Leac na Muidhe ([S11618](#)) [NN 1126 5486]. Porphyroblasts of biotite, garnet and magnetite in well foliated base of muscovite, quartz and magnetite. B. Slightly contact-altered, ¾ mile from Cruachan "Granite", Glen Etive district ([S8270](#)) [NN 112 505]. Pseudomorph, largely of cordierite and magnetite, after garnet in well foliated base of muscovite, quartz and magnetite. C. Completely reconstructed to cordierite-andalusite-hornfels, near Ben Nevis "Granite", Aonach Beag ([S13837](#)) [NN 1935 7186]. Cordierite, pale, N.W. half; andalusite, darker, S.E. half; biotite and magnetite, dark to black.

(Plate 13) An Steall, The Waterfall of a valley hanging to Glen Nevis Water-worn crags on left due to stream cascading down marginal crevasse; Roche moutonnee, Glen Nevis, by roadside above Polldubh [NN 141 686] Note gap on "sloss" side due to plucking.

## Tables

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(Table 2) Analyses of Devonian igneous rocks of sheet 53, 45 and 62 (Geol.).

(Table 3) Analyses of Devonian igneous rocks of sheet 53, 45, 54 and 62 (Geol.) continued.

(Table 4) Analyses of Appin Limestone; Analyses of xenolith and contaminated and normal Ballachulish quartz-diorite.

(Table 5) Analyses illustrating reactions between quartz xenoliths and Ballachulish quartz-diorite.

# The geology of Ben Nevis and Glen Coe



*(Front cover). Ben Nevis from the Great Glen, view from Muirshearlich, Banavie. Inverness-shire. The Ben Nevis Complex, a sequence of granitic intrusions with central cauldron subsidence of Lower Old Red Sandstone lavas and Dalradian metasedimentary rocks.*

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH  
MEMOIRS OF THE GEOLOGICAL SURVEY  
SCOTLAND

The Geology  
of  
Ben Nevis and Glen Coe  
and the Surrounding Country

(EXPLANATION OF SHEET 53)

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SECOND (REVISED) EDITION

*By*

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*with Economic Chapter by*  
T. R. M. Lawrie, B.Sc.



EDINBURGH: HER MAJESTY'S STATIONERY OFFICE

1960

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(Title page).

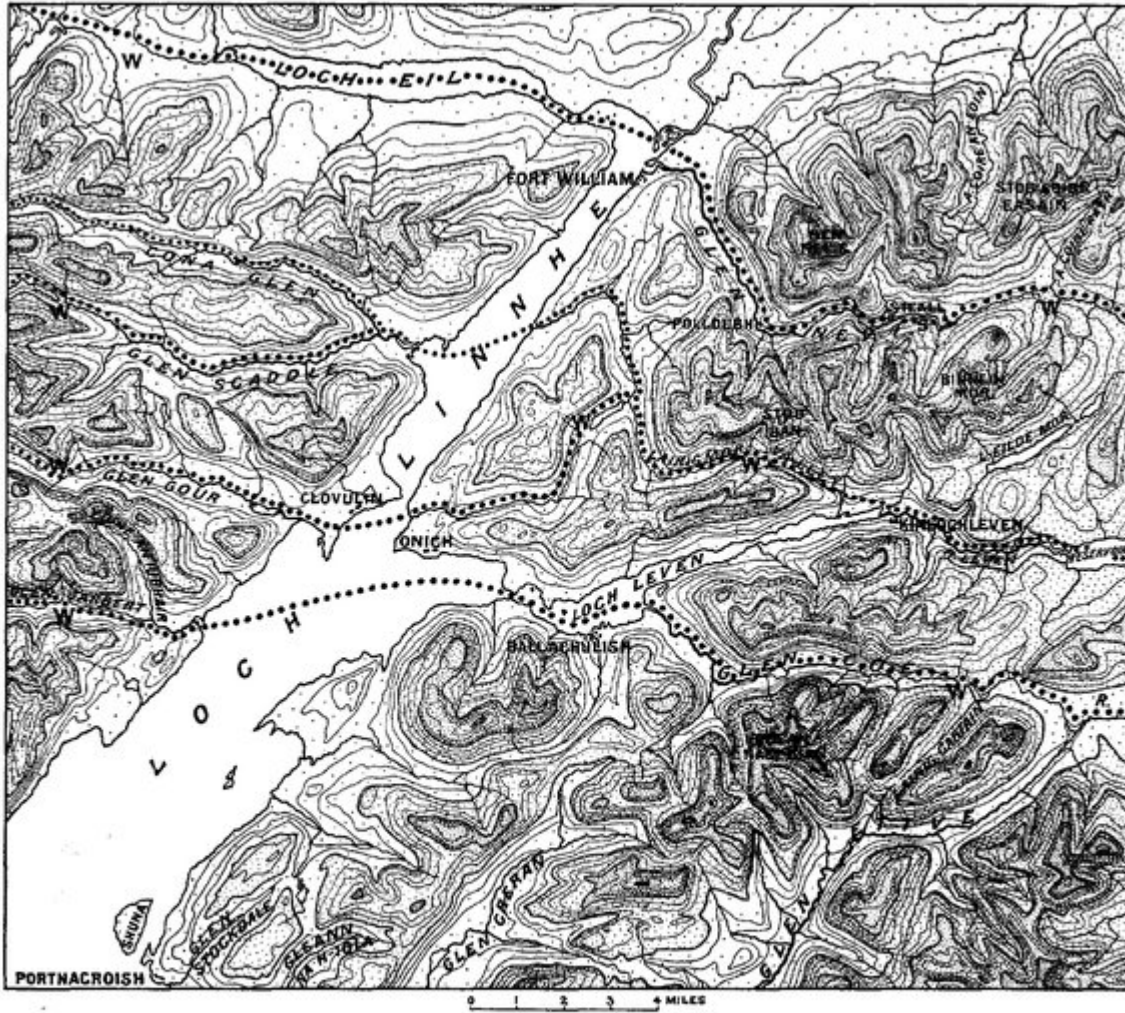


FIG. 1. Map of inferred original Tertiary drainage system (shown in heavy dots)

Shatter-belts guide Loch Linnhe, Loch Leven and Lairig Gartain.  
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 W, Secondary Watersheds. R, west end of Rannoch Moor

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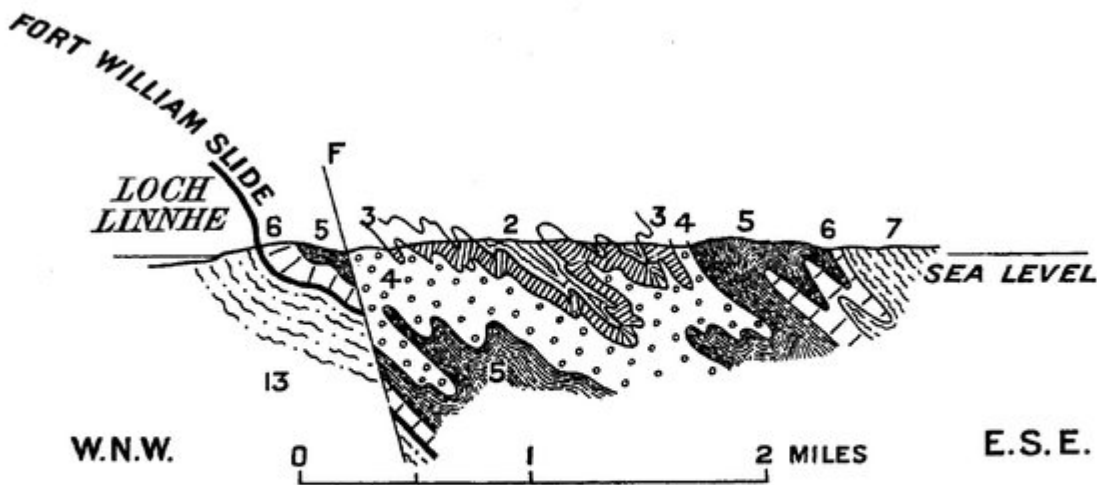


FIG. 2. Section across Appin Fold : Onich shore

2, Appin Phyllites (youngest) ; 3, Appin Limestone ; 4, Appin Quartzite ; 5, Ballachulish Slates ; 6, Ballachulish Limestone ; 7, Leven Schists ; 13, Eilde Flags

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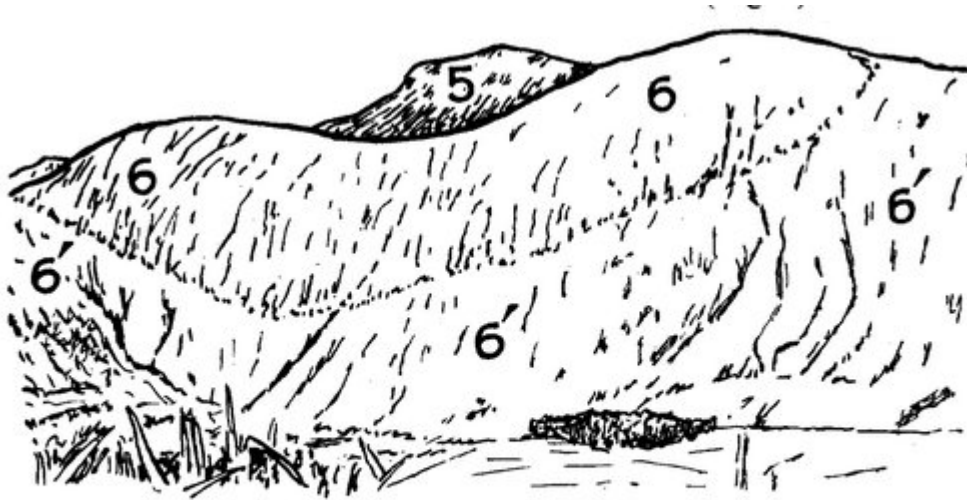


FIG. 3. Sketch of Appin Fold sectioned in S.W. wall of Glen Nevis

5, Baked Ballachulish Slates (youngest) ; 6, Marble of Ballachulish Limestone ; 6', Calc-silicate-hornfels of Ballachulish Limestone

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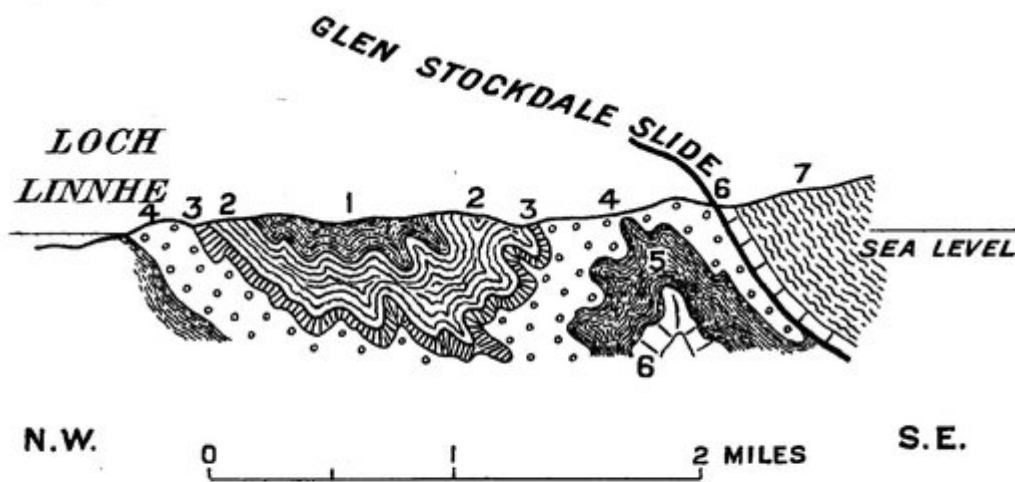


FIG. 4. Section across Appin Fold north of Cuil Bay

1, Cuil Bay Slates (youngest) ; 2, Appin Phyllites ; 3, Appin Limestone ; 4, Appin Quartzite ; 5, Ballachulish Slates ; 6, Ballachulish Limestone ; 7, Leven Schists

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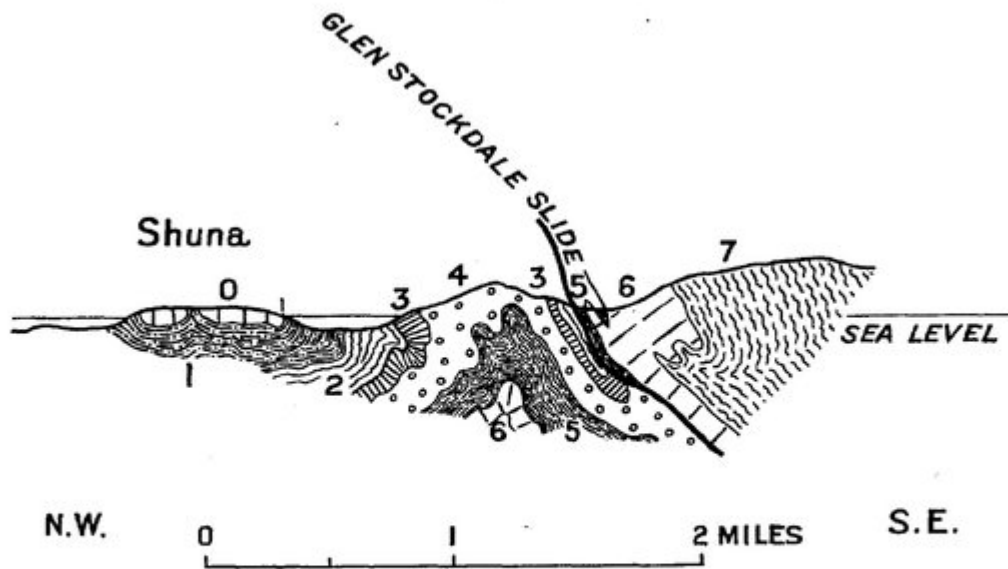


FIG. 5. Section across Appin Fold in Island of Shuna and Glen Stockdale

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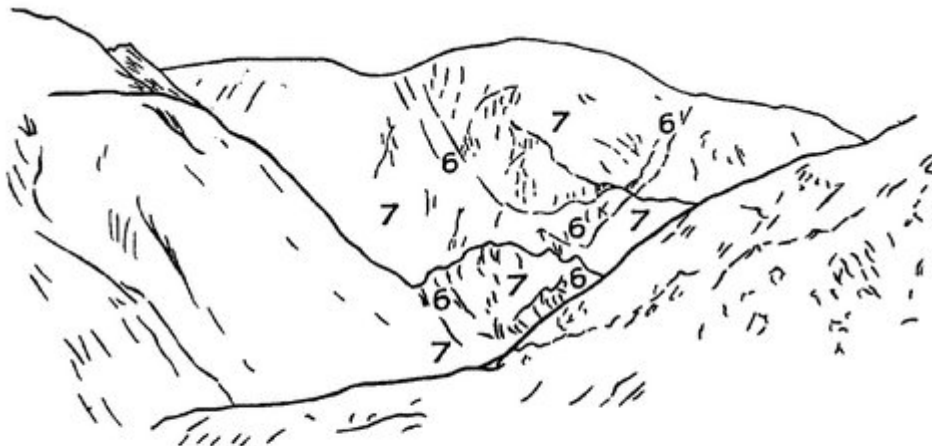


FIG. 6. View up Glen Nevis from Stob Bàn of Aonach Beag Synform

The Aonach Beag Core of Ballachulish Limestone (6), with Leven Schists (7) above and below, is refolded into a synform well seen in Aonach Beag (4060 ft) and also in Meall Cumhann in the middle distance

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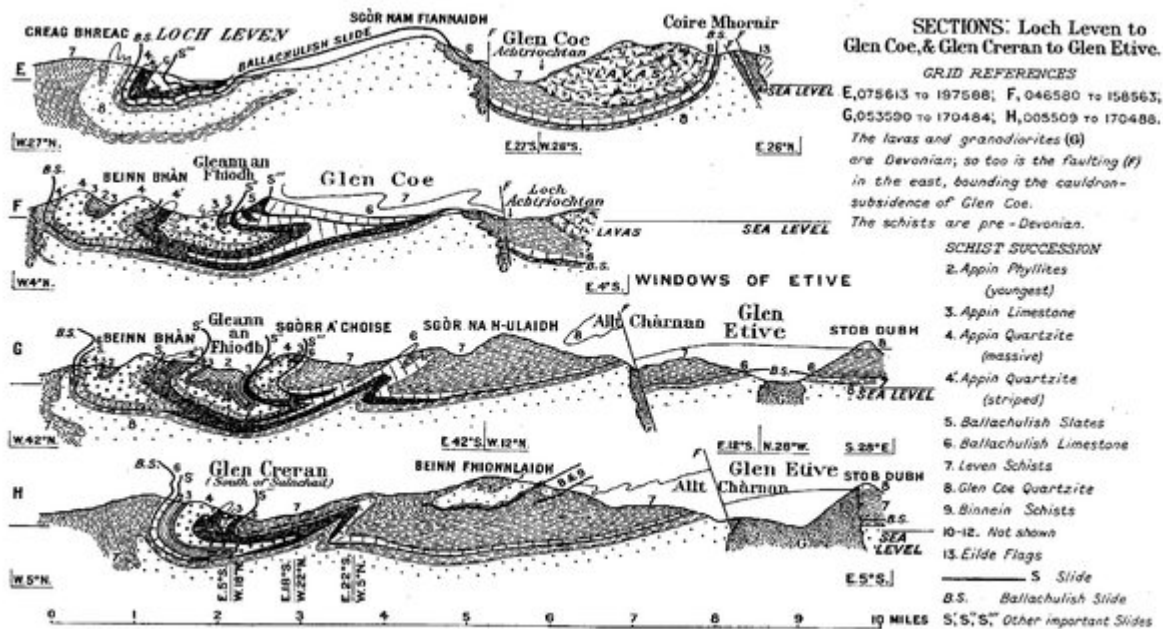
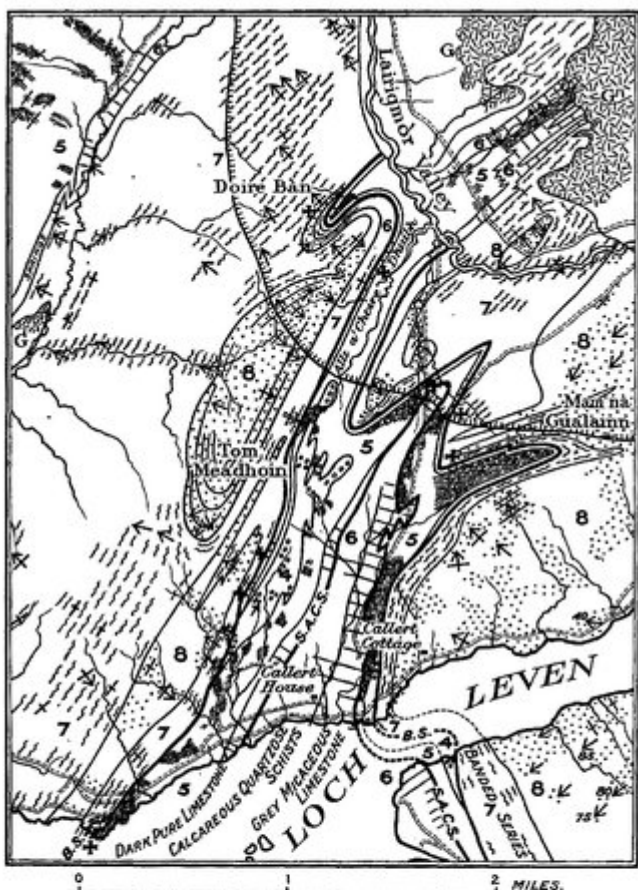


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\ Dip, amount in degrees.    \ Dip of Cleavage  
 / Steep Dip                      / Steep Dip of Cleavage  
 x Vertical Beds                x Vertical Cleavage  
 — B.S., Ballachulish Slide; S.A.C.S., Sgèrr a' Choise Slide.  
 + Exposures of attenuated Ballachulish Limestone  
 w Boundary of aureole within which the Ballachulish Limestone is represented by calc-silicate-hornfels

FIG. 8. Map showing outcrops in Callert district

4, Appin Quartzite (youngest); 5, Ballachulish Slates; 6, Ballachulish Limestone; 7, Leven Schists; 8, Glen Etive Quartzite; 9, Granite

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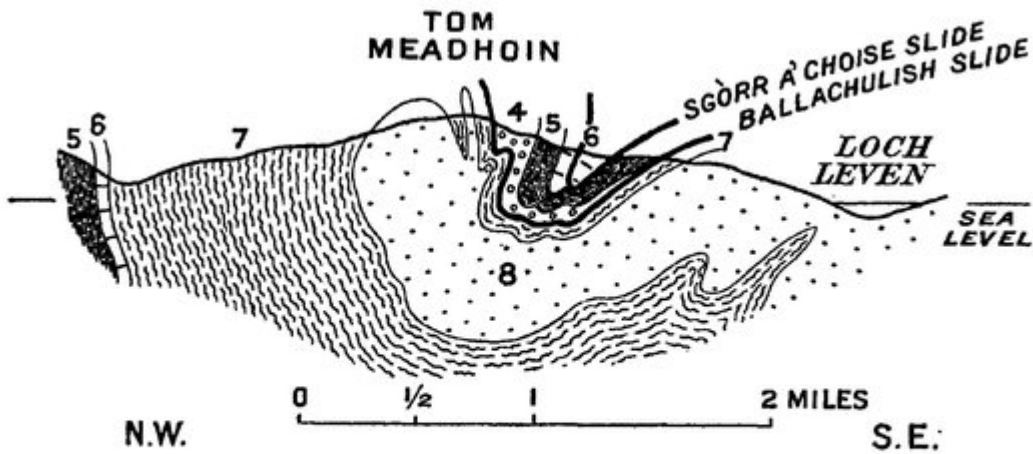


FIG. 9. Section across Fig. 8 showing the relation of the Ballachulish Slide to the Tom Meadhoin Antiform

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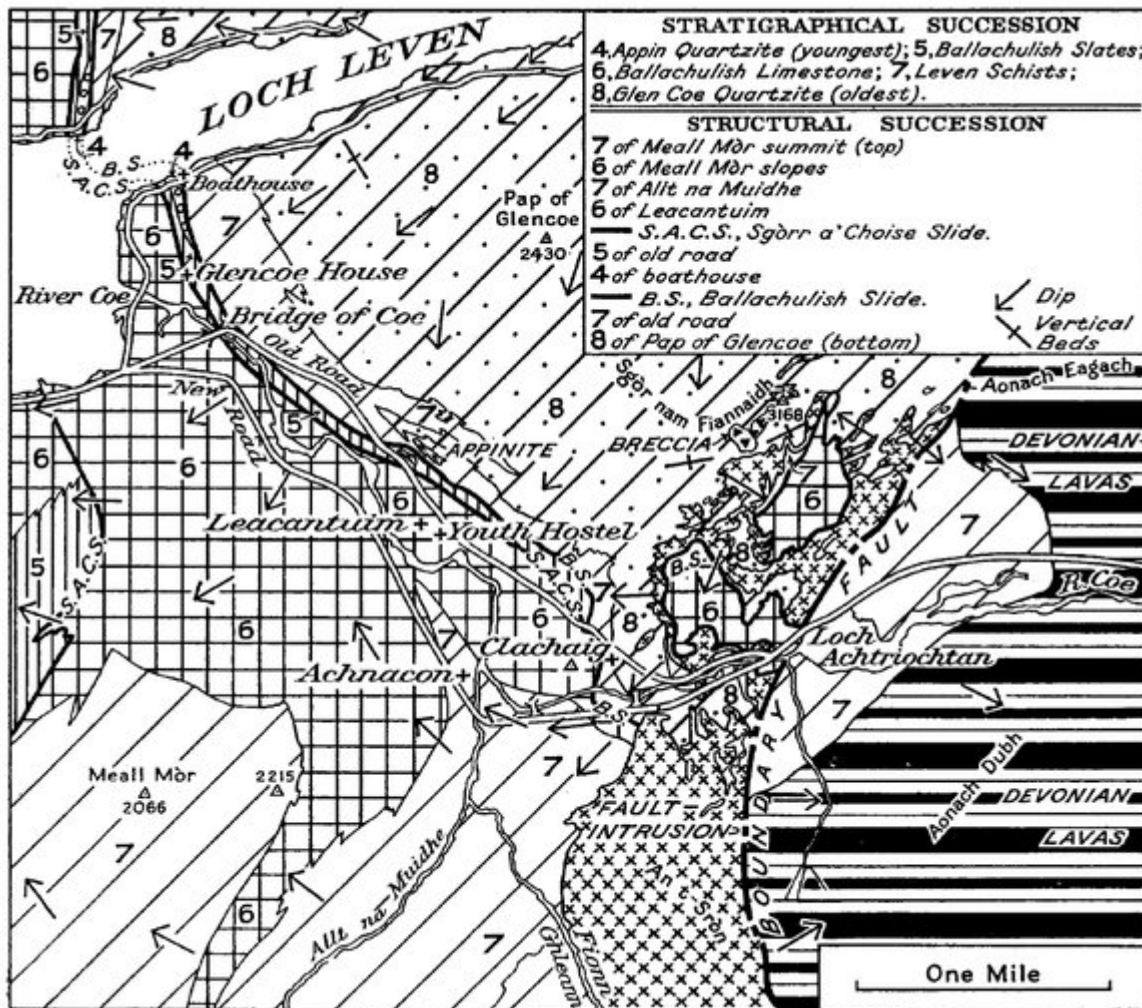


FIG. 10. Map of Lower Glen Coe

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FIG. 11. Sketch of Ballachulish Slide on S.W. side of Gleann Chàrnan

Calc-silicate-hornfels (Ballachulish Limestone) lying discordantly, through the intervention of the Ballachulish Slide, upon banded Leven Schists

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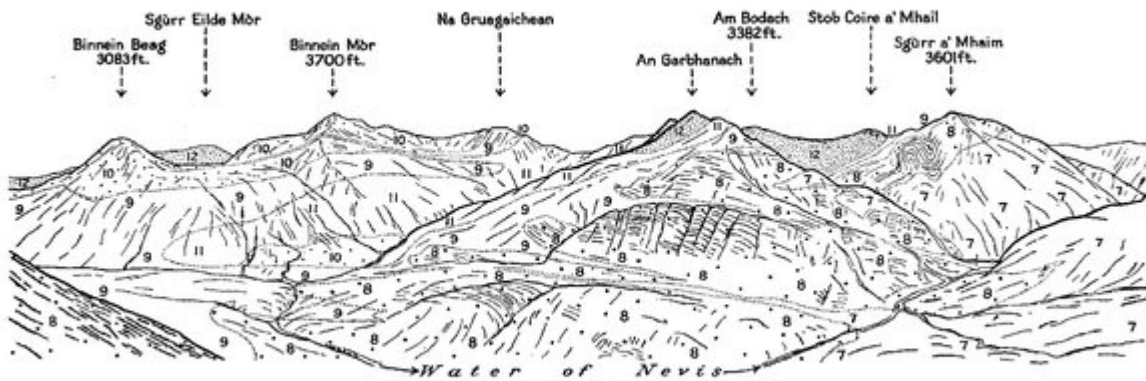


FIG. 12. View across Upper Glen Nevis, looking south

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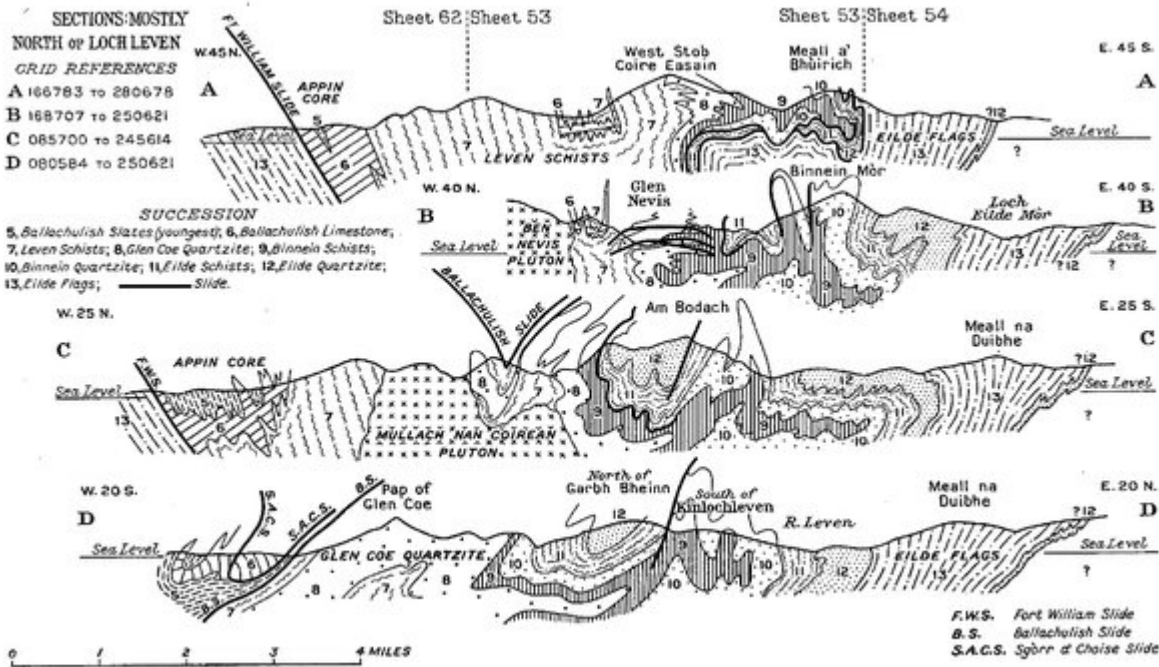


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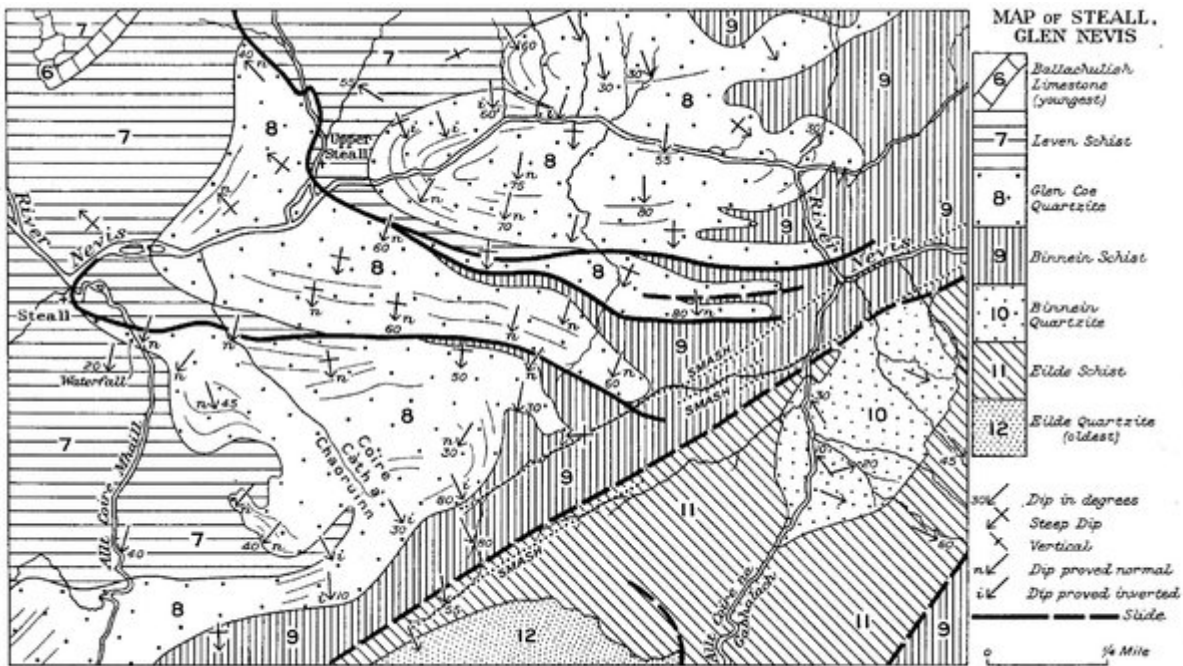


FIG. 16. Map of Steall, Glen Nevis

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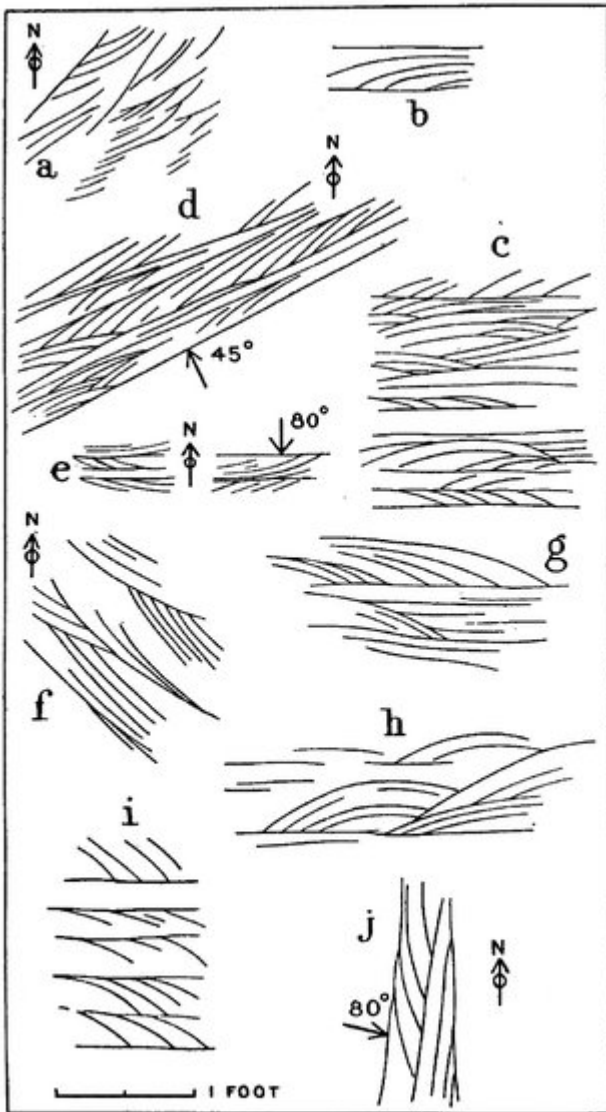


FIG. 13. Sketches of current-bedding

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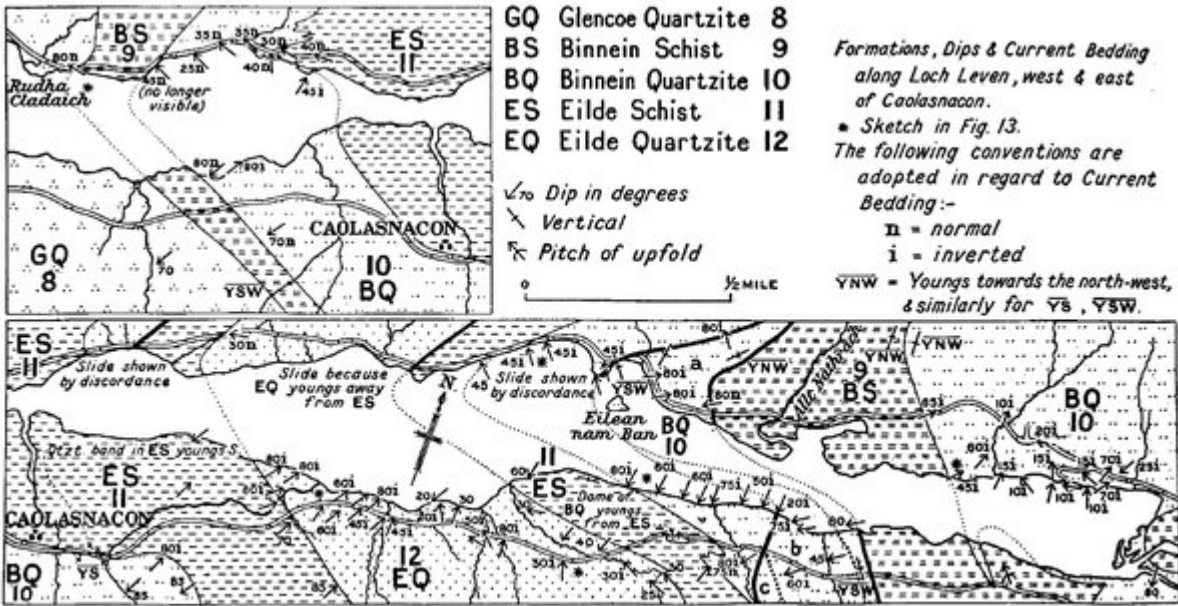


FIG. 15 (West above, east below). Formations, dip and current-bedding west and east of Caolasnacón

(Figure 15) (West above, east below). Formations, dip and current-bedding west and east of Caolasnacón.

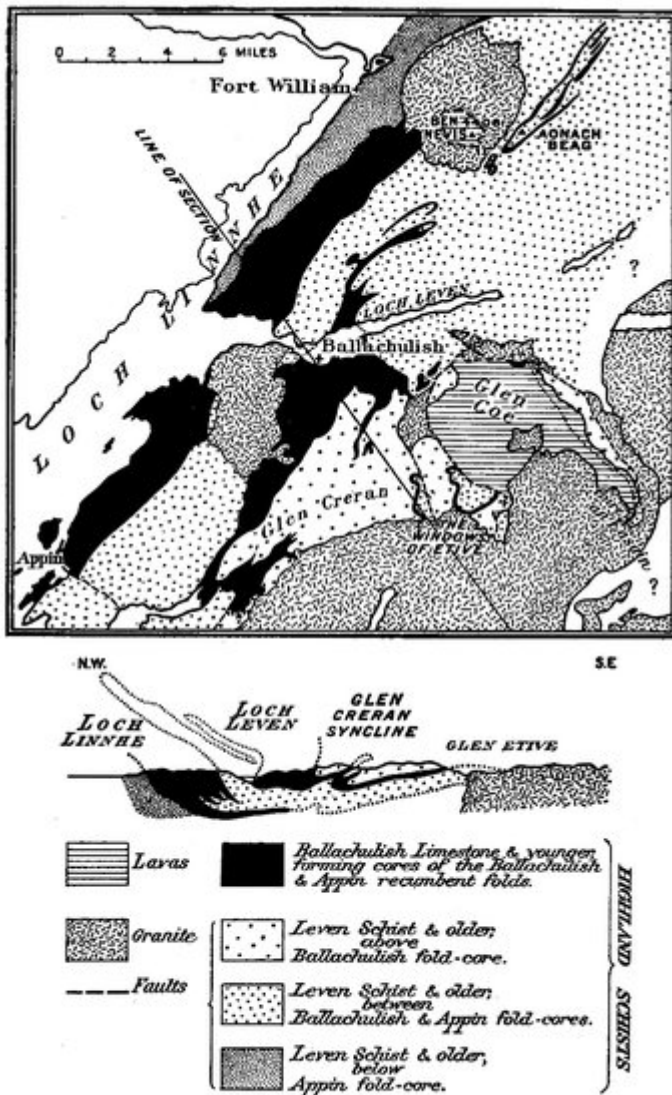


FIG. 17. Map and Section showing the structure of the Highland Schists and the positions of the cauldron-subsidences of Glen Coe and Ben Nevis

(Figure 17) Map and Section showing the structure of the Highland Schists and the positions of the cauldron-subsidences of Glen Coe and Ben Nevis.





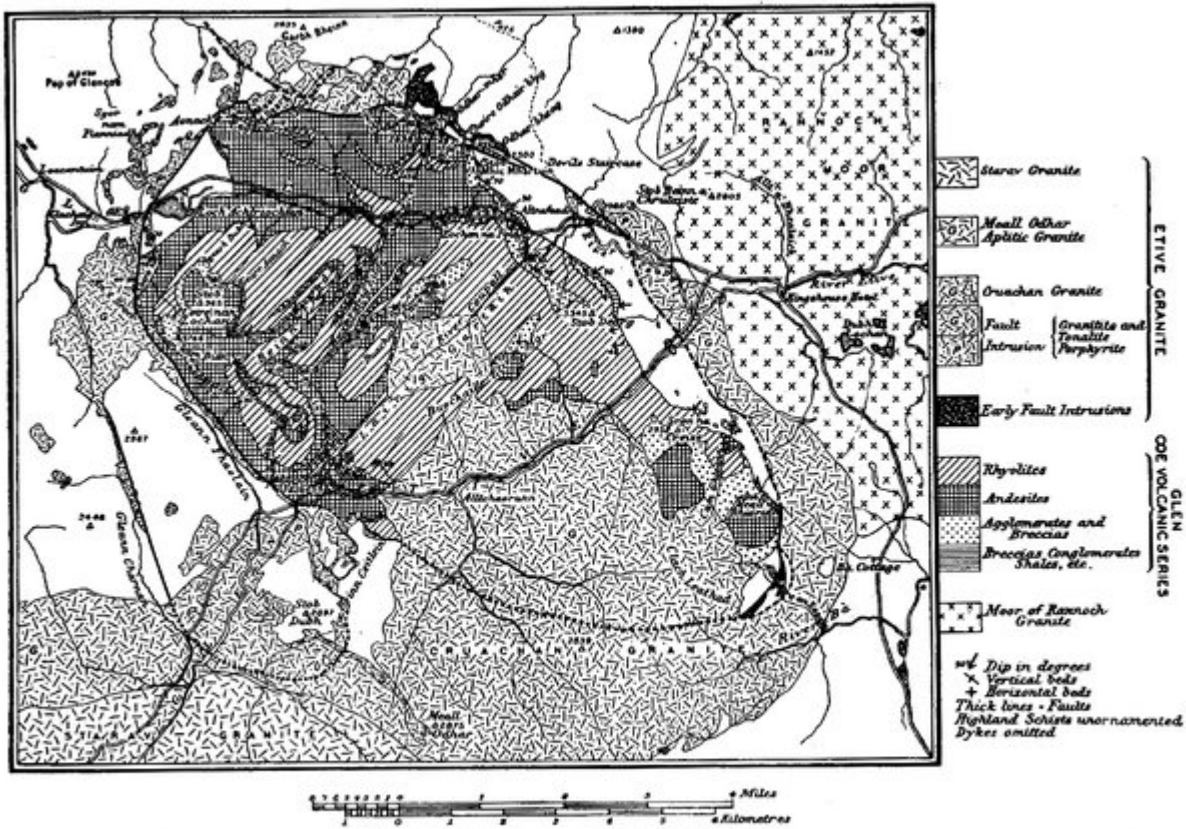


FIG. 19. Map of the Cauldron-Subsidence of Glen Coe and associated igneous phenomena  
For new road see Fig. 22

(Figure 19) Map of the Cauldron-Subsidence of Glen Coe and associated igneous phenomena. For new road see (Figure 22).

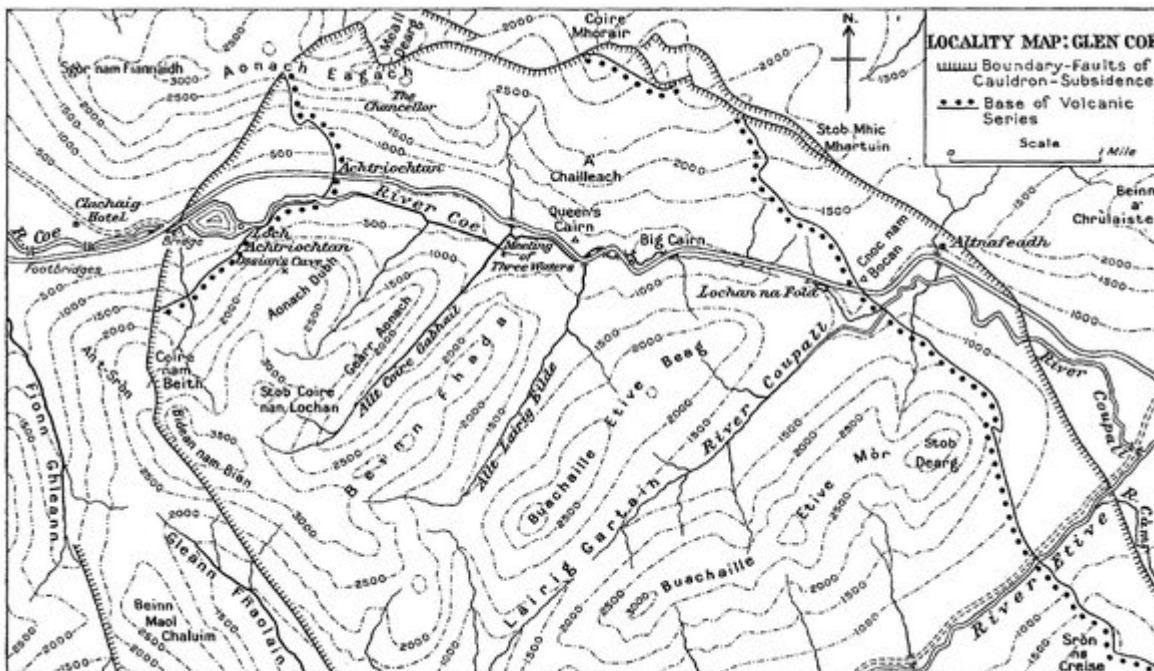


FIG. 22. Locality map : Glen Coe

(Figure 22) Locality map: Glen Coe.

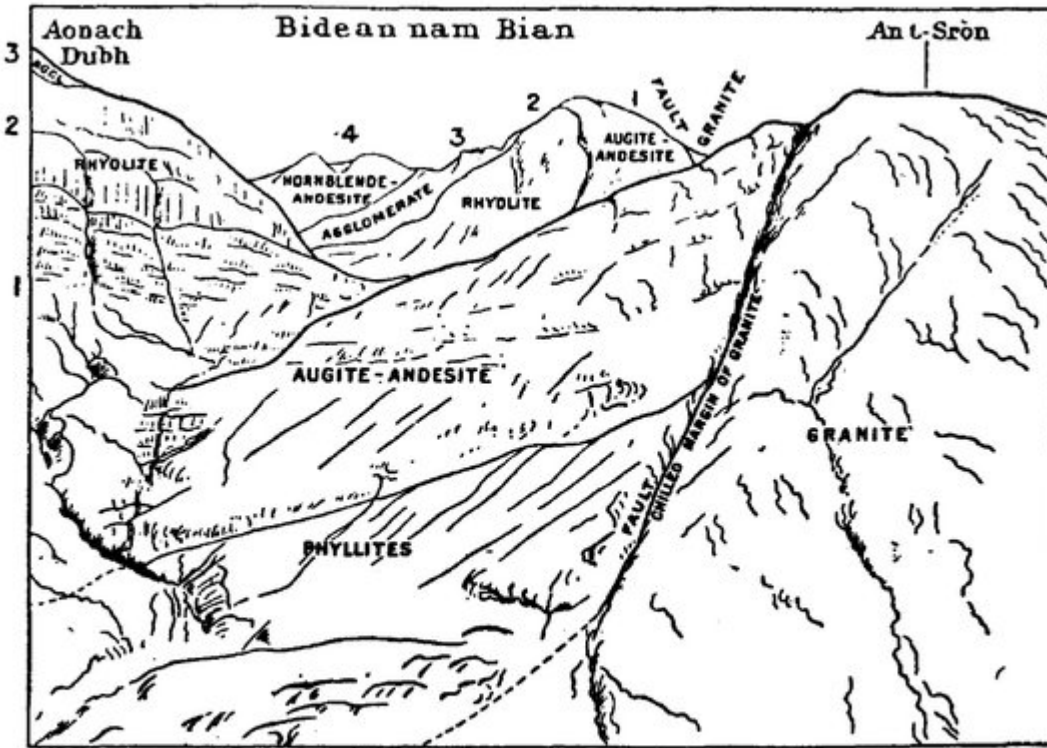


FIG. 20. View of Boundary-Fault of the Cauldron-Subsidence of Glen Coe as exposed in An t-Sròn

(Figure 20) View of Boundary-Fault of the Cauldron-Subsidence of Glen Coe as exposed in An t-Sròn.

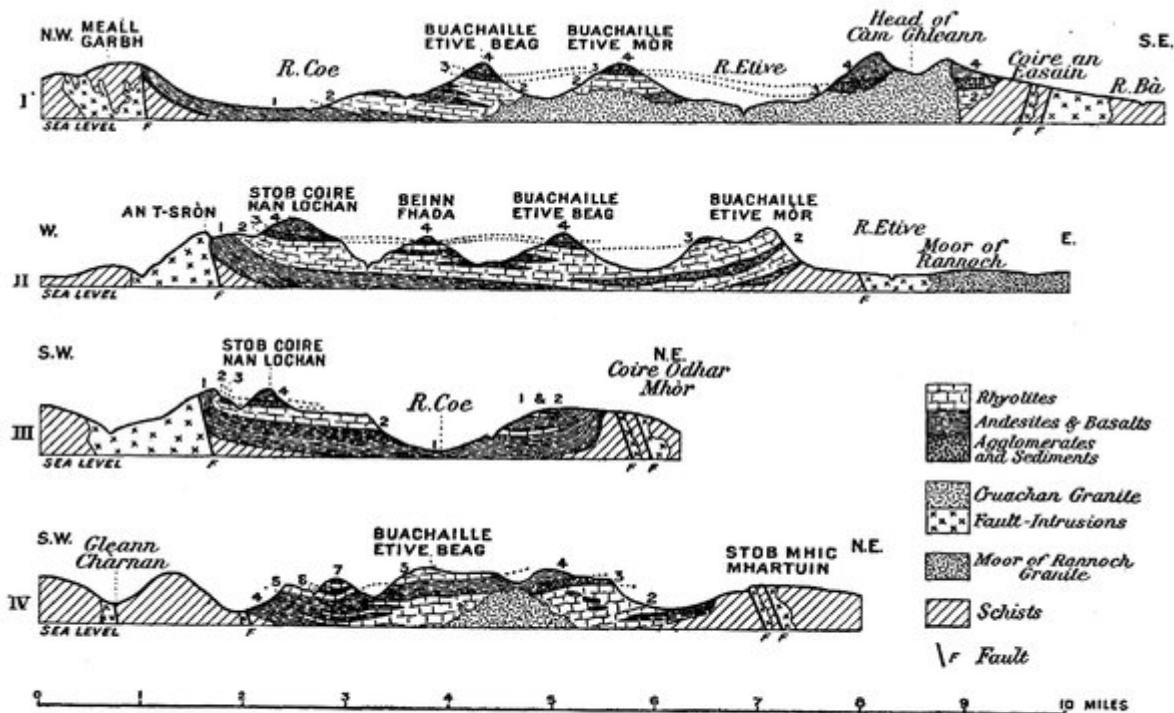


FIG. 21. Sections across the Cauldron-Subsidence of Glen Coe  
The numbers 1-7 refer to groups discussed in the text

(At Coire an Easain the boundary-faults incline outwards to S. E., not inwards as shown above)

(Figure 21) Sections across the Cauldron-Subsidence of Glen Coe The numbers 1-7 refer to groups discussed in the text  
(At Coire an Easain the boundary-faults incline outwards to S. E., not inwards as shown above).

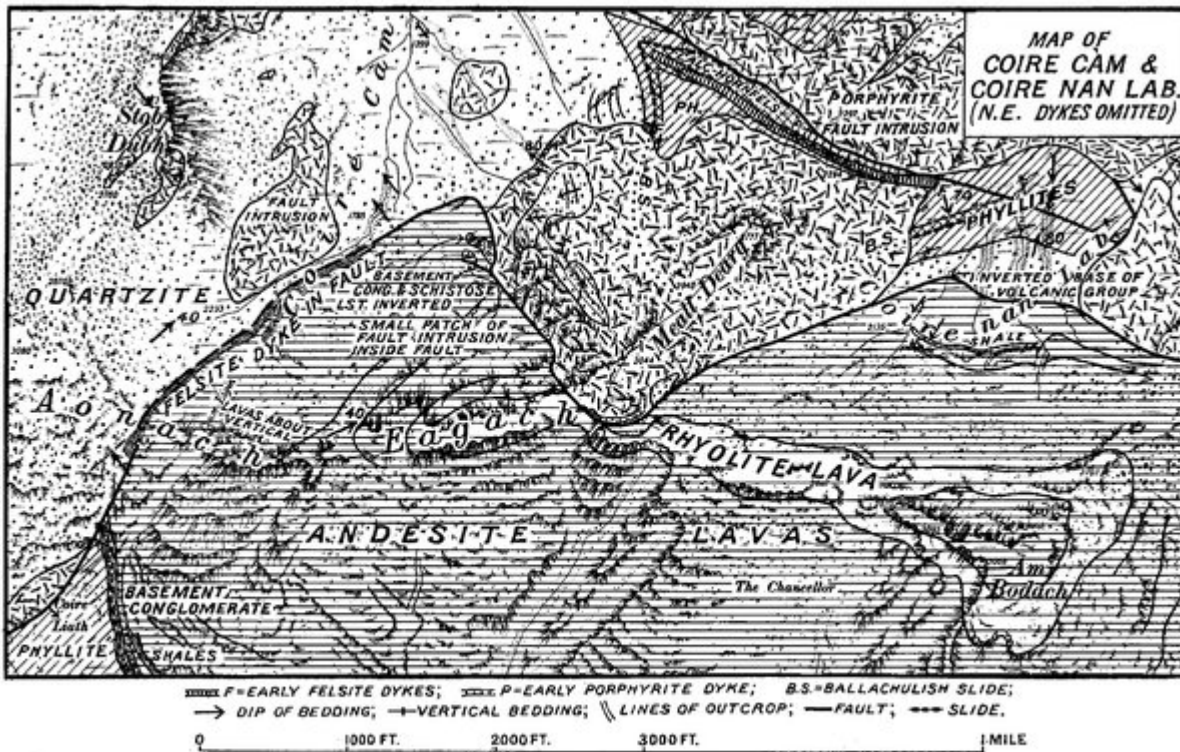


FIG. 23. Map of Coire Càrn and Coire nan Lab. North-east dykes omitted. (The Fault-Intrusion is chilled at its contact with the early dykes north of Meall Dearg)

(Figure 23) Map of Coire Càrn [NN 154 585] and Coire nan Lab [NN 167 584]. North-east dykes omitted. (The Fault-Intrusion is chilled at its contact with the early dykes north of Meall Dearg [NN 163 585]).

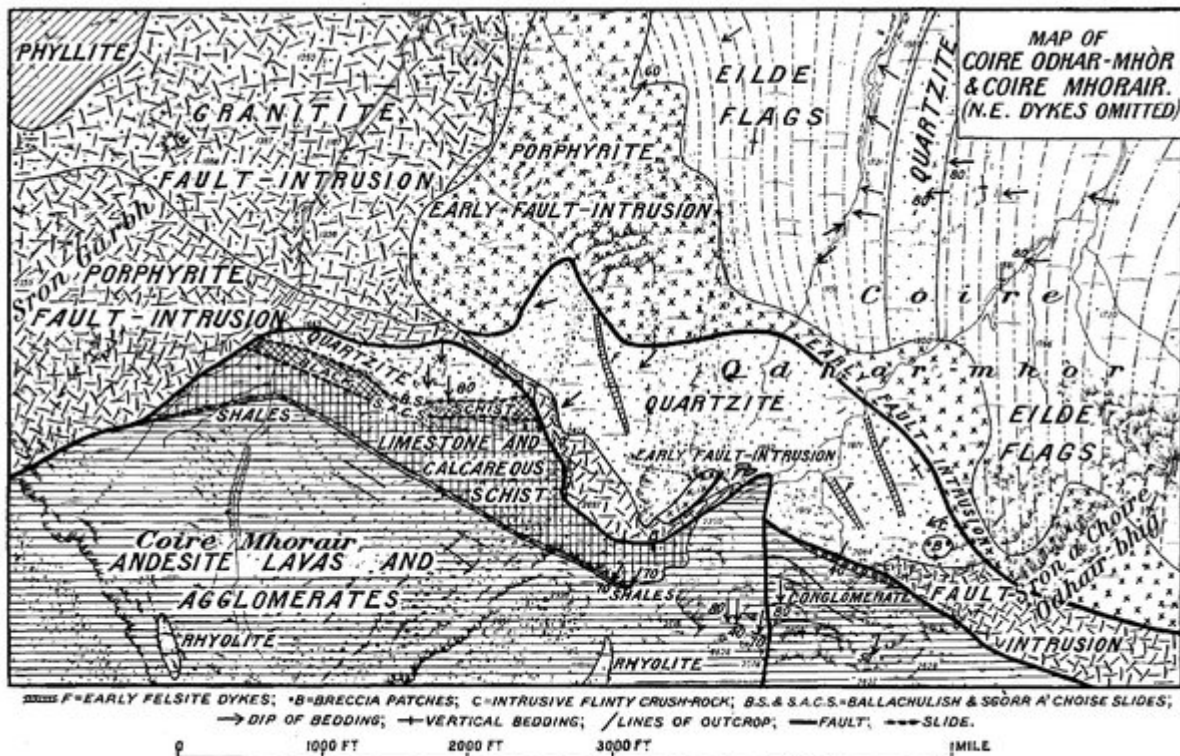


FIG. 24. Map of Coire Mhorair and Coire Odhar-mhòr

(Figure 24) Map of Coire Mhorair and Coire Odhar-mhòr [NN 196 583].

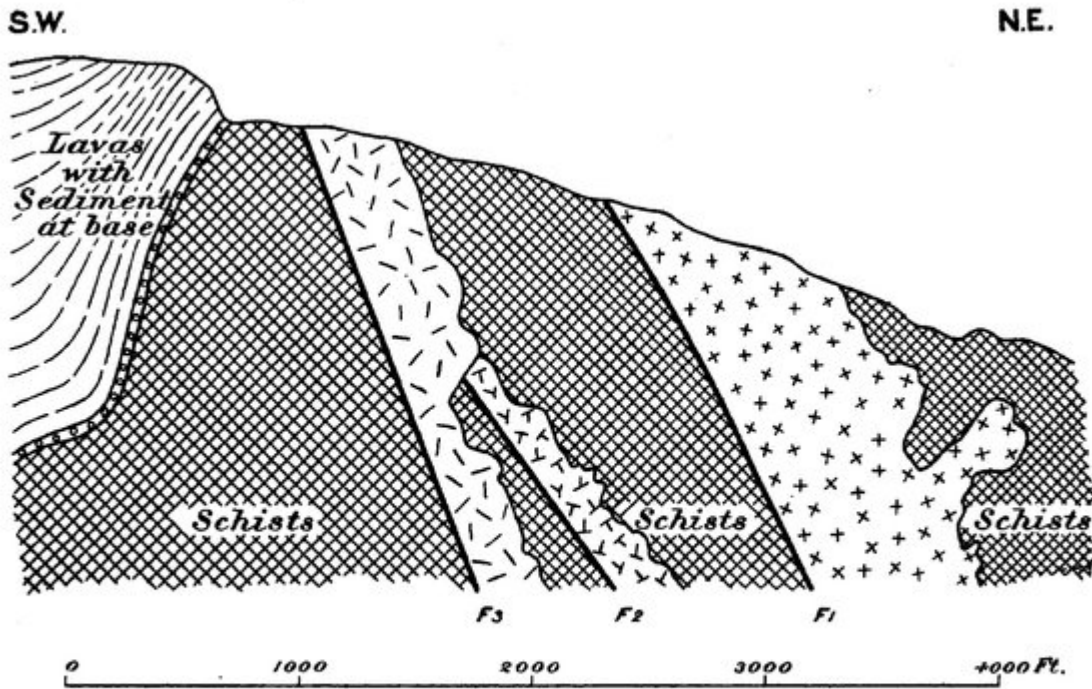


FIG. 25. Section through ridge W. of Coire Odhar-mhòr

F1 and F2 Early Boundary-Faults accompanied by Early Fault-Intrusions. F3 Main Boundary-Fault with Main Fault-Intrusion

(Figure 25) Section through ridge W. of Coire Odhar-mhòr [NN 196 583] F1 and F2 Early Boundary-Faults accompanied by Early Fault-Intrusions. F3 Main Boundary-Fault with Main Fault-Intrusion.

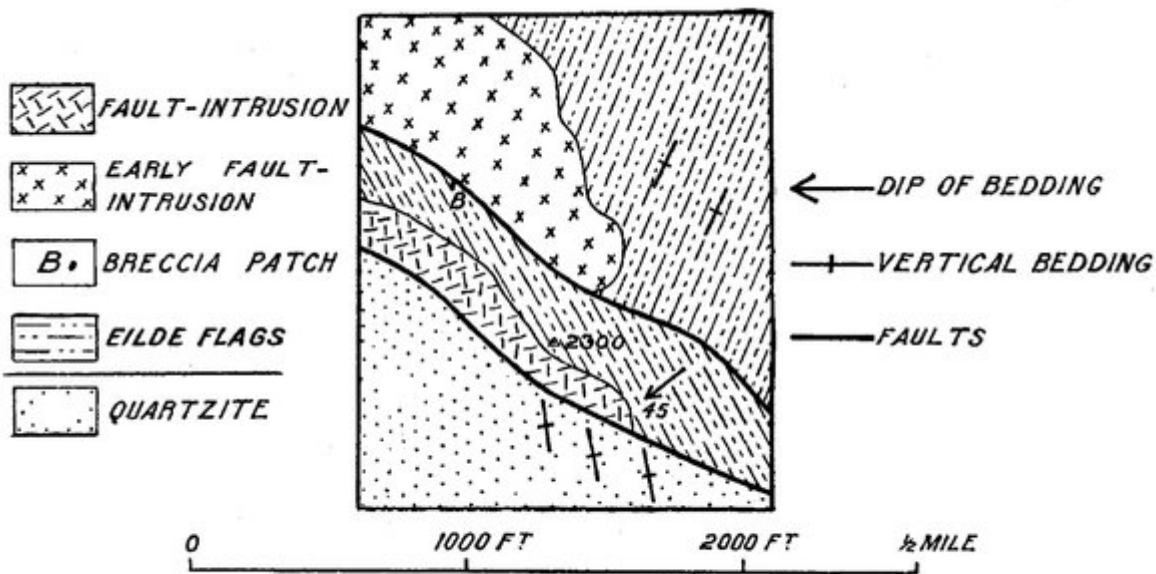


FIG. 26. Map of Stob Mhic Mhartuin. North-east dykes omitted

(Figure 26) Map of Stob Mhic Mhartuin [NN 207 575]. North-east dykes omitted.

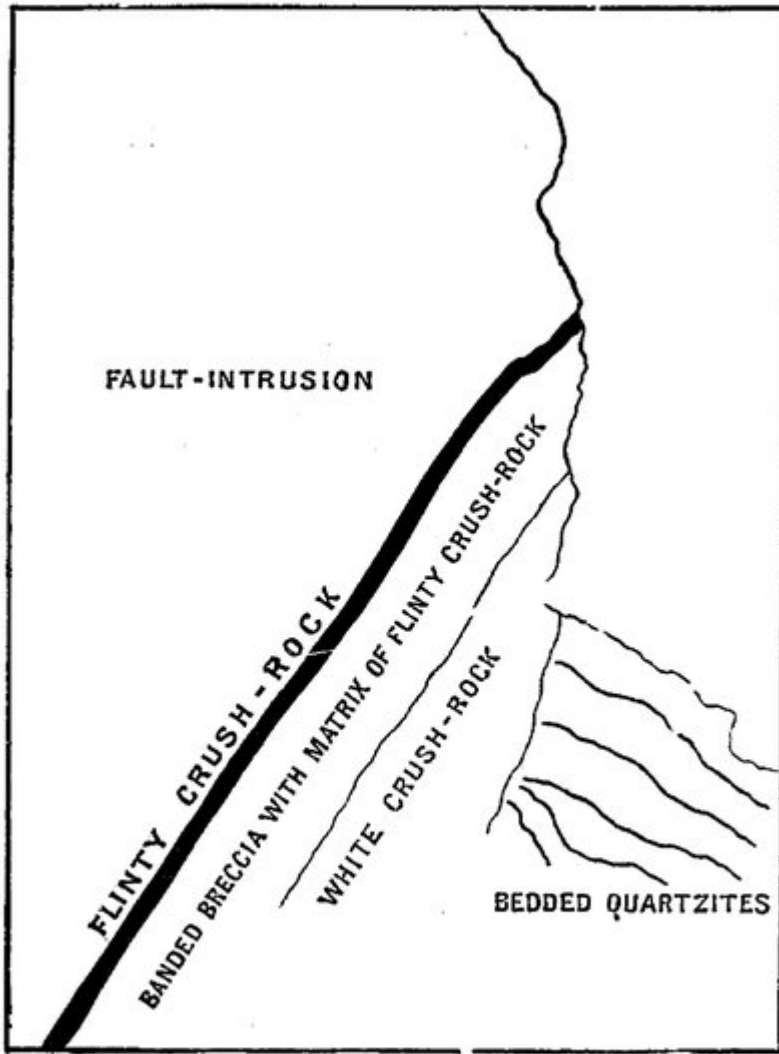


FIG. 27. Diagram explaining Pl. IX

(Figure 27) Diagram explaining (Plate 9). [Glen Coe Fault, Stob Mhic Mhartuin [NN 207 575].].





*(Plate 9) Glen Coe Fault, Stob Mhic Mhartuin [NN 207 575].*

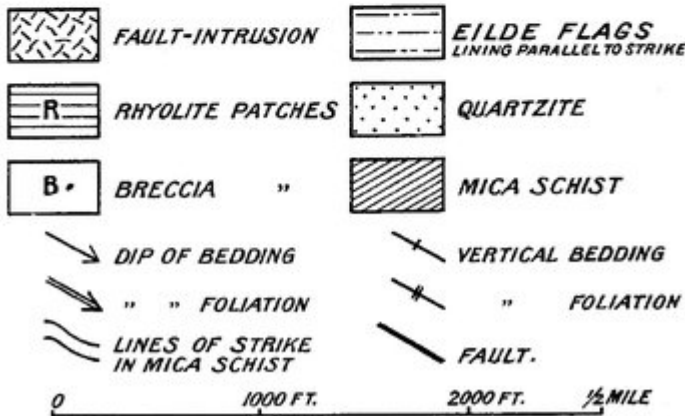
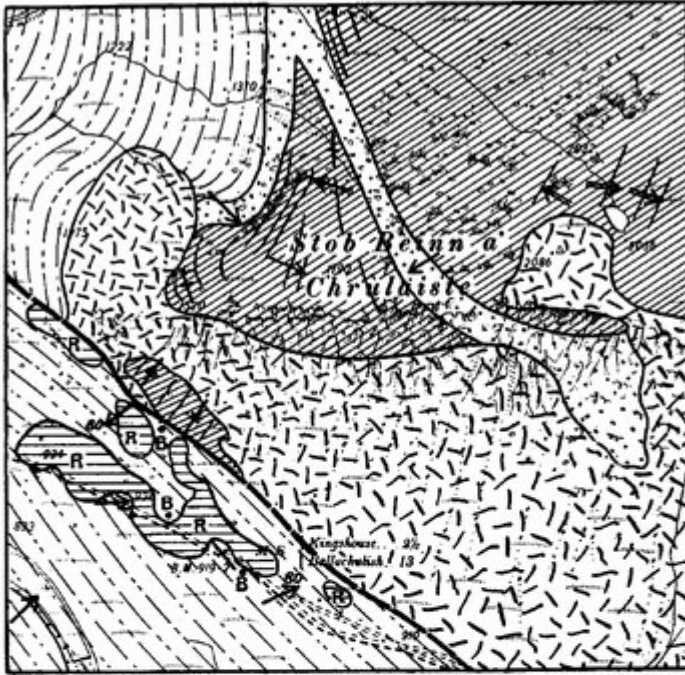


FIG. 28. Map of Stob Beinn a' Chrùlaiste. North-east dykes omitted

(Figure 28) Map of Stob Beinn a' Chrtilaiste. North-east dykes omitted.





(Figure 30) Diagram of subaerial and subterranean cauldron-subsidences accompanied by volcanic and plutonic accumulations of igneous rocks.

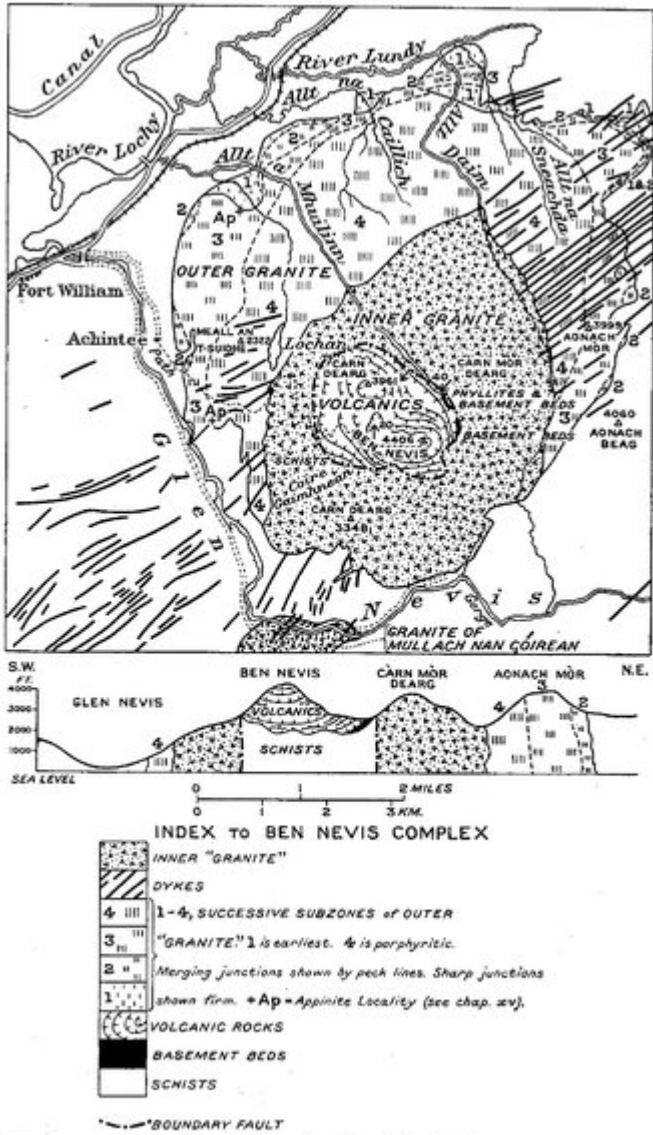


FIG. 31. Map and section of Ben Nevis

(Figure 31) Map and section of Ben Nevis.

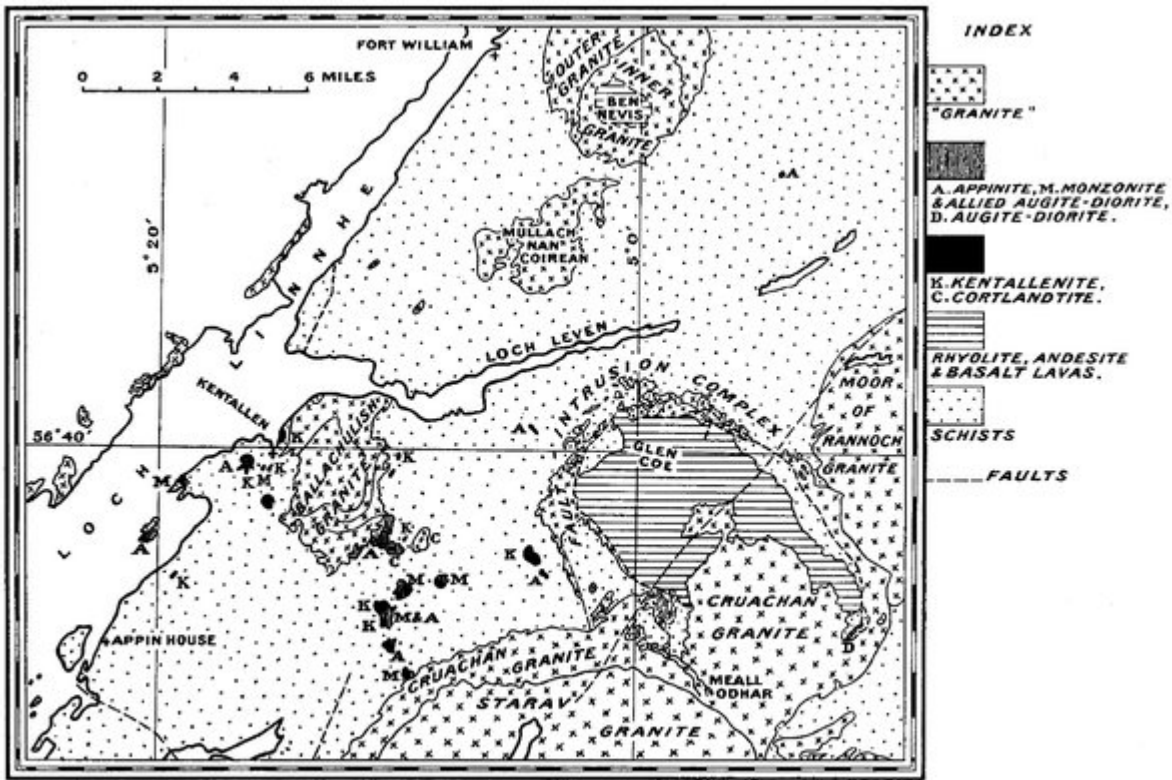


FIG. 32. Map of plutonic and volcanic rocks of Sheet 53 referred to the Lower Old Red Sandstone Period

(Figure 32) Map of plutonic and volcanic rocks of Sheet 53 referred to the Lower Old Red Sandstone Period.

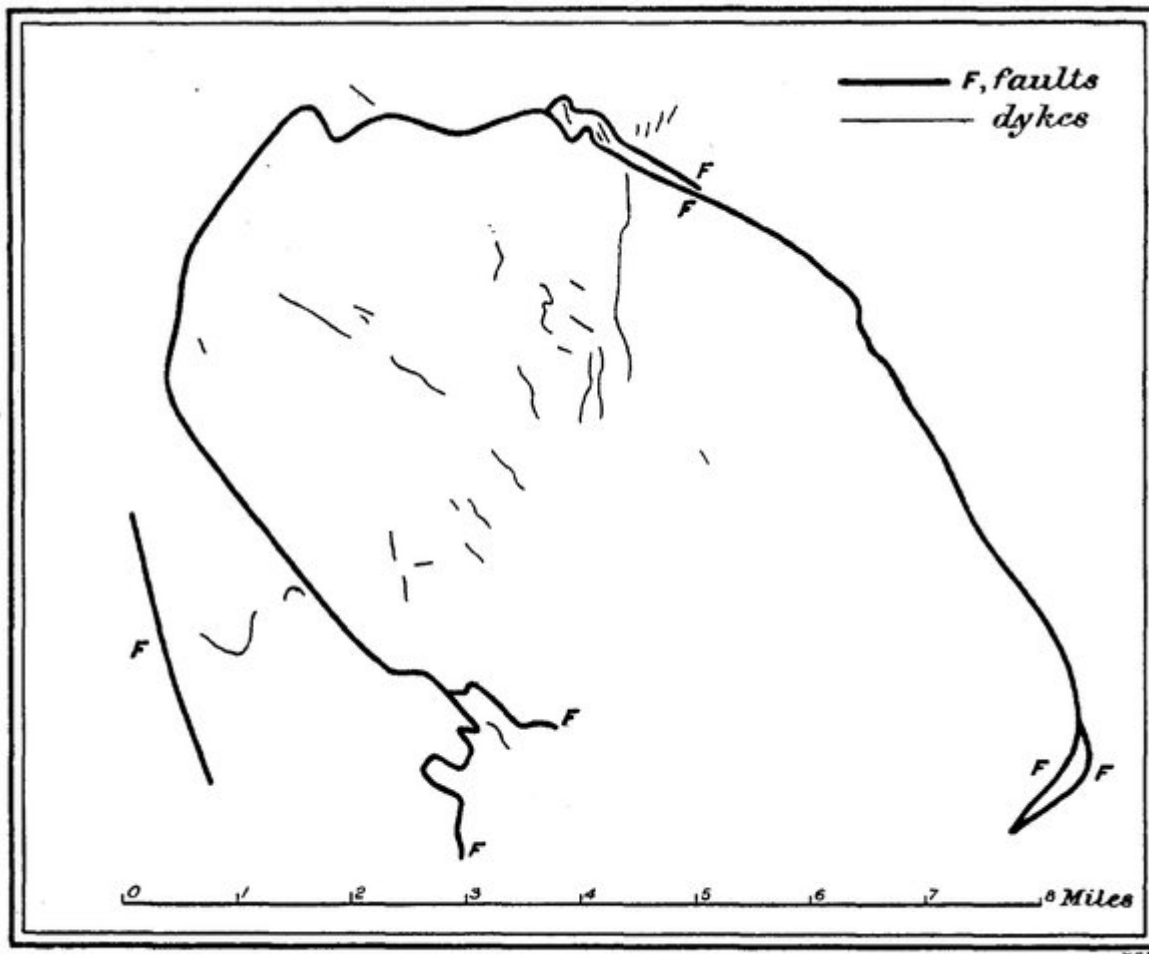


FIG. 33. Map of early felsite and andesite dykes of Glen Coe

(Figure 33) Map of early felsite and andesite dykes of Glen Coe.

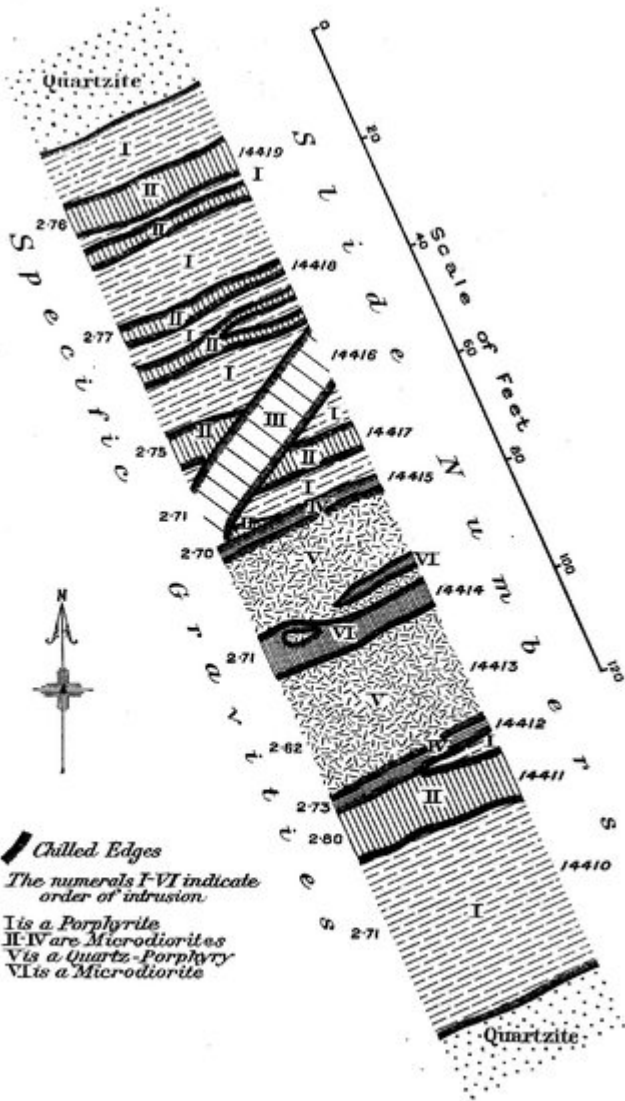


FIG. 34. Map of multiple dyke in the bed of Allt Fhaolain,  $\frac{1}{2}$  mile above the bridge, Glen Etive

(Figure 34) Map of multiple dyke in the bed of Allt Fhaolain [NN 158 510],  $\frac{1}{2}$  mile above bridge, Glen Etive.

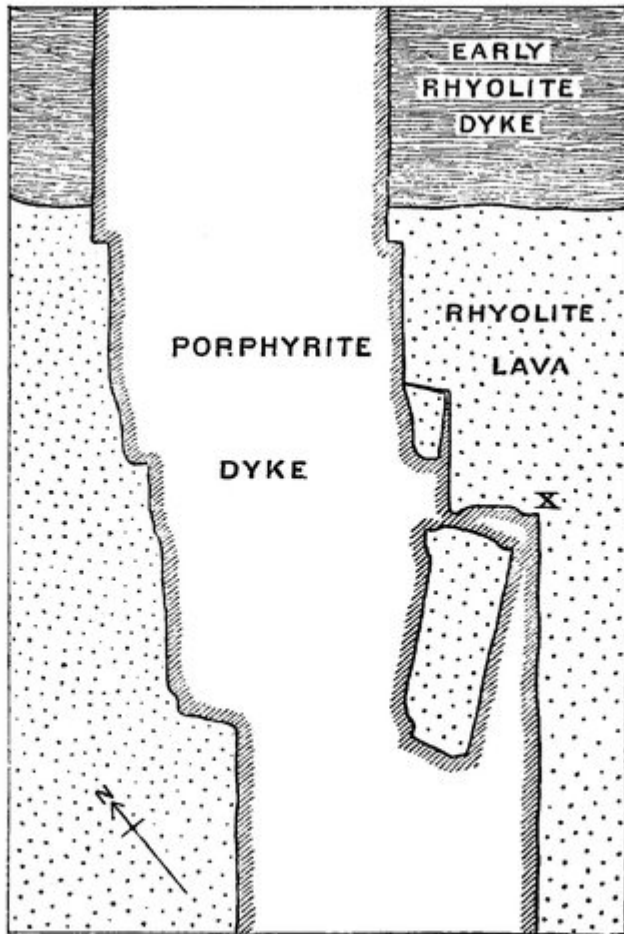
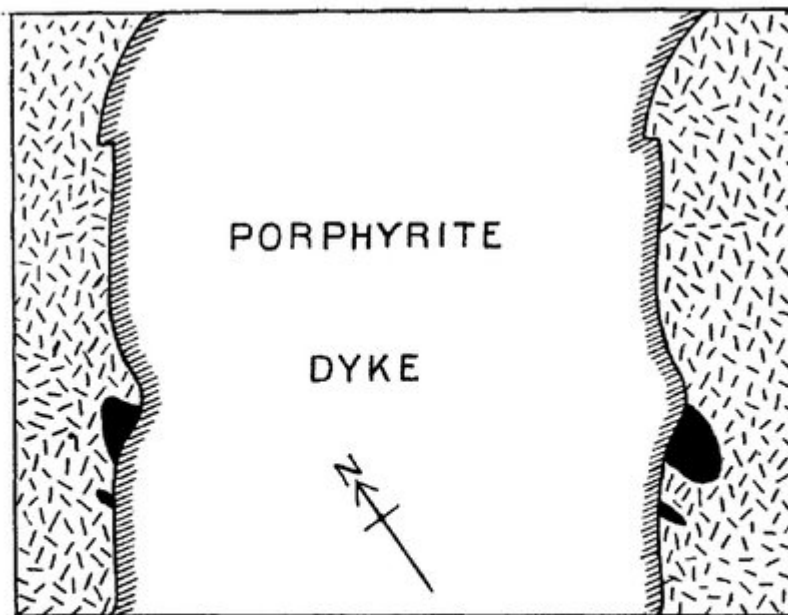


FIG. 35. Map of porphyrite dyke traversing rhyolites at the foot of the northern front of Buachaille Etive Beag

The walls of country-rock are counterparts the one of the other

(Figure 35) Map of porphyrite dyke traversing rhyolites at the foot of the northern front of Buachaille Etive Beag [NN 192 548]. The walls of country-rock are counterparts the one of the other.



(about  $\frac{1}{25}$  natural size)

FIG. 36. Map of porphyrite dyke traversing Moor of Rannoch "Granite" in bed of River Etive, 500 yd above Kingshouse (Sheet 54, Geol.)

Two basic lumps have been bisected

(Figure 36) Map of dyke, River Etive, bisecting two basic lumps in Moor of Rannoch "Granite" in bed of River Etive 500 yd above Kinghouse (Sheet 54, Geol.) Two basic lumps have been bisected.

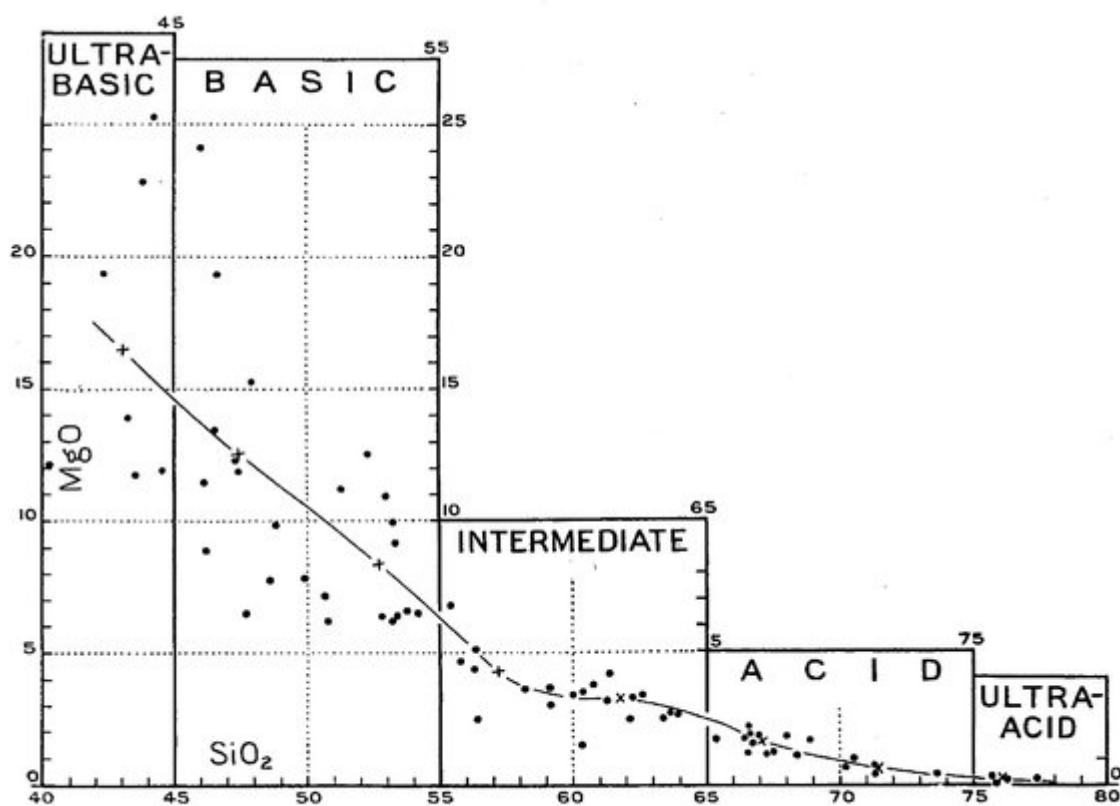


FIG. 37. Graph comparing MgO and SiO<sub>2</sub> percentages of individual Devonian igneous rocks of South-West Highlands. Crosses correspond with averages used in Fig. 37

(Figure 37) Graph comparing MgO and SiO<sub>2</sub> percentages of individual Devonian rocks of S.W. Highlands. Crosses correspond with averages used in (Figure 37).

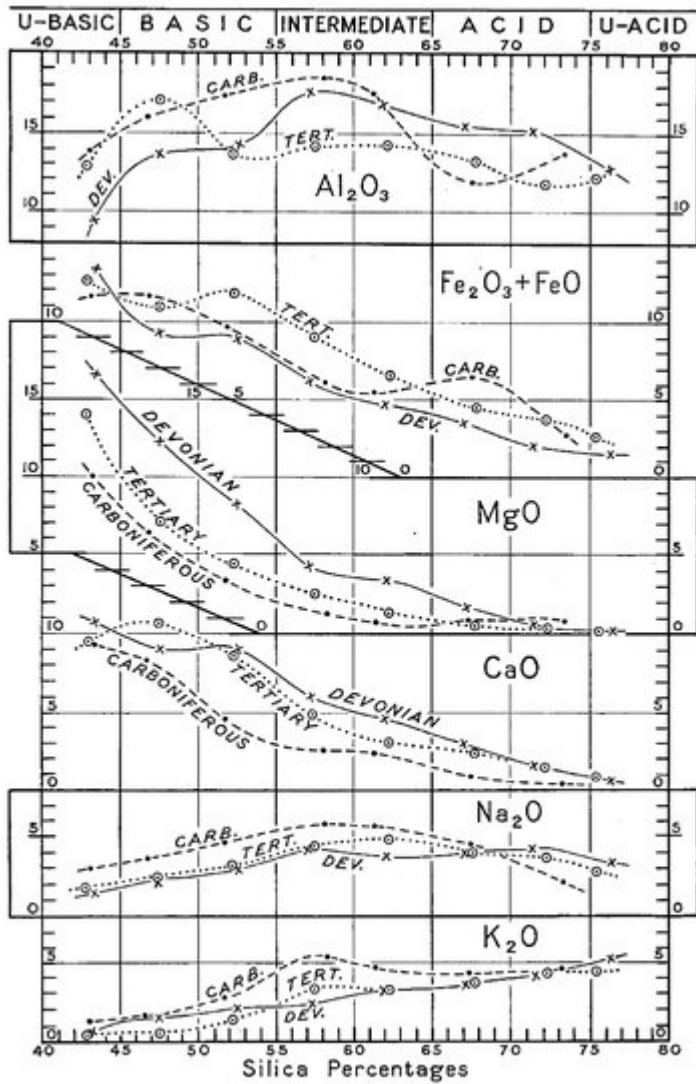


FIG. 38. Graphs comparing average analyses of igneous rocks spaced according to SiO<sub>2</sub> percentages. Tertiary and Carboniferous for all Scotland, Devonian for South-West Highlands

(Figure 38) Graphs comparing average analyses of Scottish Tertiary, Carboniferous and Devonian igneous rocks, the last-named restricted to S.W. Highlands.

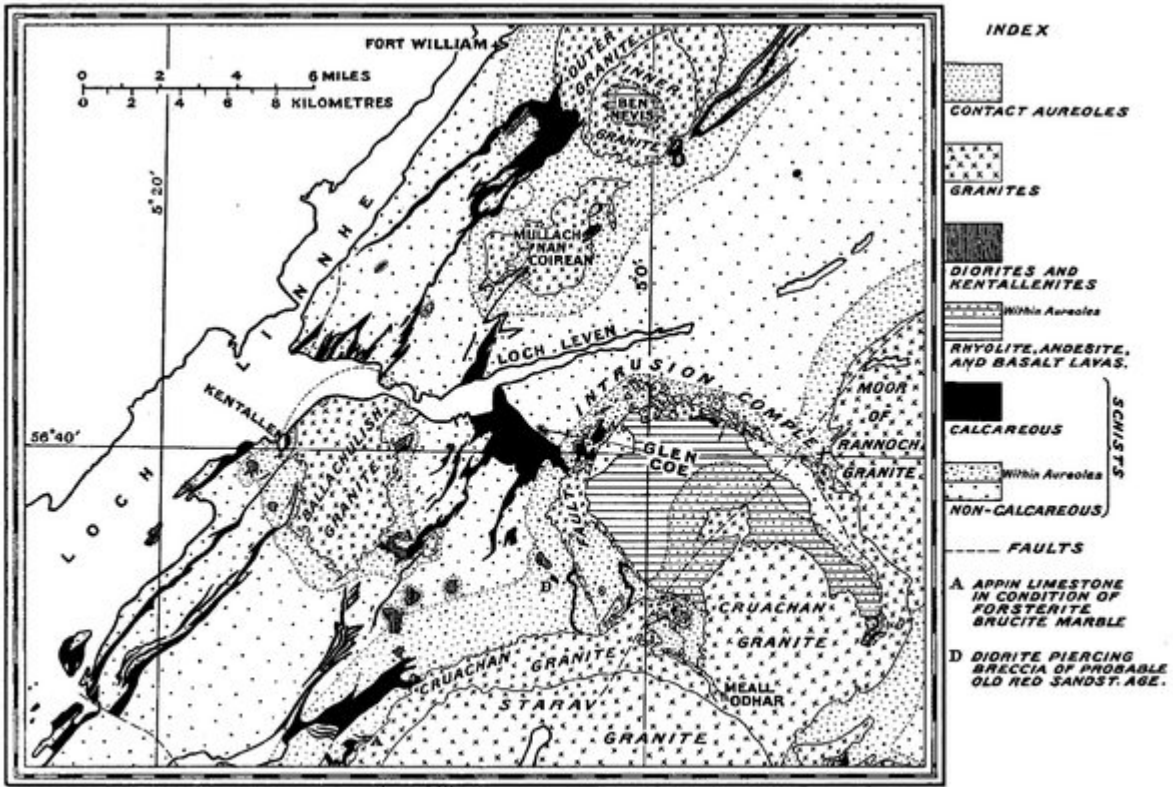


FIG. 39. Map of contact-aureoles south-east of Loch Linnhe  
 The limits drawn include alteration sufficiently intense to convert impure limestone into calc-silicate-hornfels

(Figure 39) Map of contact-aureoles south-east of Loch Linnhe. The limits drawn include alteration sufficiently intense to convert impure limestone into calc-silicate-hornfels.

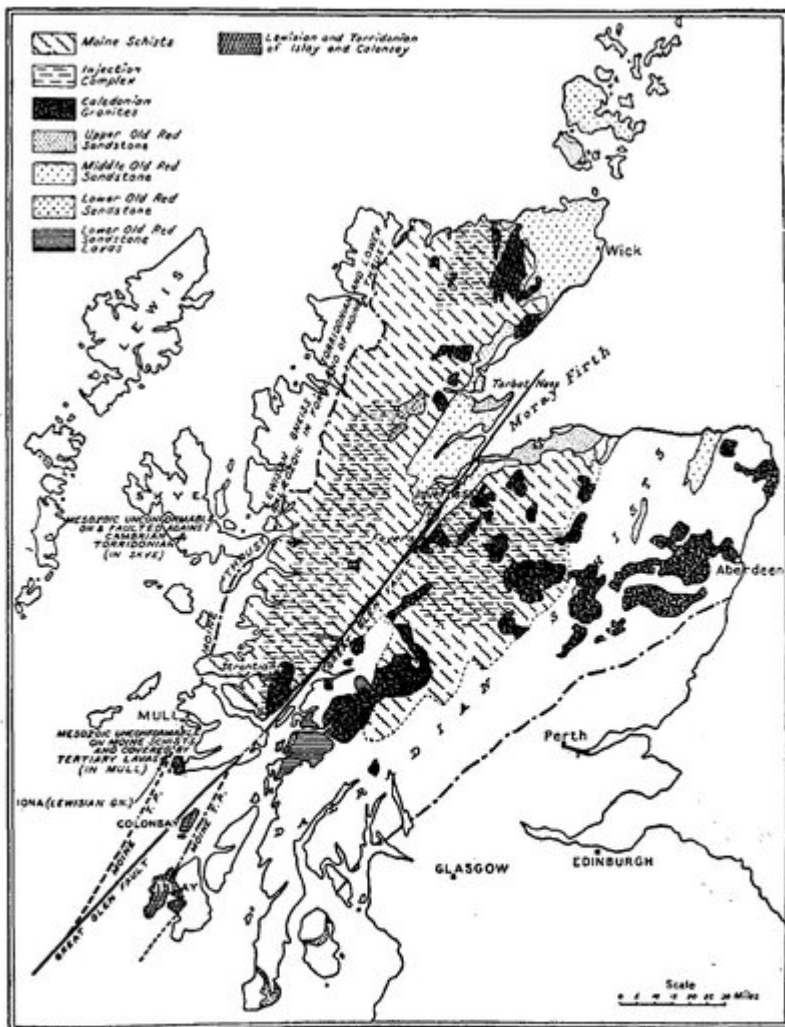


FIG. 40. Geological map of the Scottish Highlands to show the present position of the Moine injection complexes, the Strontian and Foyers granites, and the Moine Thrust-plane, after W. Q. Kennedy

(Reproduced, by permission, from *Quart. Journ. Geol. Soc.*, vol. cii, pt.i, 1946, fig. 2)

(Figure 40) Geological map of the Scottish Highlands to show the present position of the Moine injection complexes, the Strontian and Foyers granites, and the Moine Thrust-plane, after W. Q. Kennedy (Reproduced, by permission, from *Quart. Journ. Geol. Soc.*, vol. cii, pt.i, 1946, fig. 2).



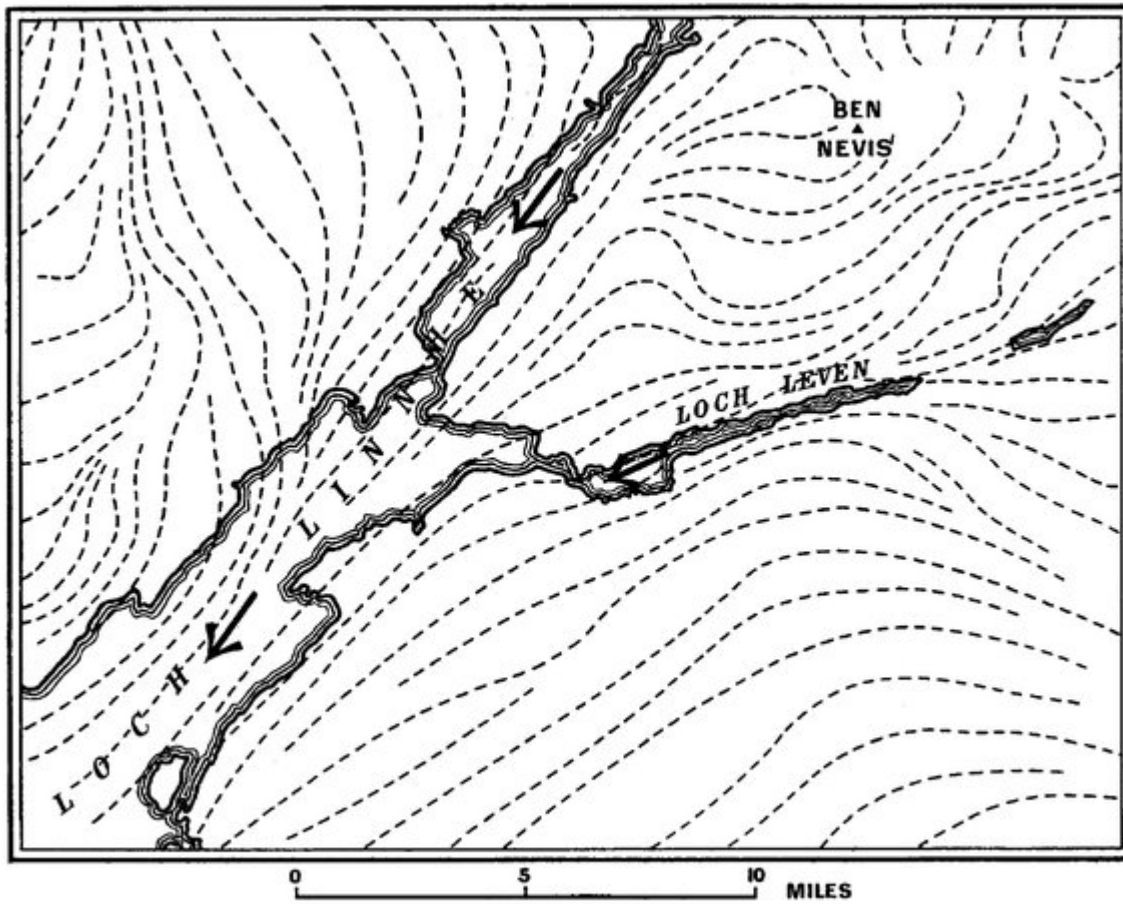


FIG. 41. Map of glacial flow-lines during the maximum stage of glaciation

(Figure 41) Map of glacial flow-lines during the maximum stage of glaciation.



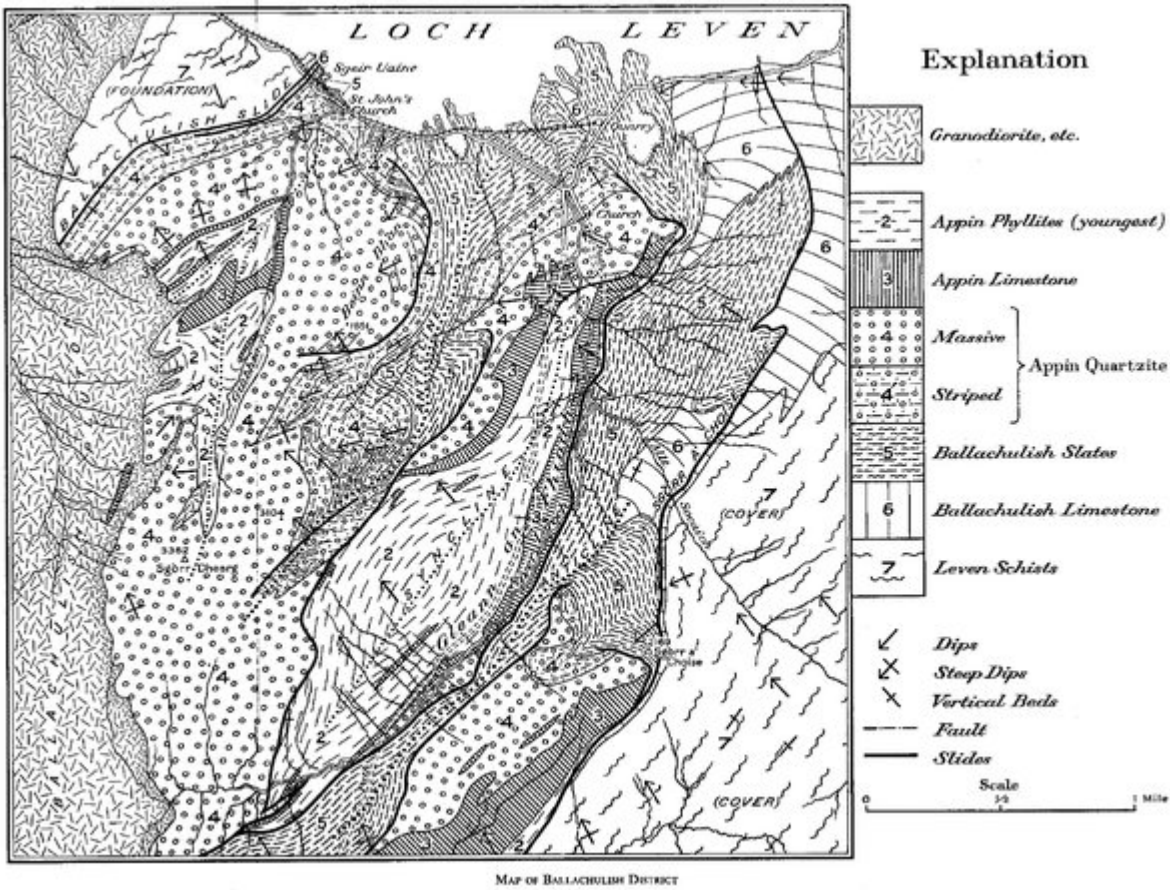
(Plate 1) Ben Nevis with hanging corrie and River Nevis [NN 200 680] disappearing into Nevis Gorge.



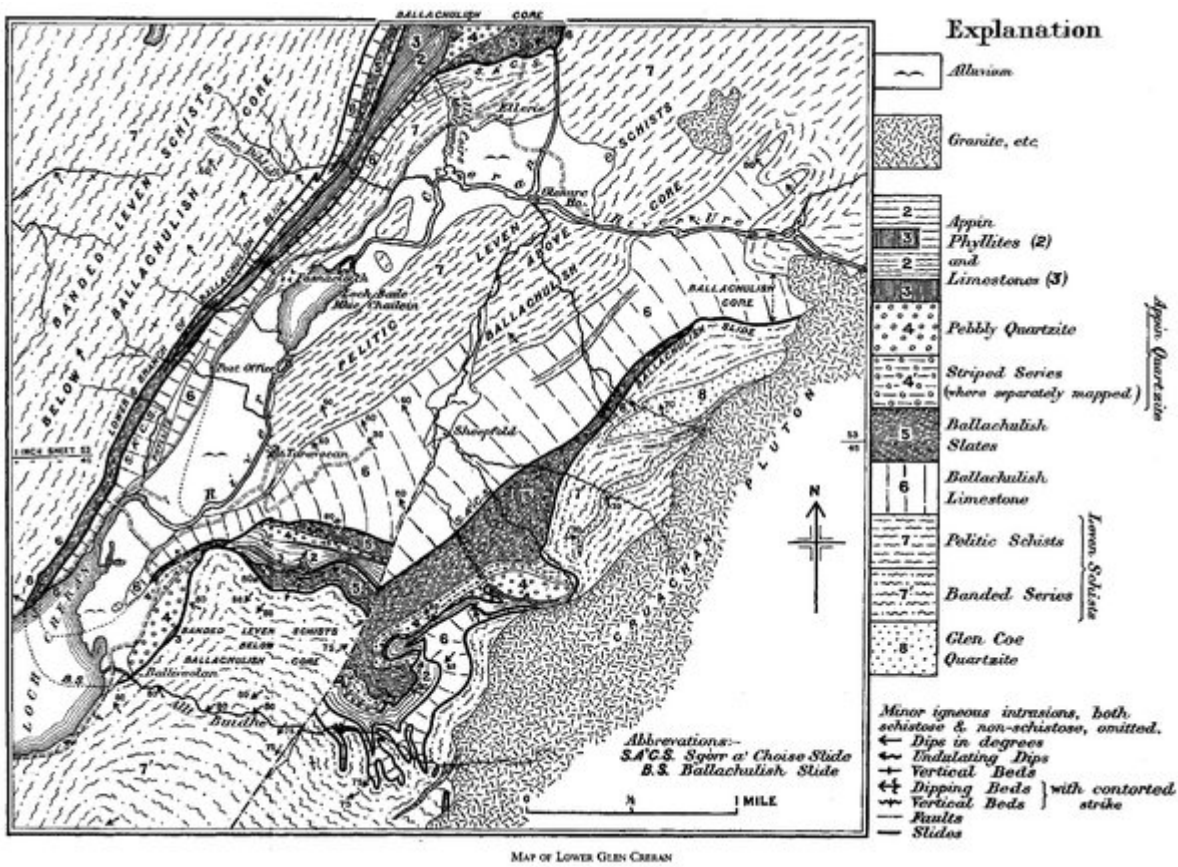
1. HANGING PORTION OF RIVER LEVEN WITH DAM SITE OF BLACKWATER RESERVOIR



(Plate 2) 1. Hanging portion of River Leven with dam site of Blackwater Reservoir [NN 250 605]. 2. Stob Bàn, Near Watershed of Lairigmòr Valley, showing comparatively recent landslide.



(Plate 3) Map of Ballachulish District.



(Plate 4) Map Of Lower Glen Creran.



*(Plate 5) Sgùrr A' Mhàim across Allt Coire A' Mhail Folded Glen Coe Quartzite.*



*(Plate 6) Gearr Aonach [NN 160 555] And Aonach Dubh: Glen Coe "sisters" Largely rhyolite lavas.*



*(Plate 7) Melting of Three Waters, Glen Coe; and Rock-Fall, Allt Core Gabhail.*

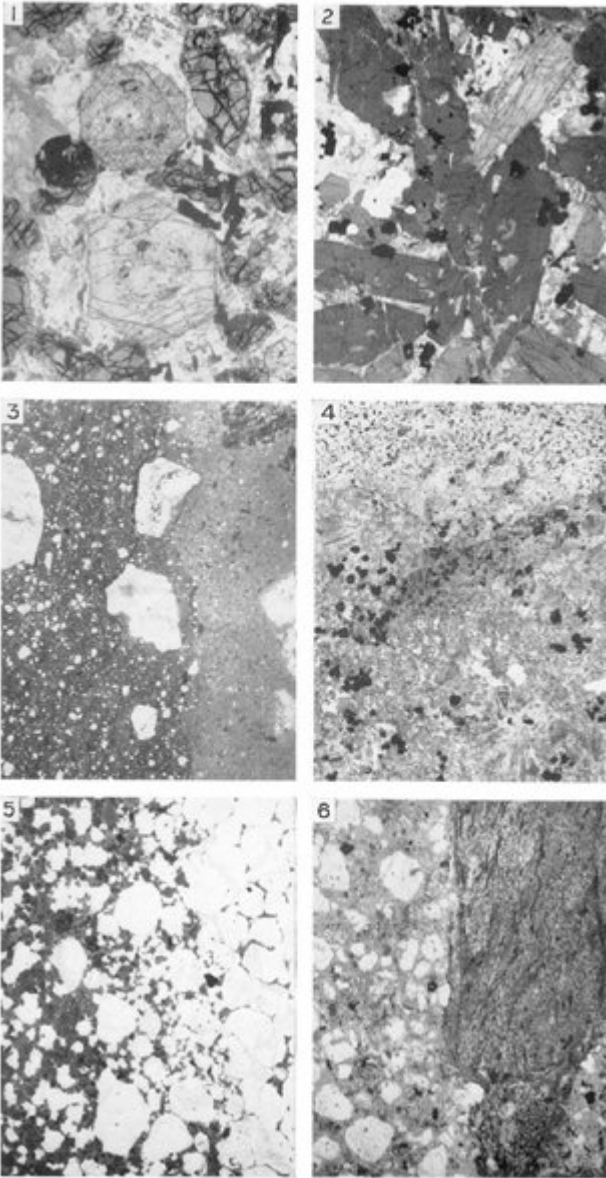




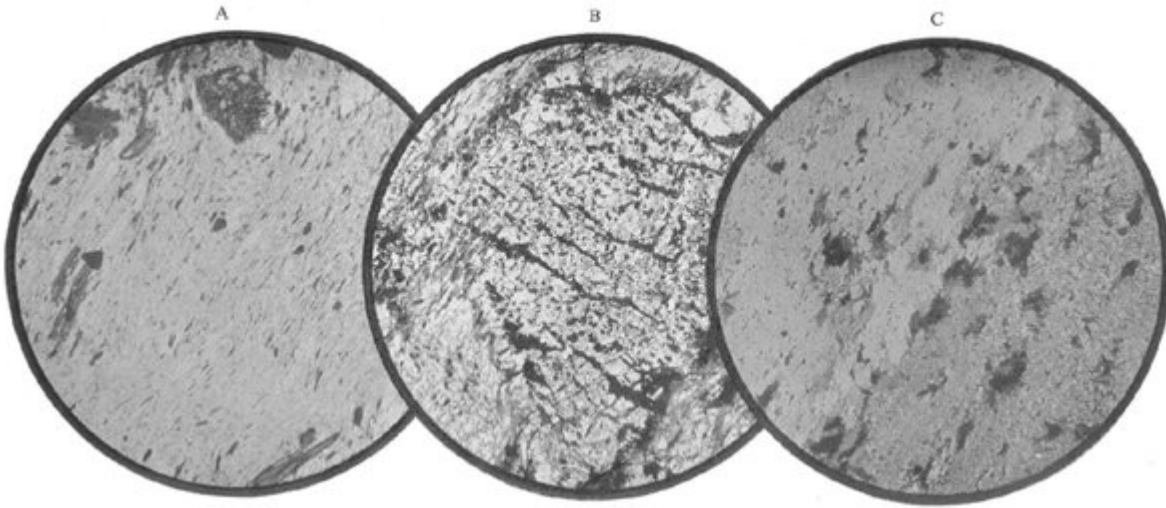
*(Plate 8) Stob Dearg Rhyolite lavas (crag) on schists (grass covered). Fossils at +.*



*(Plate 10) Allt a' Mhuilinn [NN 161 730]: Ben Nevis Volcanics on right, and Inner "Granite" on left, meeting in stream.*



(Plate 11) Photomicrographs of Kentallenite, Appinite and rocks connected with the Fault-Intrusion of Glen Coe. x 10 Dia. Explanation of (Plate 11) 1. Kentallenite, type quarry ([S7053](#)) [NN 009 577]. Olivine, with black cracks; augite, idiomorphic, grey; feldspar, clear; biotite, pale or dark. (photo M.2436; p. 212). 2. Appinite, N. of Leacantuim [NN 117 577], Glen Coe ([S11036](#)) [NN 1152 5810]. Hornblende, mainly dark; feldspar and quartz, clear. (M.2441; p. 215). 3. Junction of flinty crush-rock (left) with chilled Fault-Intrusion (right) at Boundary-Fault, Stob Mhic Mhartuin ([S13403](#)) [NN 207 575]. The minute clear grains in the flinty crush-rock are quartz. The four larger crystals in the same are xenocrysts of feldspar derived from the Fault-Intrusion. The four crystals in the Fault-Intrusion are feldspar phenocrysts, one showing dark. (M.2444; p. 162). 4. Junction of pelitic hornfels (upper third of photo) with lit par lit vein (remainder) in xenolith in Fault-Intrusion, taken from quenched zone at Boundary-Fault, An t-Sròn ([S10311](#)) [NN 136 558]. Due to quenching the vein has completed its crystallisation by developing spherulites — right at bottom corner and left at margin against hornfels. (M.2445; p. 216). 5. Fault-Intrusion (feldspar shows grey) detaching quartz xenocrysts (clear) from quartzite xenolith. Permeation area north of Glen Coe ([S11517b](#)) [NN 1592 5970]. (M.2440; p. 219). 6. Greatly sheared xenolith of basic lava (right), recrystallised with much minute hornblende. It is enclosed in chilled Fault-Intrusion (left), loaded with clear xenocrysts of quartz, and has been carried just inside Cauldron-Subsidence of Glen Coe at An t-Sròn ([S11905](#)) [NN 1362 5502]. (M.2439; p. 217).



(Plate 12) Photomicrographs of Leven Schists before and after contact-alteration.  $\times 21$  Dia. A. Not contact-altered, Glen Leac na Muidhe ([S11618](#)) [NN 1126 5486]. Porphyroblasts of biotite, garnet and magnetite in well foliated base of muscovite, quartz and magnetite. B. Slightly contact-altered,  $\frac{3}{4}$  mile from Cruachan "Granite", Glen Etive district ([S8270](#)) [NN 112 505]. Pseudomorph, largely of cordierite and magnetite, after garnet in well foliated base of muscovite, quartz and magnetite. C. Completely reconstructed to cordierite-andalusite-hornfels, near Ben Nevis "Granite", Aonach Beag ([S13837](#)) [NN 1935 7186]. Cordierite, pale, N.W. half; andalusite, darker, S.E. half; biotite and magnetite, dark to black.





(Plate 13) An Steall, The Waterfall of a valley hanging to Glen Nevis Water-worn crags on left due to stream cascading down marginal crevasse; Roche moutonnee, Glen Nevis, by roadside above Polldubh [NN 141 686] Note gap on "sloss" side due to plucking.

TABLE 1  
Glen Scaddle "Epidiorite" and "Sillimanite-Gneiss"

	I	A	II	III
SiO <sub>2</sub>	51.79	51.75	54.02	60.28
Al <sub>2</sub> O <sub>3</sub>	11.88	13.7	22.15	18.72
Fe <sub>2</sub> O <sub>3</sub>	0.67	9.5	0.77	0.30
FeO	10.66		6.64	6.03
MgO	8.51	9.2	2.22	2.68
CaO	7.92	8.5	1.54	2.44
Na <sub>2</sub> O	2.37	2.0	2.14	3.43
K <sub>2</sub> O	1.22	1.0	5.93	2.60
H <sub>2</sub> O+	0.70		2.68	1.45
H <sub>2</sub> O-	0.30		0.75	0.65
TiO <sub>2</sub>	2.92	c.1.2	1.06	1.07
P <sub>2</sub> O <sub>5</sub>	0.64		tr.	tr.
MnO	0.19		0.16	0.15
CO <sub>2</sub>	—		—	—
Total	99.77		100.06	99.80
Sp. Gr.	3.00		2.78	2.73

Analyses I, II, III by W. H. Herdsman, quoted from Drever (1940, pp. 153, 157).

I. "Epidiorite," Glen Scaddle.

A. Corresponding "average rock" of Devonian igneous series deduced from graphs, Fig. 38, p. 205.

II. "Sillimanite-gneiss" marginal to "epidiorite," Coire nam Muc.

III. "Sillimanite-gneiss," mixed from Coire nam Muc and Coire Dubh.

(Table 1) Glen Scaddle "Epidiorite" and "Sillimanite-gneiss".

TABLE 2  
Analyses of Devonian Igneous Rocks of Sheet 53, 45 and 62 (Geol.)

	Ult.-B. I	2	3	BASIC				8	9	10 (see 13)		INTERMEDIATE 11 (see 10)		12	13	14	15	16	17	18
SiO <sub>2</sub>	40.26	48.00	49.86	50.60	50.73	53.05	53.22	56.25	56.50	59.11	59.25	59.43	60.05	60.45	60.80	61.49	61.50	61.50	62.21	
Al <sub>2</sub> O <sub>3</sub>	15.74	12.52	16.33	14.67	17.08	16.96	17.20	16.30	21.15	17.85	17.30	17.24	18.55	19.89	16.25	14.98	17.35	14.43		
Fe <sub>2</sub> O <sub>3</sub>	3.44	8.74	3.62	2.81	4.59	2.95	2.64	1.60	1.55	1.78	1.15	2.58	0.93	1.76	1.70	1.51	1.27	1.77		
FeO	7.95		4.34	6.47	4.06	5.40	4.84	5.05	3.70	3.24	4.07	3.24	3.41	2.27	3.38	3.84	3.87	3.65		
MgO	12.09	15.26	7.80	7.04	6.12	6.15	6.33	5.12	2.55	3.85	3.60	2.92	3.46	1.54	3.72	3.22	4.22	5.66		
CaO	12.03	7.94	6.47	10.05	7.32	7.45	6.79	6.55	6.15	5.05	4.95	5.14	5.44	4.04	4.75	4.56	3.80	4.43		
Na <sub>2</sub> O	2.25	3.11	3.42	3.13	3.55	3.36	2.38	4.13	4.37	4.10	4.45	4.11	3.84	4.77	4.05	3.59	2.38	2.65		
K <sub>2</sub> O	1.36	2.68	2.10	2.65	1.18	1.45	4.12	2.02	2.56	3.06	2.50	2.53	2.72	3.53	3.05	2.80	2.94	2.75		
H <sub>2</sub> O+	1.75	1.36	2.77	0.50	2.00	1.10	0.61	0.95	0.65	0.73	0.50	0.84	0.35	0.70	0.60	1.68	1.00	0.66		
H <sub>2</sub> O-	0.48		1.25	0.30	0.33	0.60	0.19	0.10	0.15	0.11	1.00	0.33	0.05	0.45	0.30	0.23	0.50	0.40		
TiO <sub>2</sub>	2.42	0.22	1.06	1.25	1.90	0.92	0.69	0.90	0.45	0.30	0.70	1.11	0.42	0.30	0.90	0.96	0.75	0.88		
P <sub>2</sub> O <sub>5</sub>	0.04	—	0.54	0.24	0.35	0.54	0.28	0.40	0.22	0.14	0.21	0.26	0.29	0.23	0.28	0.32	0.17	0.20		
MnO	0.03	—	0.40	0.23	0.20	0.20	0.25	0.40	tr.	0.05	0.15	0.20	0.16	tr.	0.10	0.21	0.07	0.23		
CO <sub>2</sub>	0.03	—	0.23	nil	0.82	nil	0.57	nil	nil	—	nil	0.06	—	nil	nil	0.92	nil	0.06		
Cl	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.03	—	—		
S	—	—	—	—	—	—	—	—	0.08	0.19	—	—	—	tr.	—	—	—	—		
(Ni,Co)O	—	—	nt. fd.	—	nt. fd.	—	nt. fd.	—	—	—	—	nt. fd.	—	—	—	nt. fd.	—	nt. fd.		
BaO	—	—	0.10	—	0.07	—	0.08	—	—	0.23	—	0.13	—	—	—	0.11	—	0.07		
ZnO	—	—	—	—	—	—	—	—	—	—	—	—	0.27	—	—	—	—	—		
Li <sub>2</sub> O	—	—	tr.	—	nt. fd.	—	tr.	—	—	—	—	nt. fd.	—	—	—	nt. fd.	—	nt. fd.		
Total	99.87	99.83	100.29	99.94	100.30	100.13	100.19	99.77	100.08	99.70 <sup>1</sup>	99.83	100.12	99.94	99.93	99.88	100.45	99.82	100.05		
Sp. Gr.	3.19	2.95	2.76	3.00	2.82	2.86	2.85	2.81	—	—	2.71	2.75	—	2.64	2.76	2.71	2.76	2.76		

<sup>1</sup> After subtracting 0.09 for S

1 : Appinite; Ardsheal Hill. 2 : Kentallenite; Kentallen. 3 : Olivine-basalt with orthoclase; lava, Taynuilt, Lorne. 4 : Olivine-basalt with orthoclase; intrusion, Ardsheal Hill. 5 : Hypersthene-basalt; lava, Glen Coe. 6 : Biotite-diorite with hornblende and augite; basic phase of Beinn a' Bhuiridh (Cruachan Quarry) Diorite. 7 : Monzonite; Glen Creran. 8 : Banatite; Inner non-porphyrific Subzone 3 of Outer "Granite," Ben Nevis. 9 : Tonalite; intermediate phase of Beinn a' Bhuiridh (Cruachan Quarry) Diorite. 10 : Tonalite; Outer "Granite," Ballachulish (see 13). 11 : Banatite; Outer non-porphyrific Subzone 1 of Outer "Granite," Ben Nevis. 12 : Banatite-porphyrific; Fault-Intrusion, Glen Coe. 13 : Tonalite; Outer "Granite," Ballachulish (see 10). 14 : Hornblende-porphyrific; dyke, Ben Nevis Swarm, W. of Ballachulish Pluton. 15 : Banatite; Mid non-porphyrific Subzone 2 of Outer "Granite," Ben Nevis. 16 : Hornblende-andesite; lava, Glen Coe. 17 : Hornblende-andesite; lava, contact-altered in Beinn a' Bhuiridh screen. 18 : Kersantite microdiorite; dyke, Etive Swarm, Glen Etive.

(Table 2) Analyses of Devonian igneous rocks of sheet 53, 45 and 62 (Geol.).

TABLE 3  
Analyses (continued), Sheets 53, 45, 54 and 62 (Geol.)

	ACID											ULTRA-ACID		TRONDHJEMITES				
	19	20 (see 25)	21	22	23	24 (28, 30)	25 (see 20)	26	27	28 (24, 30)	29	30 (24, 28)	31	32	33	A	B	C
SiO <sub>2</sub>	65.30	65.72	66.50	66.71	66.91	67.30	67.78	68.02	68.40	70.27	71.35	71.70	73.70	75.71	76.14	70.30	71.95	72.11
Al <sub>2</sub> O <sub>3</sub>	15.20	15.49	15.15	15.33	15.09	16.50	16.64	14.16	17.21	15.52	13.68	13.62	12.25	11.91	15.36	15.76	15.25	
Fe <sub>2</sub> O <sub>3</sub>	2.49	2.35	1.34	1.46	1.70	1.20	1.07	1.82	tr.	0.90	1.75	16.81	0.48	1.23	1.26	0.56	0.76	0.64
FeO	2.41	2.07	2.39	2.26	1.95	1.98	1.74	1.95	0.92	0.94	0.97	1.28	0.31	0.25	2.37	0.03	0.84	
MgO	1.80	1.23	1.88	1.53	2.02	1.27	1.19	1.91	1.03	0.67	0.84	0.47	0.32	0.20	0.13	1.03	0.31	0.38
CaO	3.05	2.69	3.15	2.72	3.27	2.85	2.38	2.81	3.05	1.60	1.85	2.42	0.94	0.61	0.47	3.52	1.65	1.98
Na <sub>2</sub> O	4.13	4.49	3.90	3.67	4.16	4.70	4.27	3.90	4.48	4.45	3.75	9.00	4.05	3.79	3.37	4.30	6.63	5.43
K <sub>2</sub> O	3.37	4.38	3.68	3.96	3.16	2.75	3.48	3.92	2.88	4.16	4.36	4.85	4.73	5.30	1.45	2.22	2.04	
H <sub>2</sub> O <sup>+</sup>	0.81	0.49	0.50	0.28	0.56	0.50	0.48	0.56	0.30	—	0.51	—	Nil	0.52	0.30	0.79	0.42	0.66
H <sub>2</sub> O <sup>-</sup>	0.19	0.12	0.20	0.88	0.14	0.20	0.30	0.20	0.12	—	0.19	—	0.55	0.08	0.36	0.05	—	0.03
TiO <sub>2</sub>	0.83	0.61	0.55	0.69	0.67	0.30	0.36	0.63	0.28	0.31	0.47	—	0.36	0.21	0.15	0.35	0.08	0.17
P <sub>2</sub> O <sub>5</sub>	0.23	0.43	0.18	0.19	0.17	0.16	0.12	0.16	0.14	0.17	0.11	—	tr.	0.06	0.05	0.12	—	0.06
MnO	0.12	0.04	0.10	0.18	0.18	nil	—	0.22	—	0.04	0.18	—	nil	0.10	0.19	0.04	—	0.02
CO <sub>2</sub>	tr.	—	nil	0.15	nt. fd.	nil	—	nt. fd.	—	—	nt. fd.	—	nil	0.19	0.26	0.13	—	0.22
S	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.03	—	0.06
FeS <sub>2</sub>	—	—	—	—	—	—	—	—	1.08	—	—	—	—	—	—	—	—	—
(Ni,Co)O	nt. fd.	—	—	nt. fd.	nt. fd.	—	—	nt. fd.	—	—	nt. fd.	—	—	nt. fd.	nt. fd.	—	—	—
BaO	0.11	0.19	—	0.10	0.05	—	—	0.06	—	—	0.05	—	—	0.08	0.01	tr.	—	0.03
Li <sub>2</sub> O	nt. fd.	—	—	?	nt. fd.	—	—	nt. fd.	—	—	tr.	—	—	?	nt. fd.	—	—	—
Total Sp. Gr.	100.04 2.70	100.30 —	99.92 2.68	100.11 2.69	100.03 2.69	99.71 2.67	99.81 —	100.32 2.69	99.89 —	99.03 —	100.06 2.65	100.40 —	100.15 2.62	100.07 —	100.15 —	100.40 2.71	99.81 2.64	99.92 2.68

19 : Biotite-hornblende-porphyrte; Early Fault-Intrusion, Glen Coe. 20 : Granite; Inner Granite, Ballachulish (see 25). 21 : Granite; porphyritic subzone of Ben Nevis Outer "Granite". 22 : Hornblende-porphyrte; dyke, Etive Swarn, Glen Etive. 23 : Trondhjemite; Moor of Rannoch "Granite". 24 : Trondhjemite; Inner "Granite," Ben Nevis (see 28, 30). 25 : Granite; Inner Granite, Ballachulish (see 20). 26 : Adamellite; Northern Lobe, Cruachan "Granite". 27 : Trondhjemite; "White Granite," Ballachulish. 28 : Granite; Inner "Granite," Ben Nevis (see 24, 30). 29 : Granite; Starav Granite. 30 : Trondhjemite; Inner "Granite," Ben Nevis (see 24, 28). 31 : Binary Granite; referred to Meall Odhar Granite. 32 : Rhyolite; lava, Glen Coe. 33 : Quartz-porphyrte; dyke, Etive Swarn, Glen Etive. A, B, C : Three Norwegian Trondhjemites to compare with 23, 24, 27, 30.

Further details regarding Tables 2, 3 are given on pp. 208-9.

(Table 3) Analyses of Devonian igneous rocks of sheet 53, 45, 54 and 62 (Geol.) continued.

TABLE 4  
Analyses of Appin Limestone

	1	2	3	4	5	6	7	8	9	Dolomite
SiO <sub>2</sub>	3.4	13.9	1.9	1.3	3.5	3.3	25.9	3.7	—	—
Al <sub>2</sub> O <sub>3</sub>	1.2	5.3	1.8	—	2.1	—	5.0	—	—	—
Fe <sub>2</sub> O <sub>3</sub>	—	5.1	1.3	—	3.3	—	1.8	—	—	—
FeO	0.2	—	—	—	—	—	—	—	—	—
MgO	9.0	8.0	18.5	20.0	17.1	21.8	5.4	20.9	18.4	21.8
CaO	42.5	33.7	31.7	30.7	29.7	29.1	28.9	28.9	26.7	30.4
CO <sub>2</sub>	43.1	34.3	44.6	45.9	44.0	46.8	29.3	45.6	41.1	47.8
Etc.	0.5	0.2	0.9	—	—	0.6	4.1	—	13.1	—
Total	99.9	100.5	100.7	—	100.2	—	100.4	—	—	100.0
MgCO <sub>3</sub>	18.8	15.2	38.0	41.8	35.7	45.7	11.4	43.8	38.6	45.7
CaCO <sub>3</sub>	75.6	60.0	56.4	54.8	52.9	52.0	51.6	51.6	47.6	54.3
Surplus MgO	0.0	0.8	0.4	—	0.0	—	0.0	—	—	0.0
Surplus CO <sub>2</sub>	0.0	0.0	0.0	—	2.1	—	0.9	—	—	0.0

1. Waterfall in stream 50 yd E. of Kentallen railway station (contact-altered). Anal. I. D. Muir.
2. Onich shore, 400 yd W. by S. of church (S 15376). Anal. B. Lightfoot.
3. Three hundred yards above path S.W. of Sgòrr a' Choise (contact-altered, S 15379, 15380). Anal. B. Lightfoot.
4. Dalnatrat, near Duror station. Supplied by Stewarts and Lloyds, Ltd.
5. Hillslope, 200 yd N.E. of Portnacraoish (Appin station). Anal. B. Lightfoot.
6. Dalnatrat, near Duror station. Supplied by Steeley Lime and Basic Co., Ltd.
7. Marble Quarry, pathside, River Laroch, 660 yd S. of Laroch Bridge, Ballachulish. The full analysis by A. Muir and H. G. M. Hardie (1956, p. 20) shows Na<sub>2</sub>O 1.95, K<sub>2</sub>O 1.00.
8. Tributary of River Laroch, 660 yd S. 23°W. of Laroch Bridge, Ballachulish.
9. East of Duror railway station. Pure dolomite is quoted for comparison.

Analyses of Xenolith and of Contaminated and Normal Ballachulish Quartz-Diorite

	A	B	C	D	E	F
SiO <sub>2</sub>	54.73	59.24	62.51	59.81	59.11	51.61
Al <sub>2</sub> O <sub>3</sub>	7.42	20.80	19.10	16.61	17.85	2.18
Fe <sub>2</sub> O <sub>3</sub>	1.71	0.29	0.65	1.50	1.78	1.04
FeO	5.03	0.99	0.41	2.80	3.24	9.28
MgO	8.11	1.20	0.23	2.49	3.85	11.29
CaO	18.32	7.13	2.01	3.20	5.05	22.86
Na <sub>2</sub> O	2.35	7.47	2.18	3.49	4.10	0.43
K <sub>2</sub> O	1.19	0.85	11.47	7.92	3.06	0.07
Etc.	1.05	2.22	1.50	2.05	1.66	1.09
Total	99.91	100.19	100.06	99.87	99.70	99.85

Analyses by I. D. Muir (1953a).

- A. Xenolith of Appin Limestone transformed through immersion in Ballachulish quartz-diorite (see E. below). The specimen was taken 50 yd from 1 of previous Table.
- B. Plagioclase zone enveloping A, and 1-2 inches thick.
- C. Potash syenite zone enveloping B, 3 inches.
- D. Augite-syenite zone enveloping C, a few inches.
- E. Quartz-diorite of Ballachulish Pluton unmodified by Appin Limestone.
- F. Diopside from D.

(Table 4) Analyses of Appin Limestone; Analyses of xenolith and contaminated and normal Ballachulish quartz-diorite.

**TABLE 5**  
*Analyses illustrating Reactions between Quartz Xenoliths  
and Ballachulish Quartz-Diorite*

	I	A	II	B	III	IV	C
SiO <sub>2</sub>	59.94	49.71	59.43	46.30	62.53	59.11	45.15
Al <sub>2</sub> O <sub>3</sub>	5.04	2.85	5.54	8.60	16.49	17.85	8.10
Fe <sub>2</sub> O <sub>3</sub>	2.00	2.76	4.63	2.78	1.82	1.78	2.10
FeO	4.97	7.45	7.08	10.16	2.99	3.24	12.97
MgO	8.30	13.35	7.89	13.15	2.80	3.85	13.30
CaO	14.72	22.36	9.05	13.55	4.78	5.05	12.84
Na <sub>2</sub> O	1.87	0.60	1.65	1.05	4.17	4.10	0.66
K <sub>2</sub> O	0.14	0.04	0.58	0.48	2.12	3.06	0.32
Etc.	2.52	1.13	4.55	3.82	2.53	1.66	4.10
Total	99.50	100.25	100.40	99.89	100.23	99.70	99.54

All analyses by I. D. Muir.

- I. Augite-rich inner zone of corona.
- A. Augite from I.
- II. Hornblende-rich outer zone of corona.
- B. Hornblende from II.
- III. Modified IV, 2 inches outside corona.
- IV. Normal Ballachulish quartz-diorite.
- C. Hornblende from IV.

(Table 5) Analyses illustrating reactions between quartz xenoliths and Ballachulish quartz-diorite.