
Figures, photographs and tables

Figures

(Figure 1) Outline map of major geological provinces in Scotland, and the distribution of Caledonian igneous complexes ('granites'); with location of the Ballachulish area.

(Figure 2) Outline of lithostratigraphic units and major regional structures around the Ballachulish Igneous Complex. The position of the garnet isograd of regional metamorphism. Which formed prior to intrusion of the complex, is extrapolated across the area of the complex. From Pattison & Harte (1997).

(Figure 3) Geological cross-sections through the igneous complex (see section lines on Coloured Map (Map 1) and (Figure 7)), from Weiss (1986) and Troll and Weiss (1991). 1 - metasediments. Lined pattern indicates pelites and semipelites; lined pattern with dots represents quartzites. Squiggly lines indicate migmatitic rocks. The orientation of the lines gives the attitude of the bedding projected into the cross section. 2 - monzodiorites, showing flow- and deformation foliation. 3 - quartz diorites, showing alignment of metasedimentary xenoliths. 4 - fine grained diorites with xenoliths. 5 - granites. The flue crossed ornament in the centre represents leucogranite, and the bounding stippled margin represents a gradational contact with the main granite. 6 - hybrid transition zones between granite and quartz diorite. The dotted line labelled 'Sgorr Dhearg' represents the projected topographic expression of this peak which occurs about 300 m N of the line of section.

(Figure 4) Pressure-temperature grid of reactions in the chemical system $K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O$ for typical mineral compositions in quartz-bearing pelitic rocks from Ballachulish (Pattison Harte, 1997). Dehydration reactions below the initial melting reaction ($Pl+Kfs+Qtz+H_2O = L$) are shown in solid lines. Higher grade reactions up-temperature of the initial melting reaction are shown in dashed lines. Als = andalusite or sillimanite. V = hydrous vapour, The short dashed line numbered 3 is the metastable extension of $Ms+Qtz = Als+Kfs+V$ The dot-dashed reaction 5, $Ms=Crn+Kfs+V$, only occurs in quartz-absent rocks. The $And=Sil$ curve is from Pattison (1992). H - $And=Sil$ curve and triple point of Holdaway (1971); RGB - $And=Sil$ curve and triple point of Richardson et al. (1969). Roman numerals - contact metamorphic zones referred to in the text. Zone IV comprises two different assemblages IVa and IVb that occur at the same grade in rocks of different composition. In quartz-absent rocks, Zone V can be divided into lower grade (Va) and higher grade (Vb) subzones based on the presence of muscovite (Va) and corundum (Vb), respectively. Reaction numbering in Arabic numerals follows the text except that the 'P' prefix is omitted. Isopleths are of $(100 \times Mg/(Mg+Fe))$ in cordierite.

(Figure 5) Isograds in carbonate rocks from the Coire Giubhsachain syncline, northeast flank of igneous complex (Paulson & 1997; modified from Masch and Heuss-Aßbichler 1991 and Ferry, 1996a). Numbering of isograds is the same as in the text (with 'C' prefix omitted). Circled numbers and symbols 9, 10, CIII, 15 and 16 refer to assemblages and isograds observed in siliceous dolostones, whereas circled numbers 6 and 14 are for isograds in impure limestone.

(Figure 6) Isobaric $T-X_{CO_2}$ diagram (3 kbar) for selected equilibria in the chemical system $CaO-MgO-SiO_2-Al_2O_3-H_2O-CO_2$, showing numbered reactions discussed in the text (Pattison & Harte, 1997; modified from Masch and Heuss-Aßbichler 1991). All reactions except C18 involve H_2O and/or CO_2 . The unlabelled reactions are: $Tlc + Cal + Qtz = Tr + CO_2 + H_2O$. 18. $Gros + Qtz = An + Wo$ (phases on the right hand side of the reaction are on the high-temperature side)

(Figure 7) Outline of area for field excursions. Geological map showing location of field stops for Day 1 (see (Figure 7) for key to geological map).

(Figure 8) (a) Geological map showing location of field stops for Day 2, see ((Figure 7) for key to geological map). Corresponding topographic map showing location of field stops for Day 1 (reproduced with permission by the Ordnance Survey).

(Figure 9) (a) Geological map showing location of field stops for Day 2 (see (Figure 7)) for key to geological map) See (Figure 10) for Stop 2-1 (b) Corresponding topographic map showing location of field stops for Day 2 (reproduced with permission of the Ordnance Survey).

(Figure 10) (a) Geological map showing location of field stops for Day 3 Part 1, Fraochaidh traverse, (see (Figure 7) for key to geological map). (b) Corresponding topographic map showing location of field stops for Day 3 Part 1 (reproduced with permission of the Ordnance Survey).

(Figure 11) (a) Geological map showing location of field stops for Day 3 Part 2, (see (Figure 7) for key to geological map). Also shows Day 1, Stops 1-7 1-8 & 1-9. (b) Corresponding topographic map showing location of field stops for Day 3 Part 2: (reproduced with permission of the Ordnance Survey).

(Figure 12) (a) Geological map showing location of field stops for Day 4 (see (Figure 7) for key to geological map) (b) Corresponding topographic map showing location of field stops for Day 4 (reproduced with permission by the Ordnance Survey).

(Figure 13) (a) Geological map showing location of field stops for Day 5 (see (Figure 7) for key to geological map). (b) Corresponding topographic map showing location of field stops for Day 5 (reproduced with permission by the Ordnance Survey).

Photographs

(Photo 1) (Frontispiece). Overview of the Ballachulish Igneous Complex and Aureole from Tom Meadhoin ridge, looking SW.

(Photo 2) View to SW from the summit of Sgorr Dhearg looking across Loch Linnhe

(Photo 3) View from Beinn Man looking NE to the town of Ballachulish and Loch Leven.

(Photo 4) View of the Beinn a' Bheithir massif underlain by the Ballachulish Igneous Complex and Aureole, taken looking south across Loch Leven from the Onich shore near Stop 1-1. The hill complex seen is referred to Collectively as Beinn Bheithir and the peaks of Sgorr Dhearg and Sgorr Dhonuill form the highest parts of this complex. To the right of the Ballachulish bridge one looks up into the valley of Gleann Chaolais. bounded on the right (west) by the rounded flank of Creag Ghorm (758 m), and on the left (east) by a ridge leading from the rounded shoulder of Meall a' Chaolais up to the slimy white peak of Sgorr Dhearg (1024 m). At the head of Gleann a' Chaolais and to the right (west) of Sgorr Dhearg is Sgorr (1001 m) and its subsidiary peak in the foreground, the Devil's Tooth, which forms a prominent cliff-rimmed triangular peak overlooking the head of Gleann a' Chaolais. To the left (east) of Sgorr Dhearg is another more rounded, white peak (unnamed) with a ridge leading down to the rounded shoulder of Beinn Bhan the latter separated from the Sgorr Dhearg ridge by Coire Giubhsachain. The eastern contact of the Ballachulish igneous complex with the host Dalradian metasediments is subparallel with the lower part of the Meall Chaolais - Sgorr Dhearg ridge, but was obliquely across it in the grassy portion of the ridge just above Meall a' Chaolais, so that it lies on the nearside of the Sgorr Dhearg summit. Interbedded metapelitic, quartzitic and calcareous layers of the Appin Group give rise to the generally more angular exposures along the upper parts of the Meall a' Chaolais– Sgorr Dhearg ridge. The white peak of Sgorr Dhearg itself and the white outcrops along the Beinn Bhan ridge up to the unnamed top to the left (east) of Sgorr Dhearg are formed by Appin Quartzite. On the right-hand (west) side of the mountain panorama, the boundary of the igneous complex lies between Creag Ghorm (on the photo) and the next hill (off the photo to the west). Thus most of the ground across the loch is underlain by rocks of the Ballachulish Igneous Complex, which gives rise to generally rounded outcrops. Most of Creag Ghorm and Meall o'Choalais are occupied by various varieties of monzodiorite and quartz diorite (see Coloured Map (Map 1)), the earliest of two main phases of the igneous complex. The second phase of granitic rocks, which were emplaced into the diorites in the central parts of the complex, form Sgorr Dhonuill, the Devil's Tooth and the upper more southerly parts of Creag Ghorm (hugely out of sight).

(Photo 5) Stop 1-2. Gametiferous phyllite/schist of the Leven Schist lithology, immediately west of the Ballachulish Slide.

(Photo 6) Stop 1-2. Fine grained graphitic black slate/phyllite of the Ballachulish Slate lithology interbedded with dark grey marble of the Ballachulish Limestone lithology (foreground). These rocks lie immediately east of the Ballachulish Slide.

(Photo 7) Stops 1-3 and 3-1. Cordierite porphyroblasts visible as dark patches on cleavage planes of regional phyllites and schists. Note that the size of the patches varies in different parts of the rock. This sample comes from roadside exposures near the parking place for Day 3, Part 1, and shows a coarser development of cordierite patches than at Stop 1-3; but the style of development is similar at both these and other localities in the aureole.

(Photo 8) Stop 1-7/1. Inclusion-rich quartz diorite. The inclusions range from metasedimentary, especially metapelitic, xenoliths, to intermediate-mafic igneous inclusions of similar mineralogy to the host quartz diorite.

(Photo 9) Stops 1-8, 5-4 and 5-5. Interbedded psammite (light layers) and pelitic hornfels (dark, knobby layers, rich in cordierite+K feldspar+andalusite), from Zone V. The actual exposure in the photograph is from near Stop 5-5, but is similar to exposures seen in the vicinity of Stop 1-8.

(Photo 10) Stops 1-8 and 1-9. Incipient migmatitic features in interbedded pelitic and semipelitic hornfels, upper Zone V. See description of Stop 1-9 for an explanation of the features.

(Photo 11) Stop 3-3. Massive, pitted pelitic hornfels from the high grade end of Zone III. Fraochaidh transect. The pits represent the sites of weathered out cordierite crystals. The matrix surrounding the pits is rich in muscovite, biotite and quartz. Scale bar in cms.

(Photo 12) Stops 3-4, 1-8, 5-2, 5-4 and 5-5. Massive Crd+Kfs-bearing pelitic hornfels characteristic of Zone IVb. The photograph was taken near Stop 5-5 in Coire Giubhsachain, but is representative of Zone IVb in many parts of the aureole. Note the mesh or honeycomb texture, defined by randomly orientated, weathered-out cordierite crystals (represented by pits) within a resistant, light coloured matrix rich in K-feldspar. Note also that the matrix surrounding the pits is lighter colorant and more sharply defined than the matrix in hornfels from Zone III (compare with (Photo 1)).

(Photo 13) Stops 3-11 to 3-13. View of a typical exposure of the Chaotic Zone migmatites. Note the isolated fragments of metapelitic hornfels randomly orientated within a granular matrix containing veins. See the description of Stop 3-11 for a fuller description and explanation of these features.

(Photo 14) Stops 3-11 to 3-13. Detail of the Chaotic Zone migmatites. An isolated metasedimentary schollen, with relic bedding still preserved, occurs in lower part and is surrounded by a granular semipelitic matrix. An andalusite-rich domain occurs just below the scale bar in upper part.

(Photo 14) View of the contact between granite of the igneous complex (light coloured upper crags) and the Chaotic Zone pelitic migmatites (dark lower exposures).

(Photo 16) Stop 4-3. Crenelated graphitic phyllite of the Ballachulish Slate lithology with abundant cordierite porphyroblasts forming roughly ovoid 'blobs'. Characteristic of Zone III in this vicinity.

(Photo 17) Stop 1-5. A crenulated cleavage surface of the graphitic phyllite of the Ballachulish Slate lithology. The short elongate ribs, with widely varying orientation, mark the occurrence of abundant mm- to cm-long andalusite prisms. The full mineral assemblage in the rock is andalusite + cordierite + biotite + muscovite + quartz, characteristic of Zone IVa (see discussion under Stop 1-5). The andalusite in the rock shown is a little coarser grained than in most exposures in Zone IVa.

(Photo 18) Stops 5-3 to 5-6, 1-8 and 3-5. Randomly orientated andalusite prisms in a massive cordierite+K-feldspar-rich pelitic hornfels (Zone V). The photograph was taken at Stop 5-5.

(Photo 19) Stops 5-5, 1-8 and 3-5. Corundum-rich, quartz-absent pelitic hornfels of Zone Vb. The corundum is visible as abundant small, rounded 'pimples' that contrast with the more prismatic andalusite crystals seen below the pencil

(compare with Photo 1S).

(Photo 20) Stop 5-6. Anastomosing veins rich in K-feldspar + quartz, within layered cordierite+K-Feldspar-rich pelitic and semipelitic hornfels. The prominent light coloured vein (lower left of photograph) is of granitic material from the igneous complex. See notes of Stop 5-6 (above 560 m) and Stop 1-9 for a fuller description and explanation of the veins and other features. From the ridge/plateau area around Stop 5-6.

(Photo 21) Stop 5-6. Detail of migmatitic rocks with boudin-type structures. The original lithology was of interlayered pelitic and semipelitic material and now shows rigid, pulled apart cordierite-rich hornfels (metapelite) layers (A), ductile semipelitic layers (B) and segregated Kfs+Qtz-rich leucosomes occupying the gaps between the pulled apart hornfels layers (C). Notice how the leucosome merges into the ductile semipelite, giving the impression of being extracted from it. Field of view is 5 cm across. See notes of Stop 1-9 for further explanation.

(Photo 22) (opposite, above). Stops-7. Calcite+spinel (Spl)+Forsterite-bearing dolomitic marble with folded veins of calcite and forsterite. The Forsterite is commonly, extensively altered to serpentine giving the veins a yellow-brown colour on the weathered exposure surface.

(Photo 23) Stop 5-9. Calcsilicate rock rich in grossular (equant crystals) and vesuvianite (indicated 'vesuv').

(Photo 24) Stop 5-10. 'Chocolate-tablet' migmatites. See the notes under Stop 5-10 for a description and explanation of the features visible in the top part of the photograph. Cutting across the bottom of the photograph is a lighter coloured dyke-like body of quartz-diorite, carrying many inclusions of pelitic hornfels; boundary picked out with white line.

(Photo 25) Stop 5-10. Detail of 'chocolate-tablet' migmatite. The rock consists of interlayered pelitic and semipelitic. Cordierite-rich hornfels layers and broken into angular fragments in a tablet structure, with mobile leucocratic material both cross-cutting and running parallel to the layering. The mobile leucocratic material separating the hornfels fragments merges into semi-pelitic layers and does not form extensively cross-cutting veins. Compare with (Photo 10) and (Photo 21).

Tables

(Table 1) a. Principal itinerary of stops for Day 1: Overview of the Ballachulish Igneous Complex, Dalradian host rocks and contact hornfelses b. Optiollal additional stops during Day 1 itinerary.

(Table 2) Itinerary of stops for Day 2: Rock types and intrusive relationships of the igneous complex.

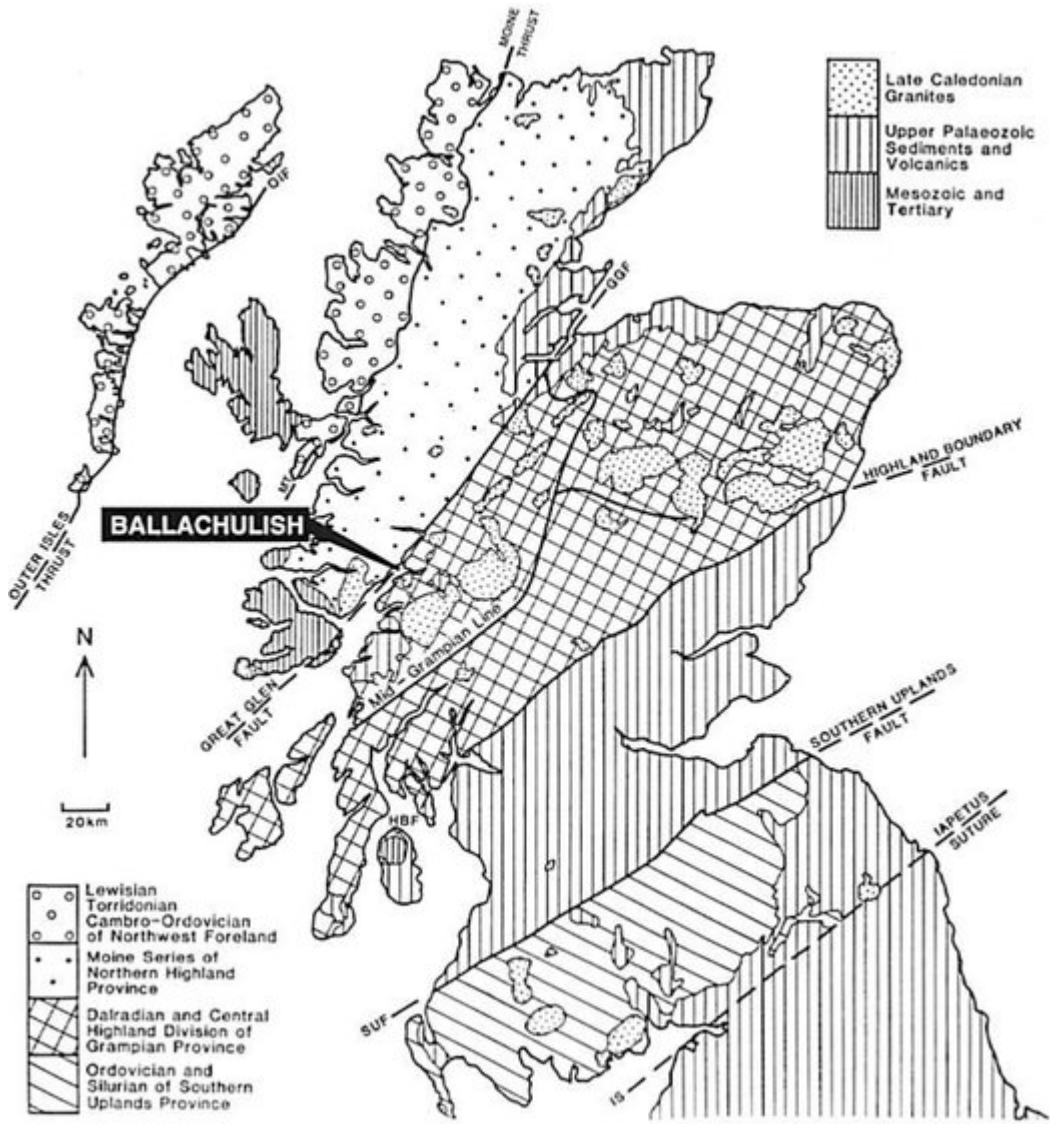
(Table 3) Itinerary of stops for Day 3: Part 1 Fraochaidh prograde sequence. b. Itinerary of stops for Day 3 Part 2 Chaotic Zone migmatites and nearby carbonates and calcsilicates.

(Table 4) Itinerary of stops for Day 4: Prograde metapelitic hornfels zones in the Ballachulish Slate along the Gleann a' Fhiodh-Coire Chaorann ridge: appinite and quartz diorite relations; migmatites and Crd+Grt+Opx hornfelses.

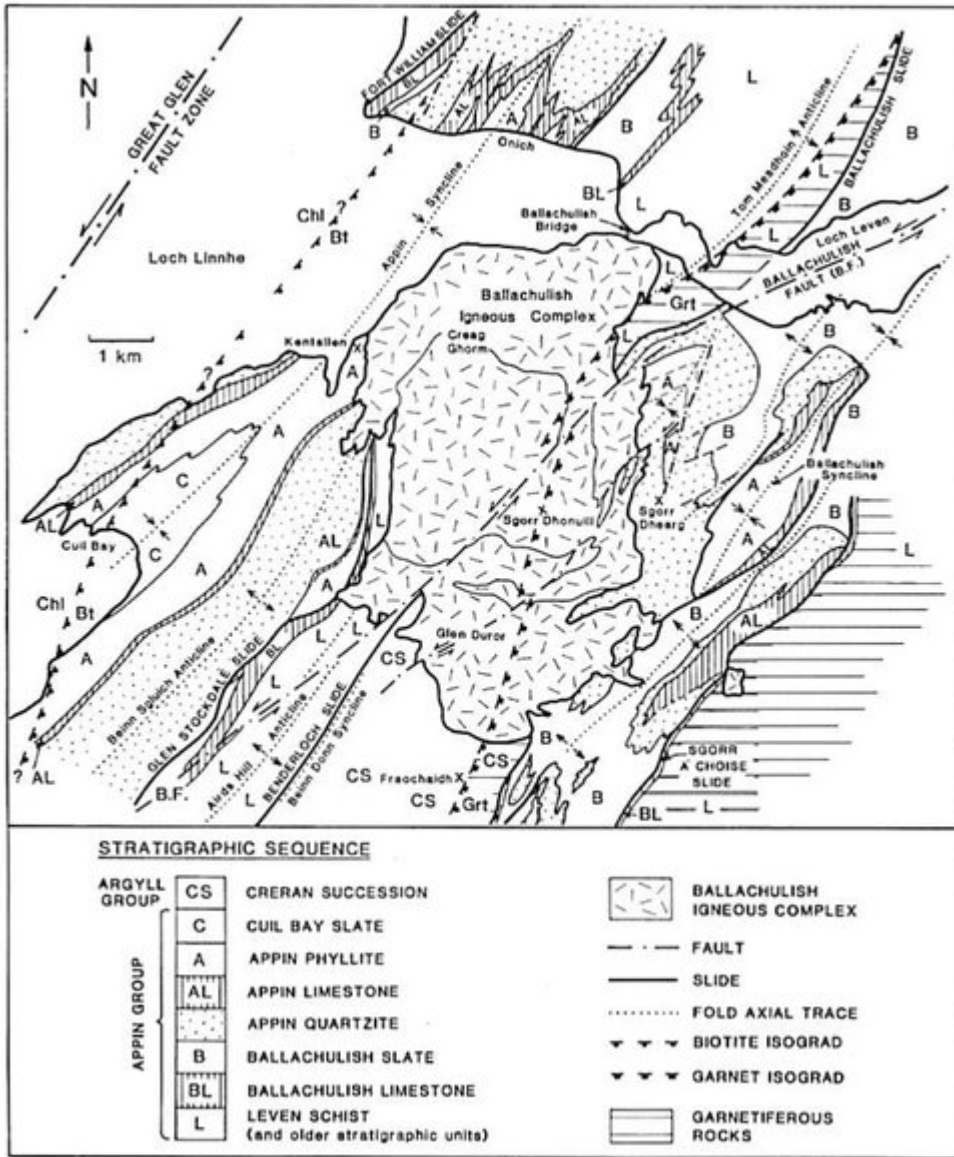
(Table 5) Itinerary of stops for Day 5: Medium- to high-grade interbedded pelitic and calcsilicate hornfelses and marbles; various migmatites, including 'chocolate-tablet' type; summit(s) of Beinn a' Bheithir.

(Map 1) Geological map of the Ballachulish Igneous Complex and aureole. (map in endpocket).

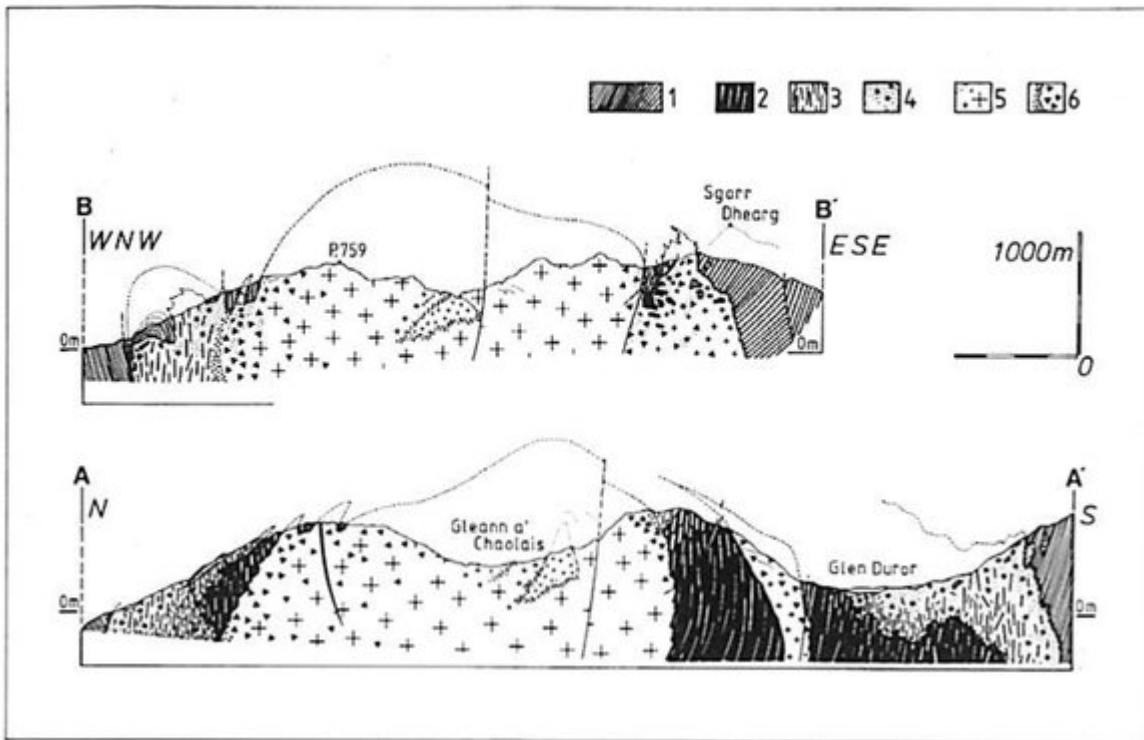
(Front cover) Cover photograph. View looking east from the summit of Sgorr Dhonuill to Sgorr Dhearg. The ridge in the foreground is underlain by granite of the Ballachulish Igneous Complex. The summit of Sgorr Dhearg, is underlain by white Appin Quartzite or the host Dalradian metasediments. On the left skyline is Ben Nevis and the peaks of the Mamore range.



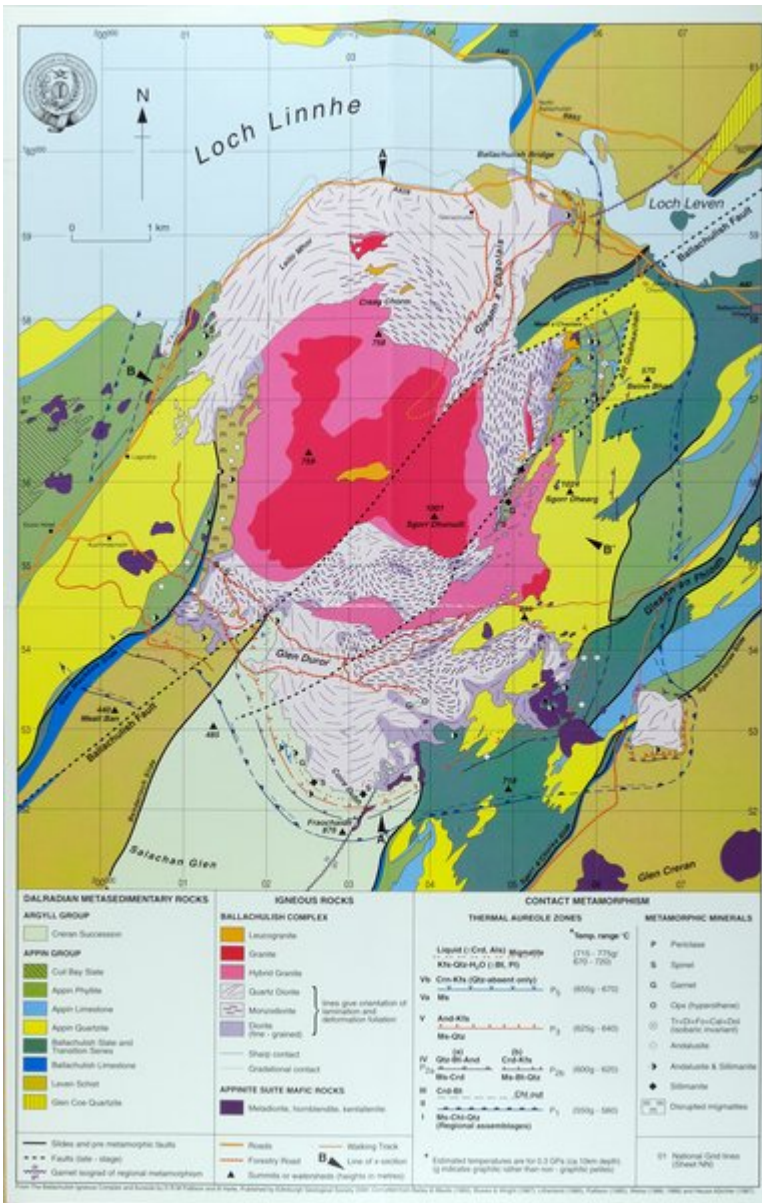
(Figure 1) Outline map of major geological provinces in Scotland, and the distribution of Caledonian igneous complexes ('granites'); with location of the Ballachulish area.



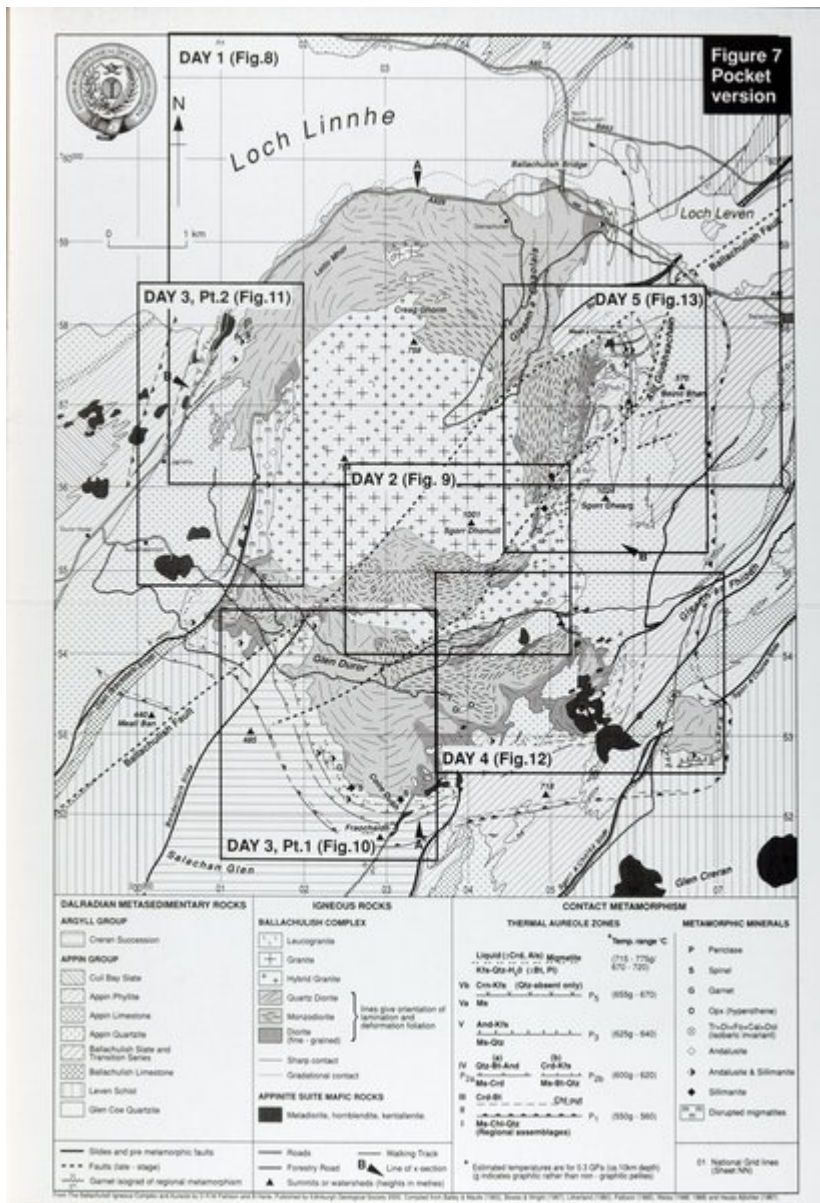
(Figure 2) Outline of lithostratigraphic units and major regional structures around the Ballachulish Igneous Complex. The position of the garnet isograd of regional metamorphism. Which formed prior to intrusion of the complex, is extrapolated across the area of the complex. From Pattison & Harte (1997).



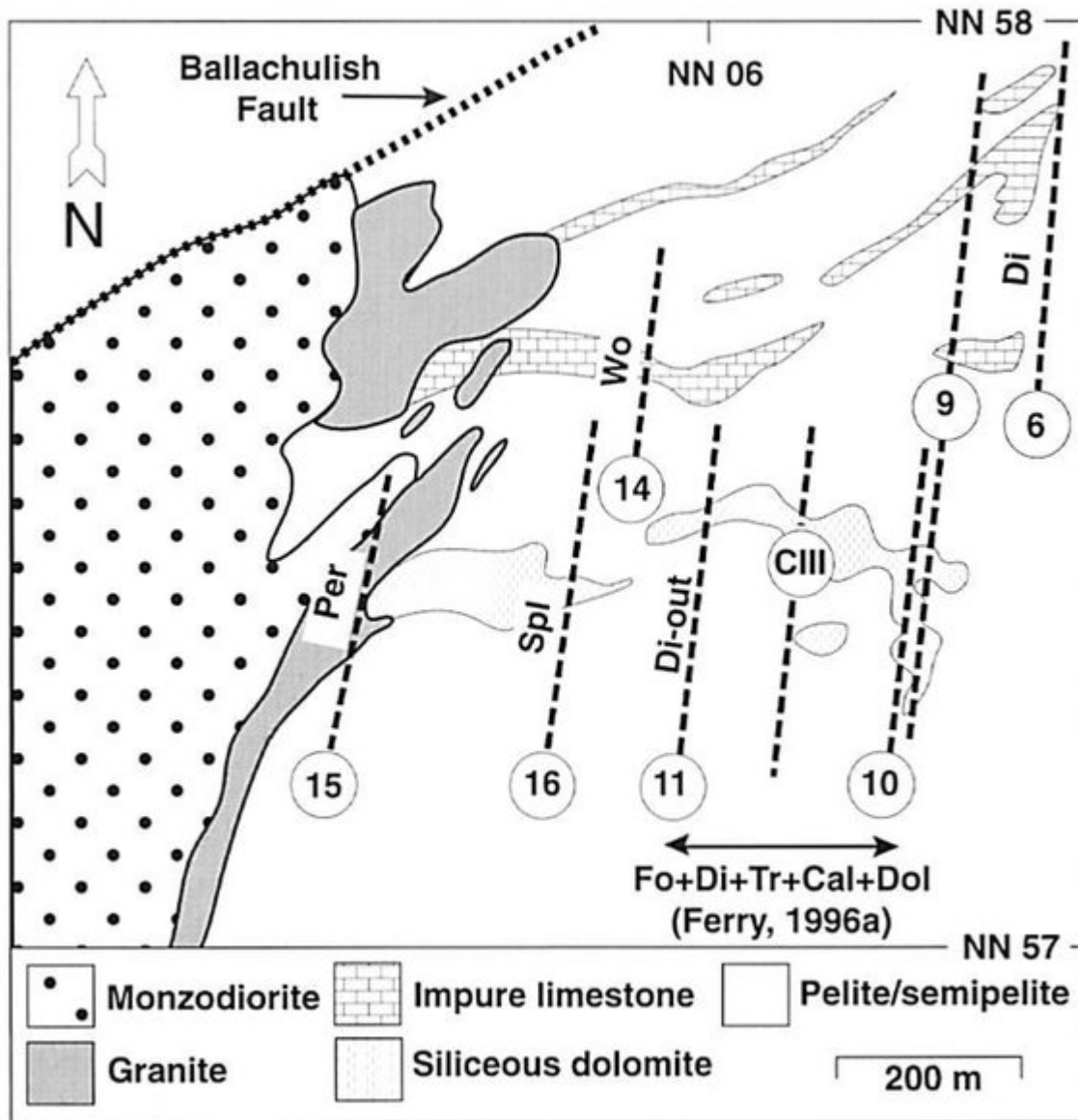
(Figure 3) Geological cross-sections through the igneous complex (see section lines on Coloured Map (Map 1) and (Figure 7)), from Weiss (1986) and Troll and Weiss (1991). 1 - metasediments. Lined pattern indicates pelites and semipelites; lined pattern with dots represents quartzites. Squiggly lines indicate migmatitic rocks. The orientation of the lines gives the attitude of the bedding projected into the cross section. 2 - monzodiorites, showing flow- and deformation foliation. 3 - quartz diorites, showing alignment of metasedimentary xenoliths. 4 - fine grained diorites with xenoliths. 5 - granites. The fine crossed ornament in the centre represents leucogranite, and the bounding stippled margin represents a gradational contact with the main granite. 6 - hybrid transition zones between granite and quartz diorite. The dotted line labelled 'Sgorr Dhearg' represents the projected topographic expression of this peak which occurs about 300 m N of the line of section.



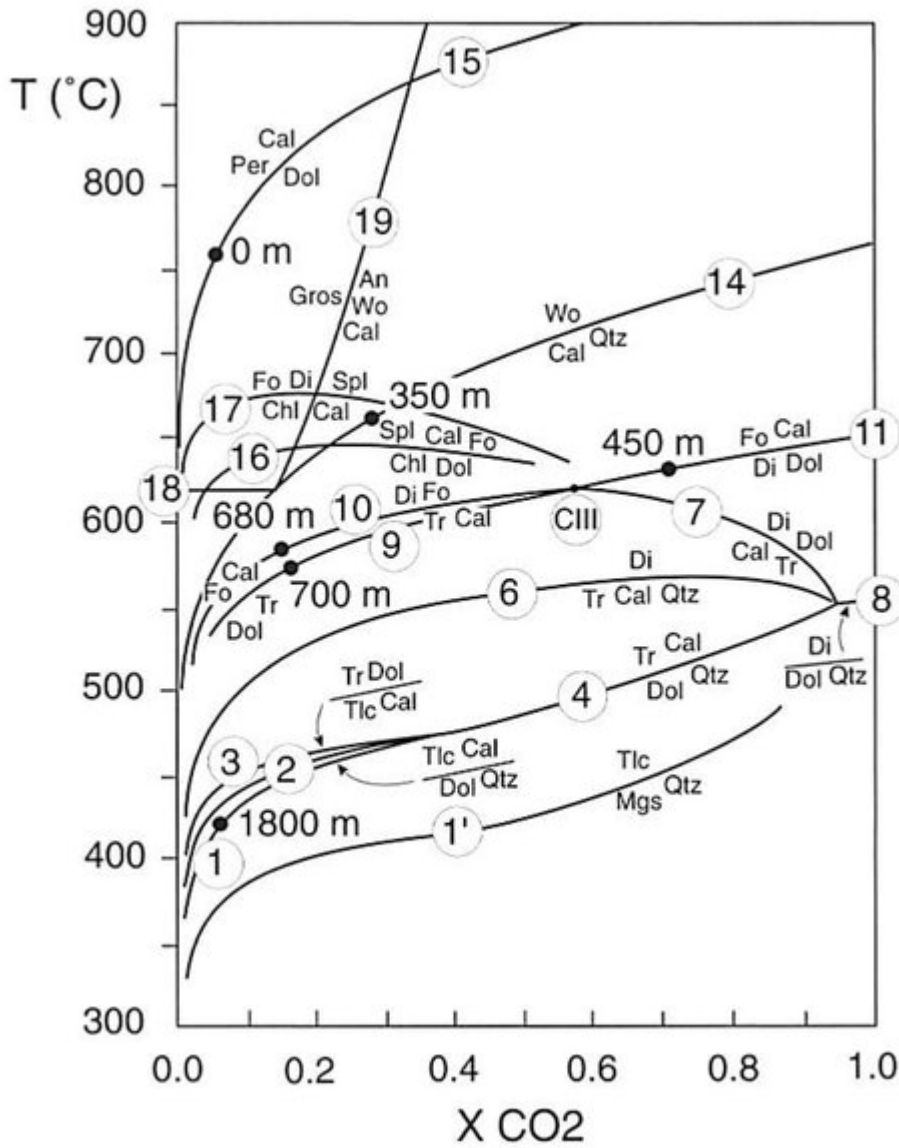
(Map 1) Geological map of the Ballachulish Igneous Complex and aureole. (map in endpocket).



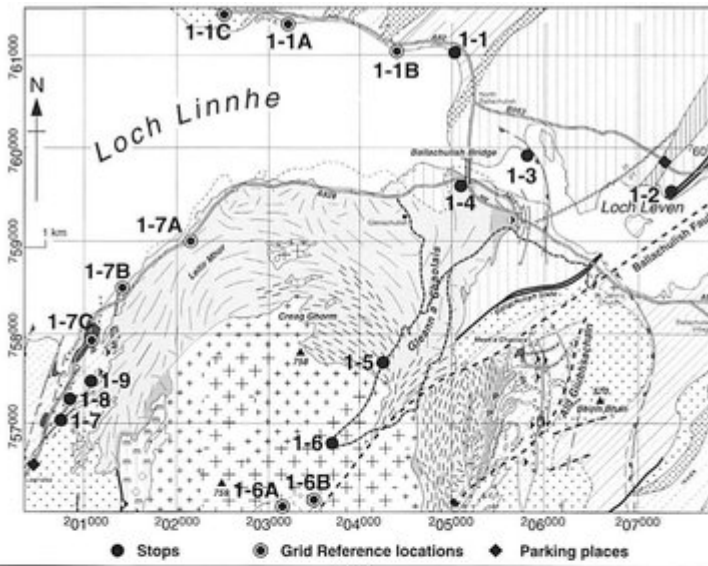
(Figure 7) Outline of area for field excursions. Geological map showing location of field stops for Day 1 (see (Figure 7) for key to geological map).



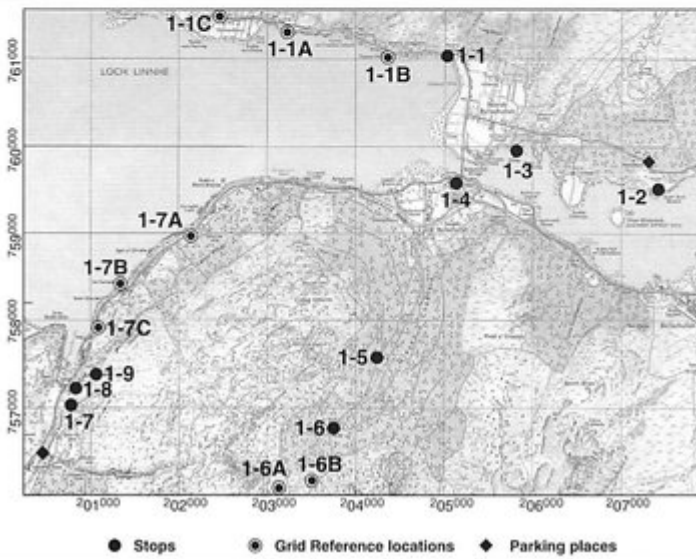
(Figure 5) Isograds in carbonate rocks from the Coire Giubhsachain syncline, northeast flank of igneous complex (Paulson & 1997; modified from Masch and Heuss-Aßbichler 1991 and Ferry, 1996a). Numbering of isograds is the same as in the text (with 'C' prefix omitted). Circled numbers and symbols 9, 10, CIII, 15 and 16 refer to assemblages and isograds observed in siliceous dolostones, whereas circled numbers 6 and 14 are for isograds in impure limestone.



(Figure 6) Isobaric $T-X_{CO_2}$ diagram (3 kbar) for selected equilibria in the chemical system $CaO-MgO-SiO_2-Al_2O_3-H_2O-CO_2$, showing numbered reactions discussed in the text (Pattison & Harte, 1997; modified from Masch and Heuss-Aßbichler 1991). All reactions except C18 involve H_2O and/or CO_2 . The unlabelled reactions are: $Tlc + Cal + Qtz = Tr + CO_2 + H_2O$. 18. $Gros + Qtz = An + Wo$ (phases on the right hand side of the reaction are on the high-temperature side)

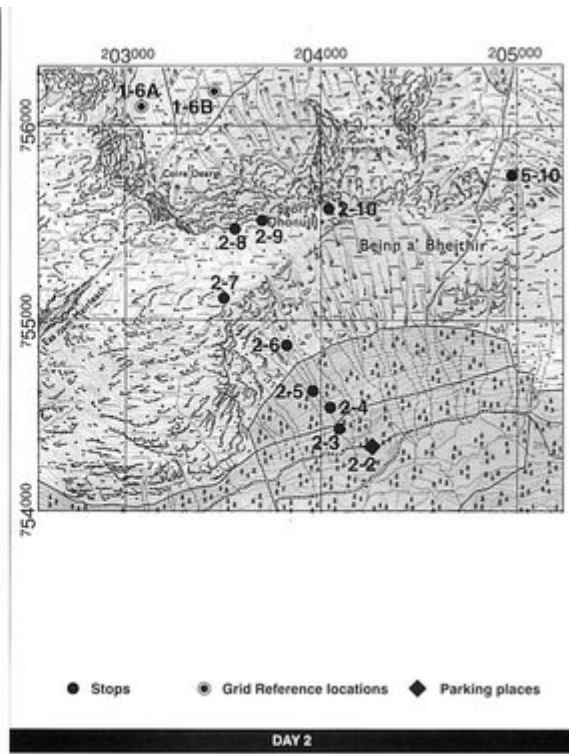
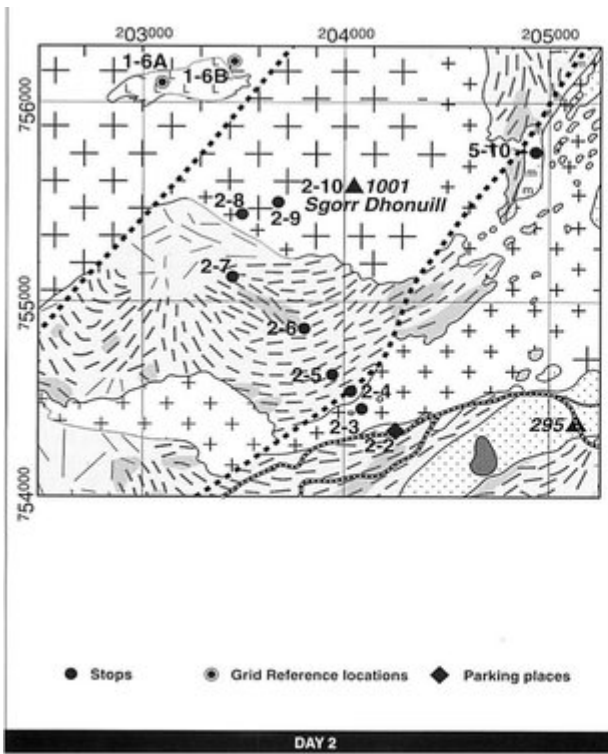


DAY 1

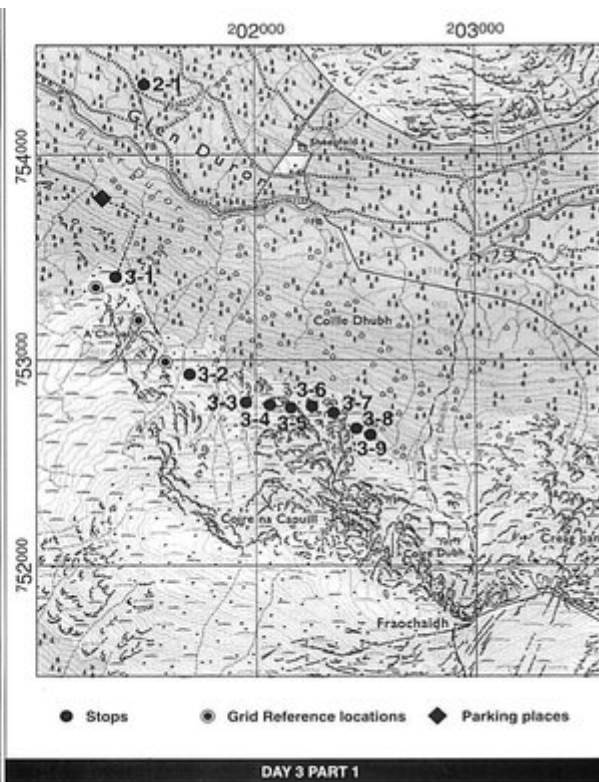
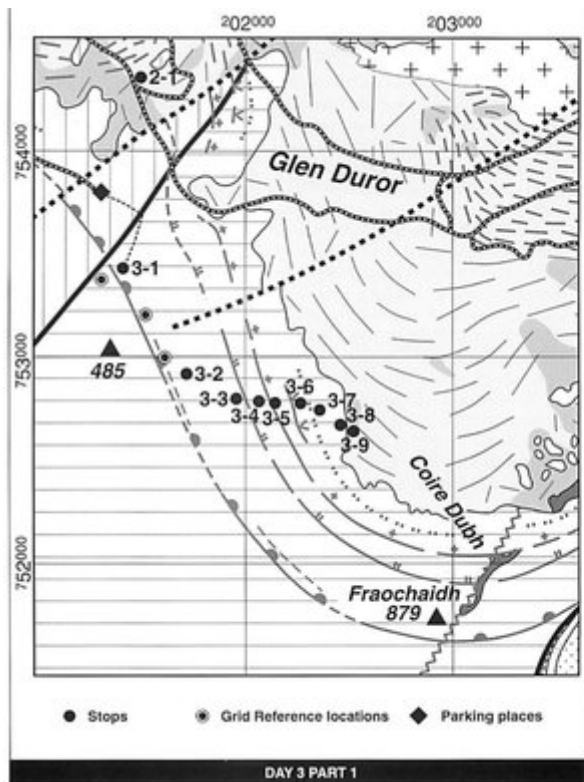


DAY 1

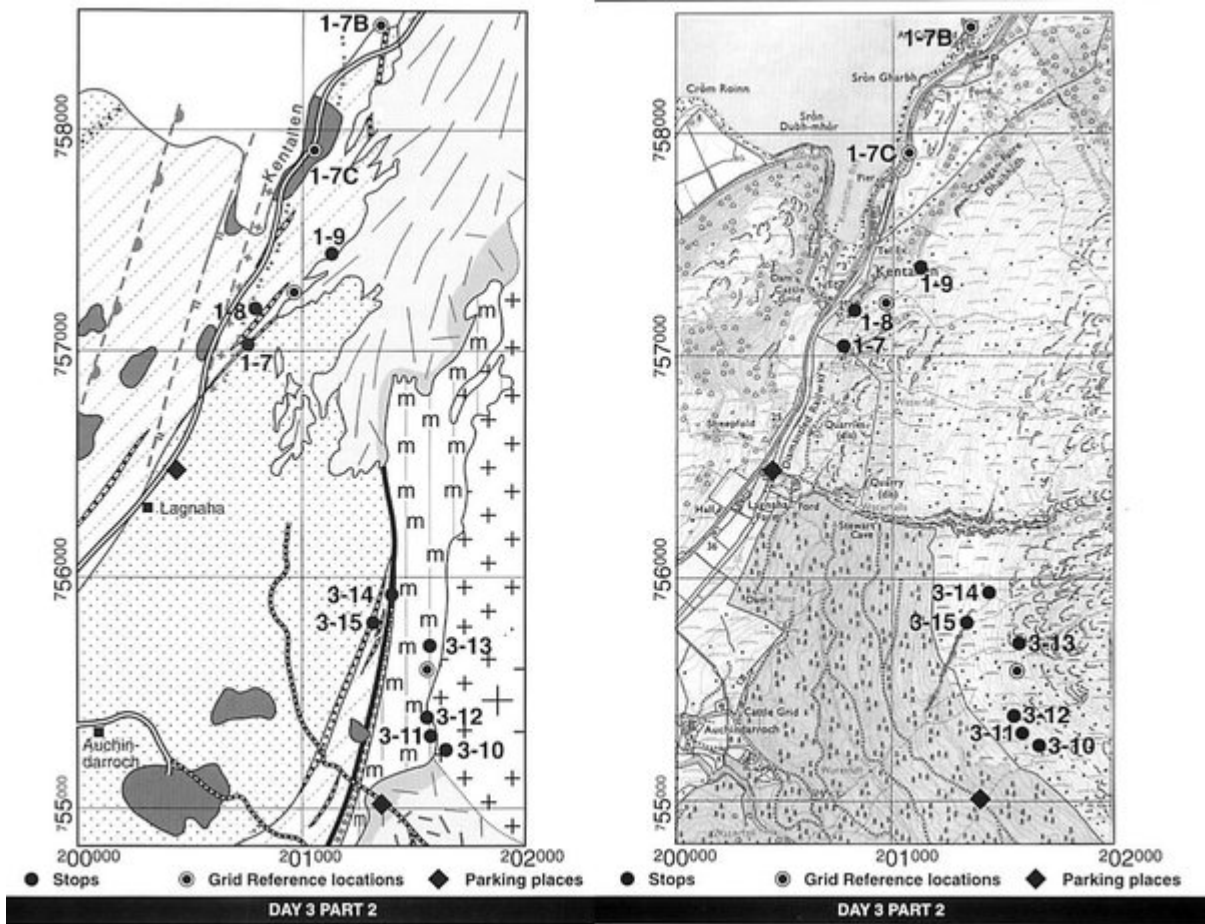
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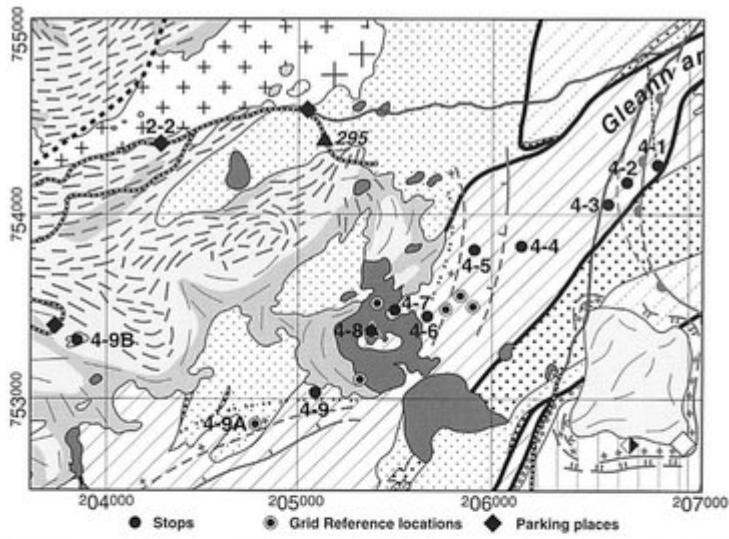
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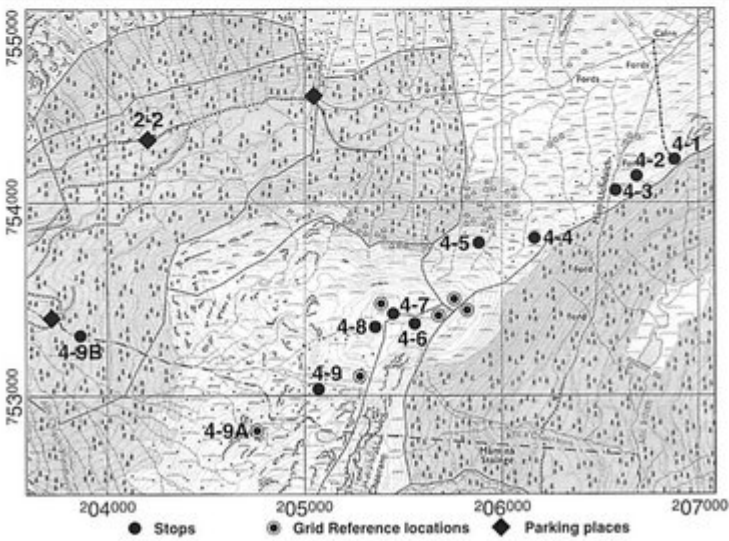
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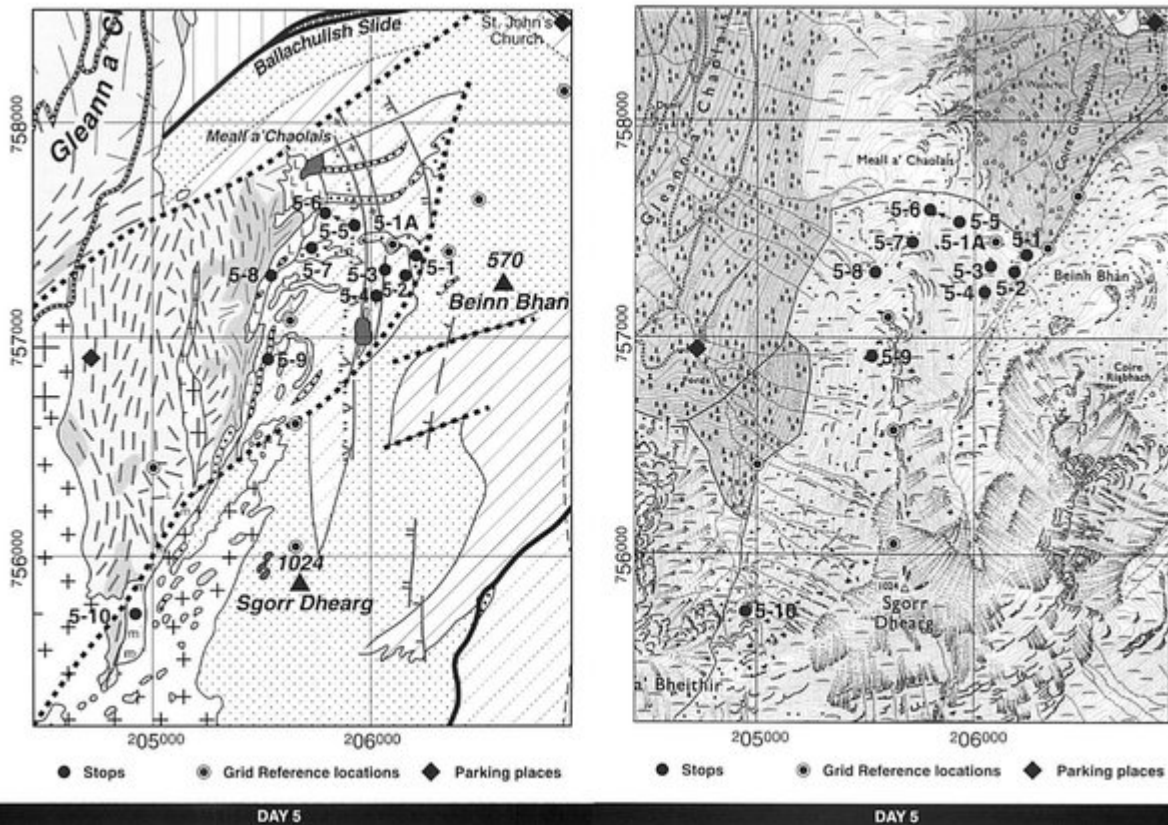


DAY 4



DAY 4

(Figure 12) (a) Geological map showing location of field stops for Day 4 (see (Figure 7) for key to geological map) (b) Corresponding topographic map showing location of field stops for Day 4 (reproduced with permission by the Ordnance Survey).



(Figure 13) (a) Geological map showing location of field stops for Day 5 (see (Figure 7) for key to geological map).(b) Corresponding topographic map showing location of field stops for Day 5 (reproduced with permission by the Ordnance Survey).



(Photo 1) (Frontispiece). Overview of the Ballachulish Igneous Complex and Aureole from Tom Meadhoin ridge, looking SW.



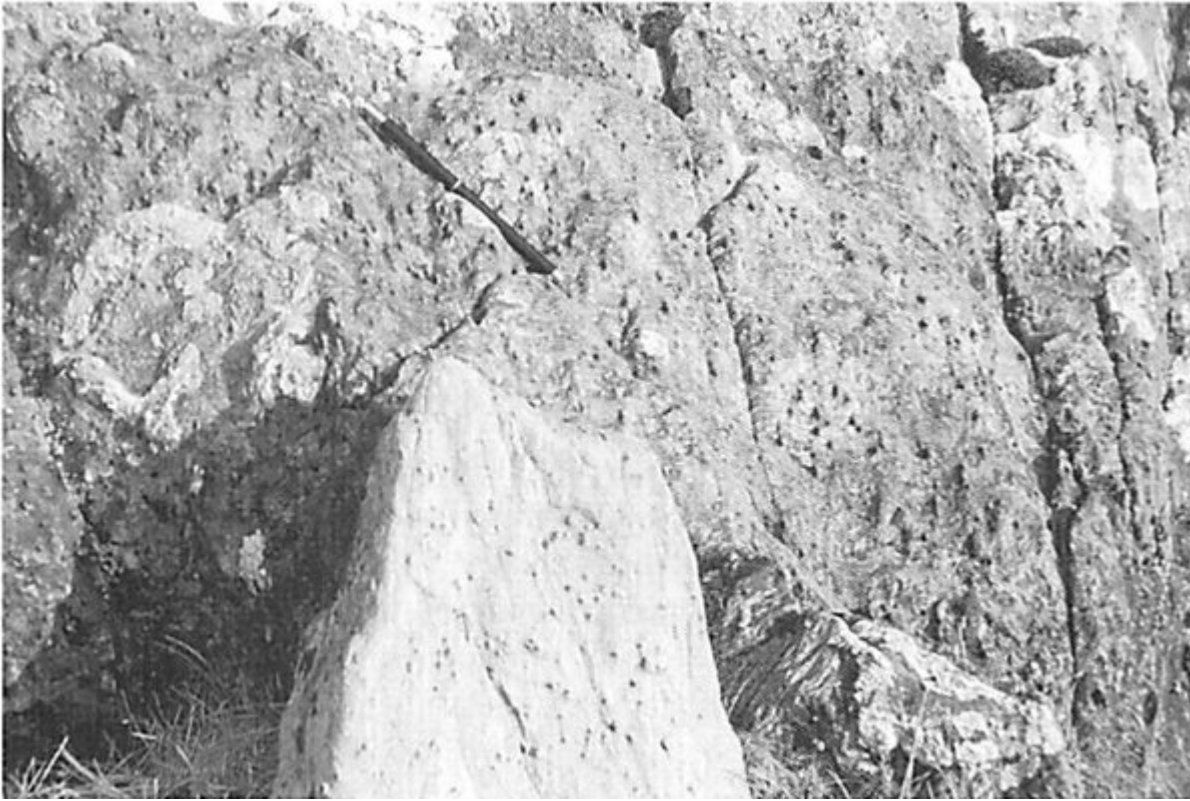
(Photo 2) View to SW from the summit of Sgorr Dhearg looking across Loch Linnhe



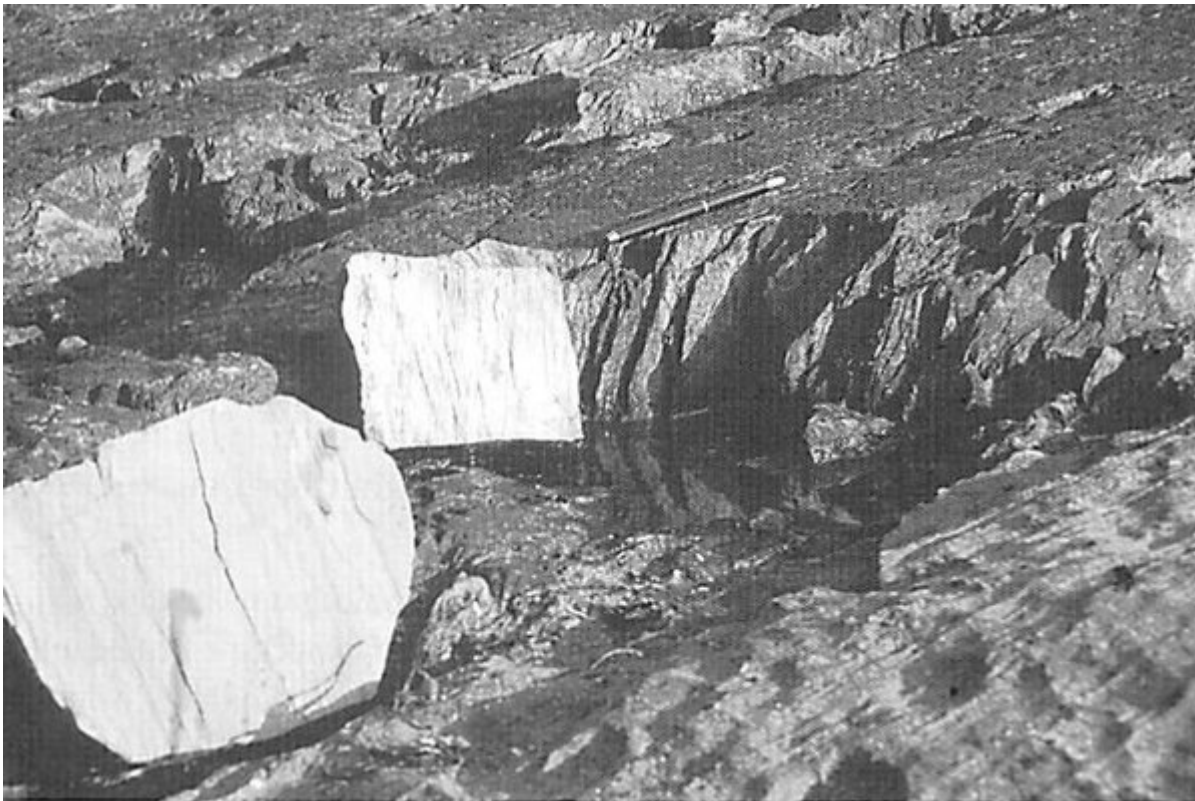
(Photo 3) View from Beinn Man looking NE to the town of Ballachulish and Loch Leven.



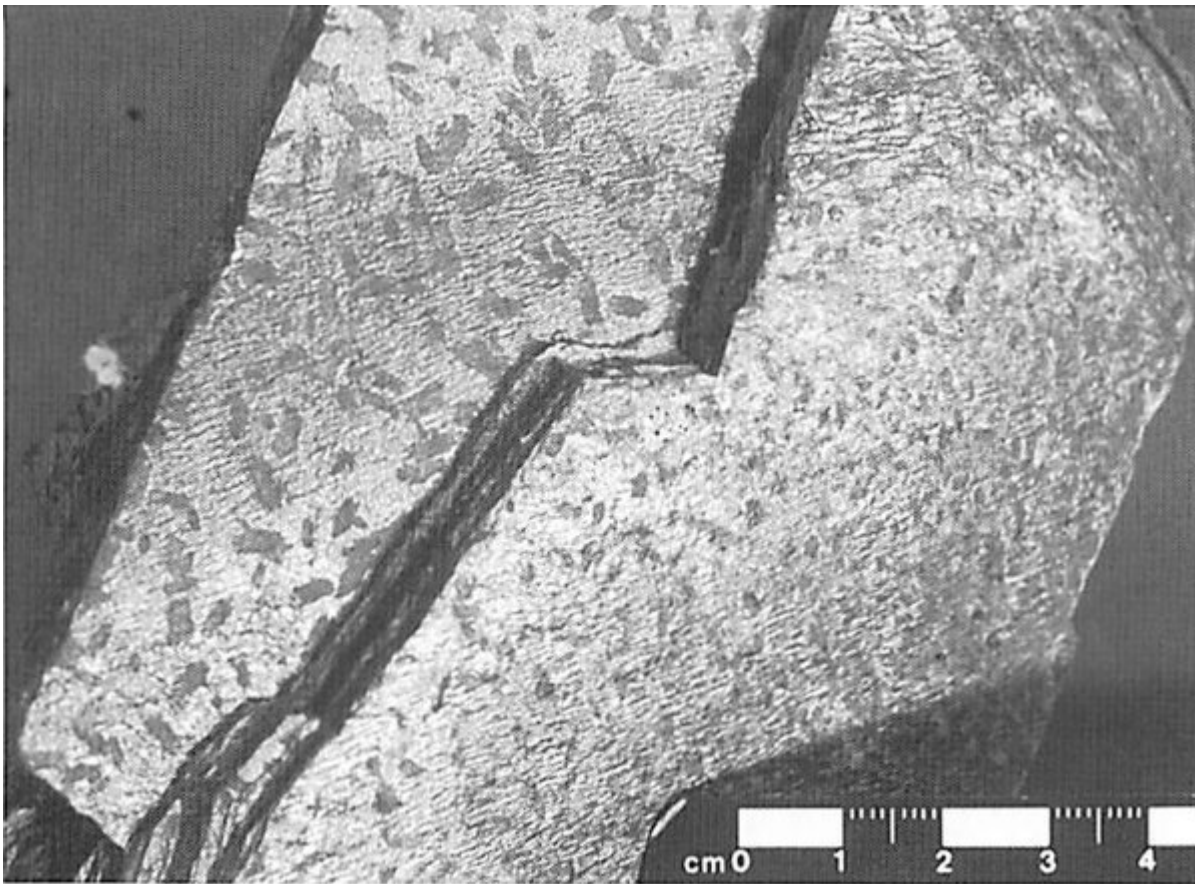
(Photo 4) View of the Beinn a' Bheithir massif underlain by the Ballachulish Igneous Complex and Aureole, taken looking south across Loch Leven from the Onich shore near Stop 1-1. The hill complex seen is referred to Collectively as Beinn Bheithir and the peaks of Sgorr Dhearg and Sgorr Dhonuill form the highest parts of this complex. To the right of the Ballachulish bridge one looks up into the valley of Gleann Chaolais. bounded on the right (west) by the rounded flank of Creag Ghorm (758 m), and on the left (east) by a ridge leading from the rounded shoulder of Meall a' Chaolais up to the slimy white peak of Sgorr Dhearg (1024 m). At the head of Gleann a' Chaolais and to the right (west) of Sgorr Dhearg is Sgorr (1001 m) and its subsidiary peak in the foreground, the Devil's Tooth, which forms a prominent cliff-rimmed triangular peak overlooking the head of Gleann a' Chaolais. To the left (east) of Sgorr Dhearg is another more rounded, white peak (unnamed) with a ridge leading down to the rounded shoulder of Beinn Bhan the latter separated from the Sgorr Dhearg ridge by Coire Giubhsachain. The eastern contact of the Ballachulish igneous complex with the host Dalradian metasediments is subparallel with the lower part of the Meall Chaolais - Sgorr Dhearg ridge, but was obliquely across it in the grassy portion of the ridge just above Meall a' Chaolais, so that it lies on the nearside of the Sgorr Dhearg summit. Interbedded metapelitic, quartzitic and calcareous layers of the Appin Group give rise to the generally more angular exposures along the upper parts of the Meall a' Chaolais– Sgorr Dhearg ridge. The white peak of Sgorr Dhearg itself and the white outcrops along the Beinb Bhan ridge up to the unnamed top to the left (east) of Sgorr Dhearg are formed by Appin Quartzite. On the right-hand (west) side of the mountain panorama, the boundary of the igneous complex lies between Creag Ghorm (on the photo) and the next hill (off the photo to the west). Thus most of the ground across the loch is underlain by rocks of the Ballachulish Igneous Complex, which gives rise to generally rounded outcrops. Most of Creag Ghorm and Meall o'Choalais are occupied by various varieties of monzodiorite and quartz diorite (see Coloured Map (Map 1)), the earliest of two main phases of the igneous complex. The second phase of granitic rocks, which were emplaced into the diorites in the central parts of the complex, form Sgorr Dhonaill, the Devil's Tooth and the upper more southerly parts of Creag Ghorm (hugely out of sight).



(Photo 5) Stop 1-2. Gametiferous phyllite/schist of the Leven Schist lithology, immediately west of the Ballachulish Slide.



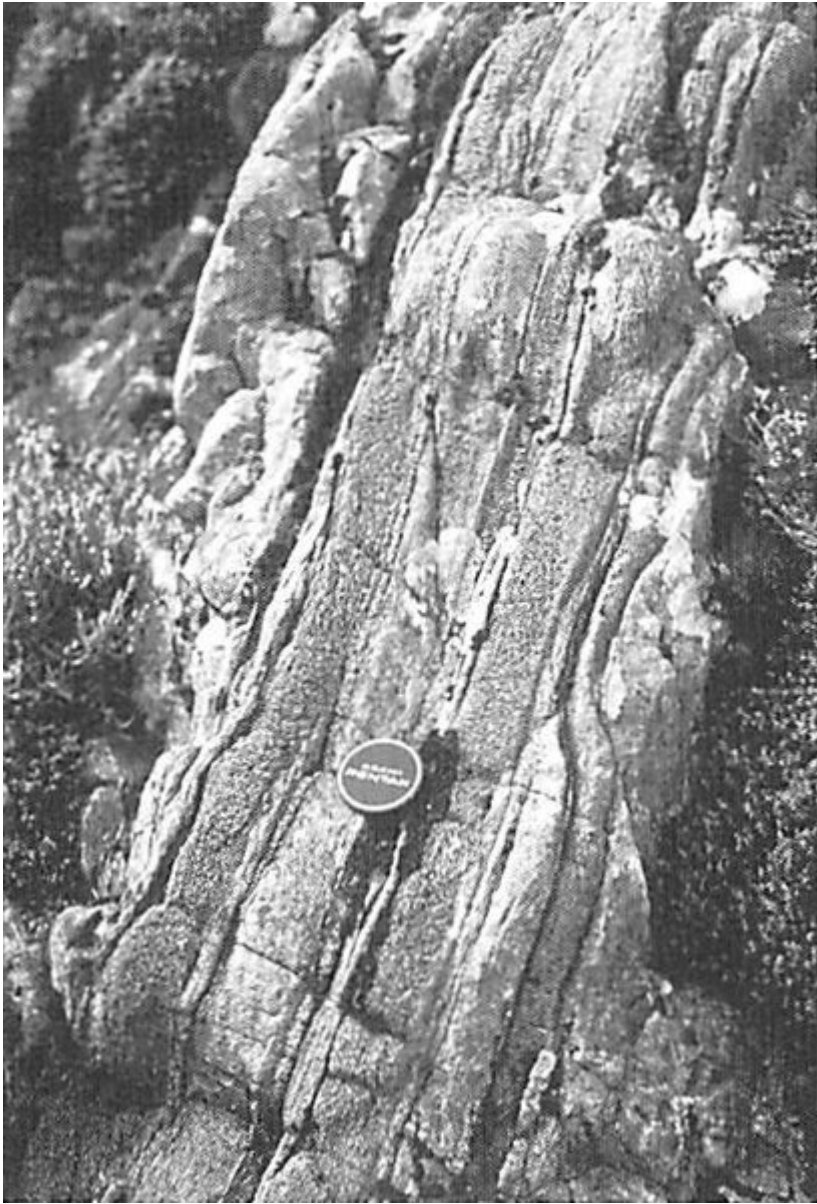
(Photo 6) Stop 1-2. Fine grained graphitic black slate/phyllite of the Ballachulish Slate lithology interbedded with dark grey marble of the Ballachulish Limestone lithology (foreground). These rocks lie immediately east of the Ballachulish Slide.



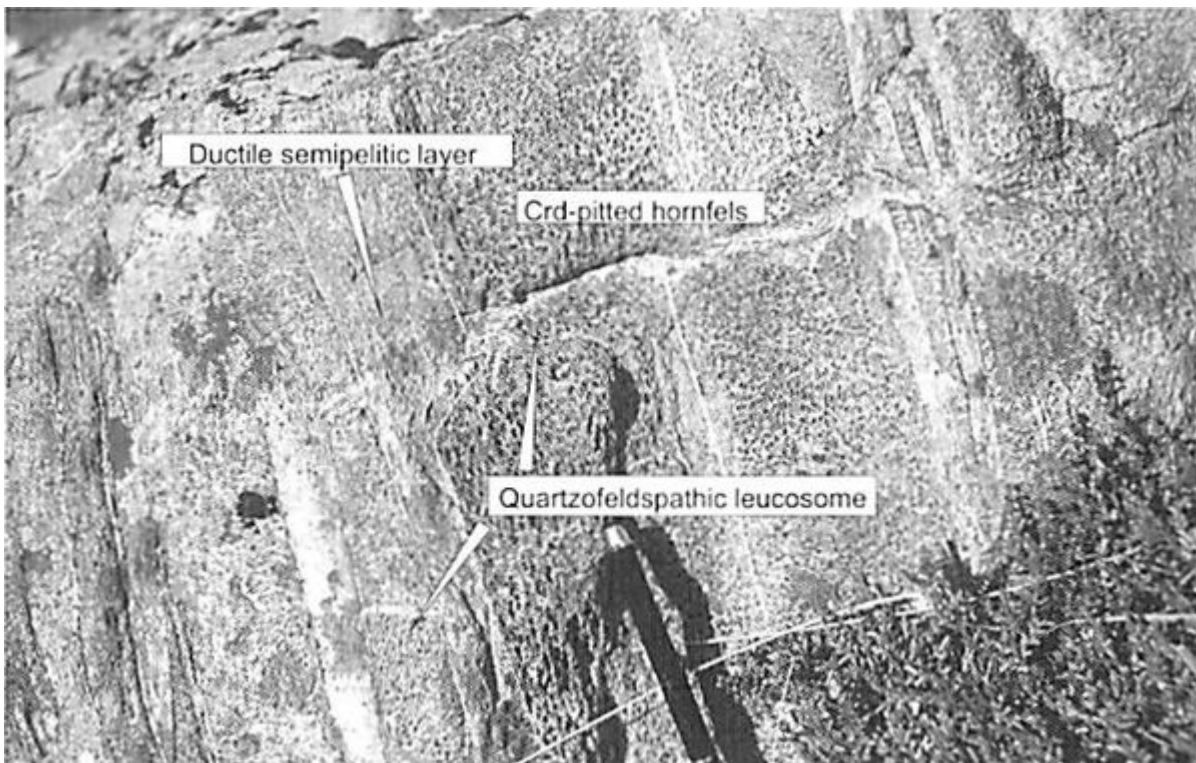
(Photo 7) Stops 1-3 and 3-1. Cordierite porphyroblasts visible as dark patches on cleavage planes of regional phyllites and schists. Note that the size of the patches varies in different parts of the rock. This sample comes from roadside exposures near the parking place for Day 3, Part 1, and shows a coarser development of cordierite patches than at Stop 1-3; but the style of development is similar at both these and other localities in the aureole.



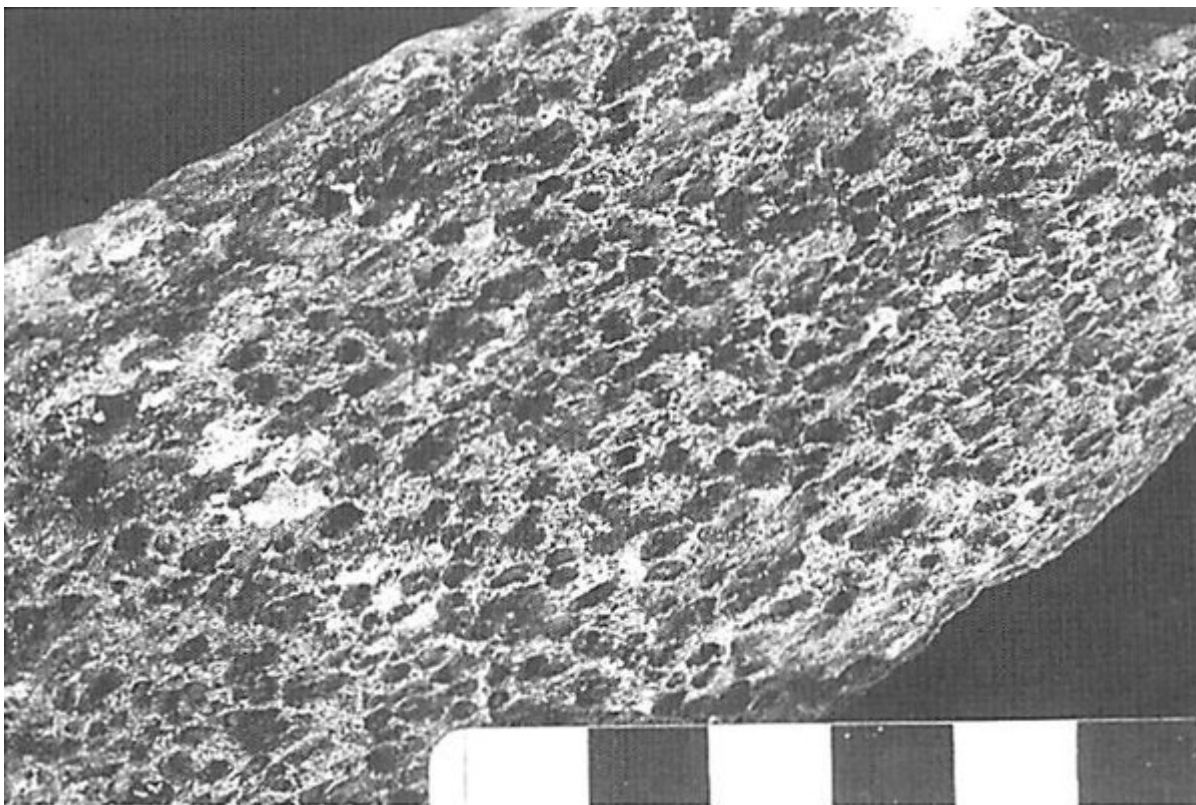
(Photo 8) Stop 1-7/1. Inclusion-rich quartz diorite. The inclusions range from metasedimentary, especially metapelitic, xenoliths, to intermediate-mafic igneous inclusions of similar mineralogy to the host quartz diorite.



(Photo 9) Stops 1-8, 5-4 and 5-5. Interbedded psammite (light layers) and pelitic hornfels (dark, knobby layers, rich in cordierite+K feldspar+andalusite), from Zone V. The actual exposure in the photograph is from near Stop 5-5, but is similar to exposures seen in the vicinity of Stop 1-8.



(Photo 10) Stops 1-8 and 1-9. Incipient migmatitic features in interbedded pelitic and semipelitic hornfels, upper Zone V. See description of Stop 1-9 for an explanation of the features.



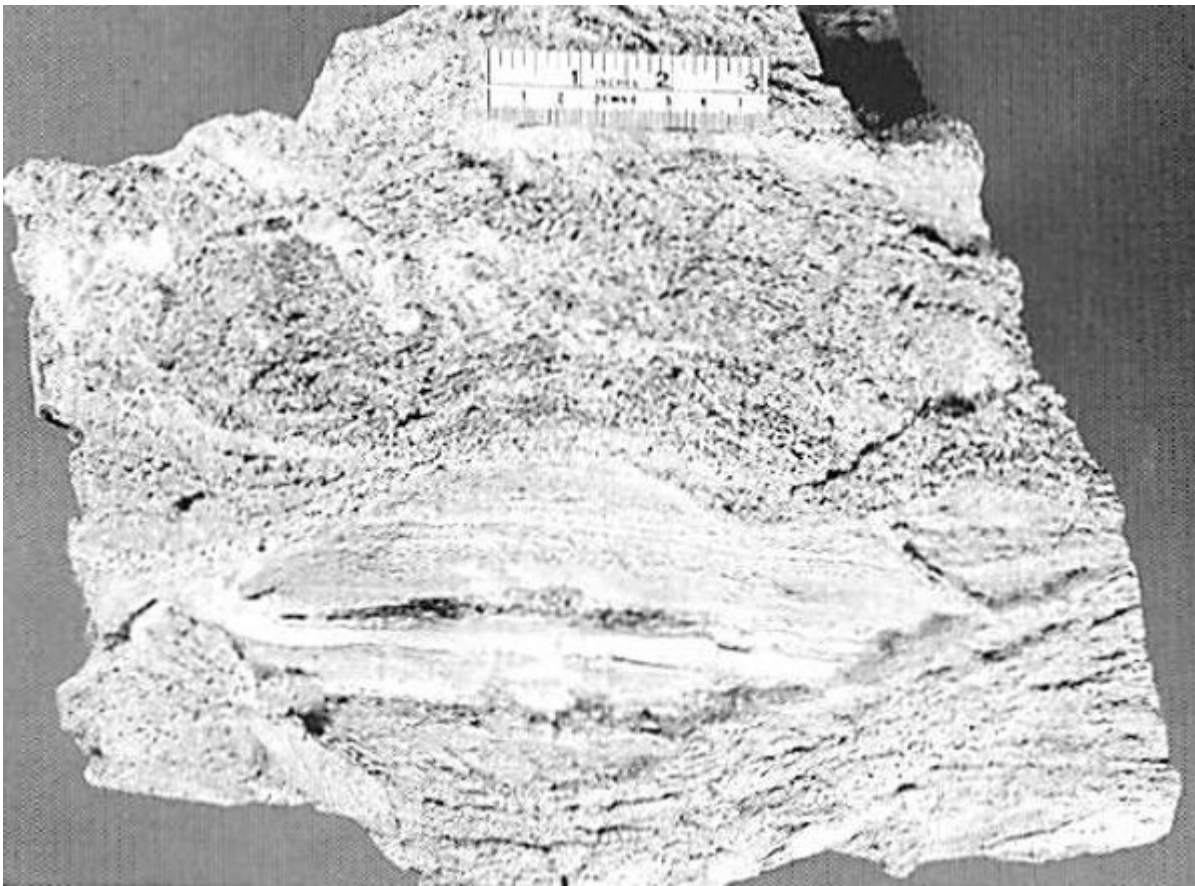
(Photo 11) Stop 3-3. Massive, pitted pelitic hornfels from the high grade end of Zone III. Fraochaidh transect. The pits represent the sites of weathered out cordierite crystals. The matrix surrounding the pits is rich in muscovite, biotite and quartz. Scale bar in cms.



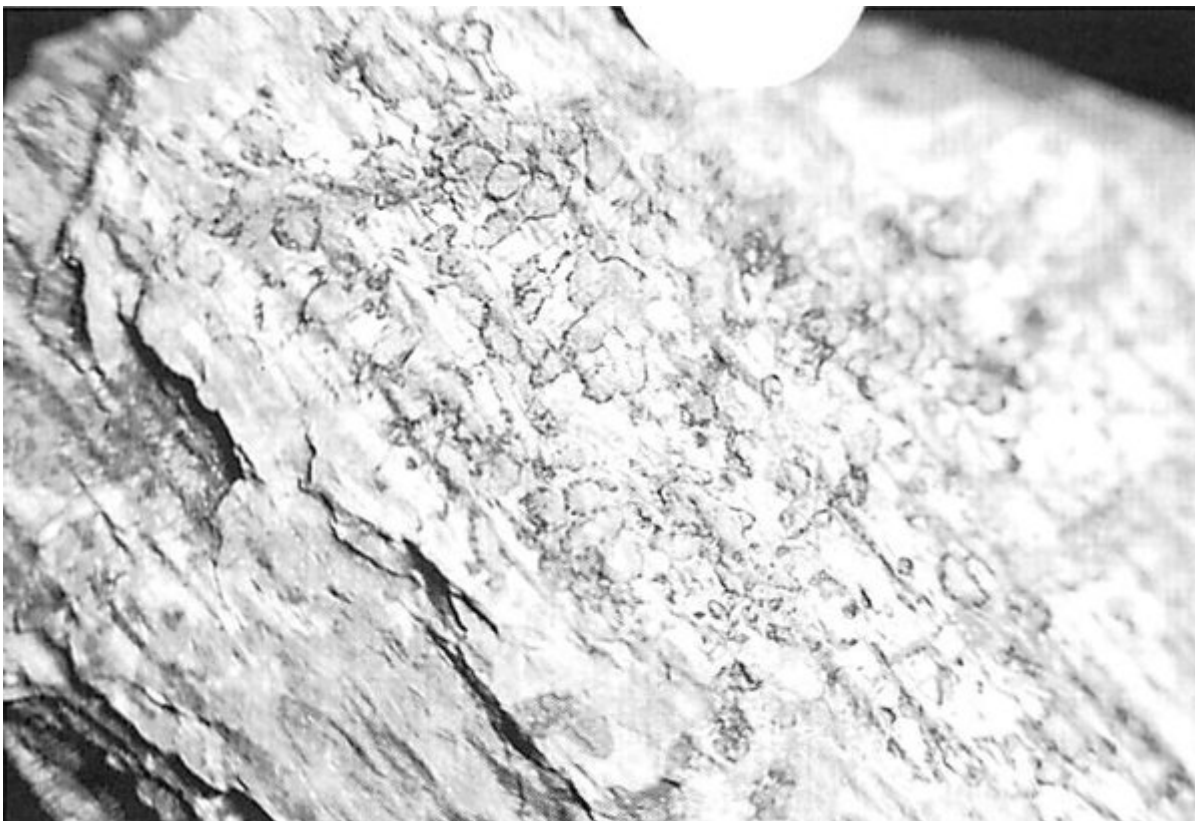
(Photo 12) Stops 3-4, 1-8, 5-2, 5-4 and 5-5. Massive Crd+Kfs-bearing pelitic hornfels characteristic of Zone IVb. The photograph was taken near Stop 5-5 in Coire Giubhsachain, but is representative of Zone IVb in many parts of the aureole. Note the mesh or honeycomb texture, defined by randomly orientated, weathered-out cordierite crystals (represented by pits) within a resistant, light coloured matrix rich in K-feldspar Note also that the matrix surrounding the pits is lighter colorant and more sharply defined than the matrix in hornfelses from Zone III (compare with (Photo 1)).



(Photo 13) Stops 3-11 to 3-13. View of a typical exposure of the Chaotic Zone migmatites. Note the isolated fragments of metapelite hornfels randomly orientated within a granular matrix containing veins. See the description of Stop 3-11 for a fuller description and explanation of these features.



(Photo 14) Stops 3-11 to 3-13. Detail of the Chaotic Zone migmatites. An isolated metasedimentary schollen, with relic bedding still preserved, occurs in lower part and is surrounded by a granular semipelitic matrix. An andalusite-rich domain occurs just below the scale bar in upper part.



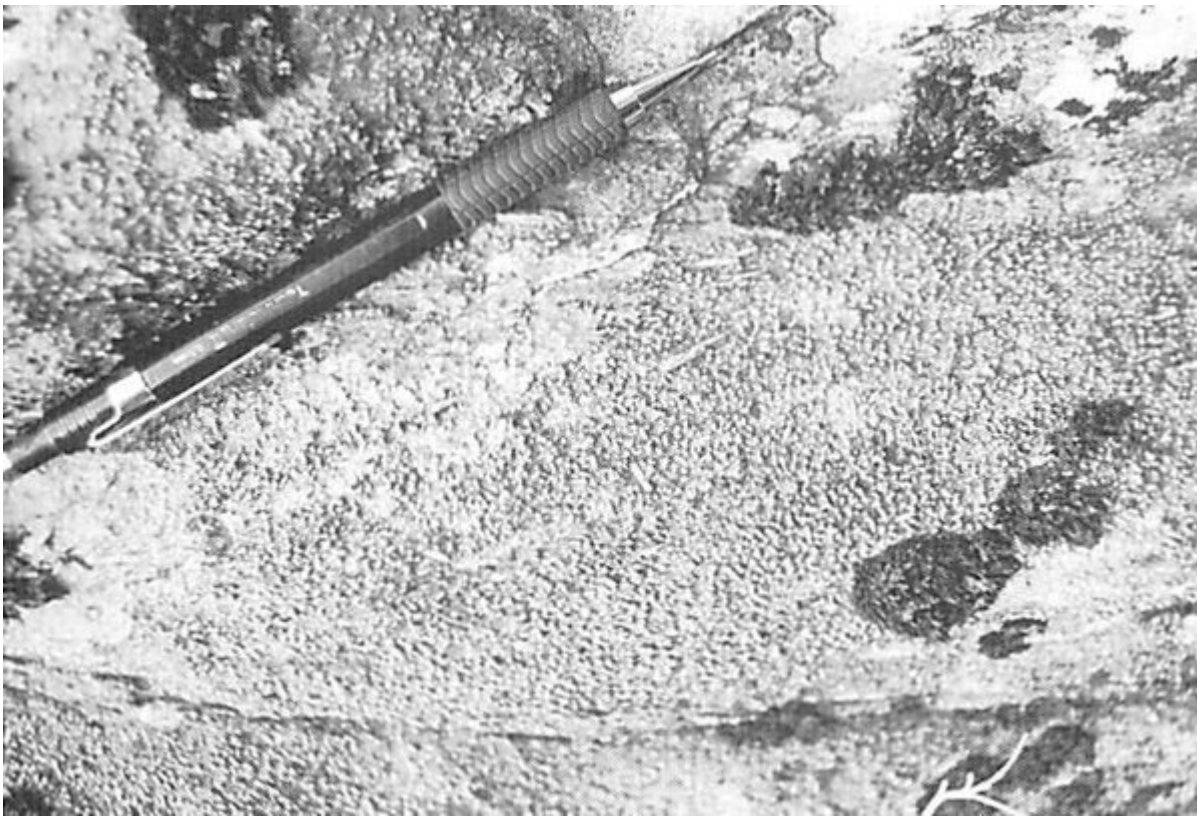
(Photo 16) Stop 4-3. Crenulated graphitic phyllite of the Ballachulish Slate lithology with abundant cordierite porphyroblasts forming roughly ovoid 'blobs'. Characteristic of Zone III in this vicinity.



(Photo 17) Stop -1- 5. A crenulated cleavage surface of the graphitic phyllite of the Ballachulish Slate lithology. The short elongate ribs, with widely varying orientation, mark the occurrence of abundant mm- to cm-long andalusite prisms. The full mineral assemblage in the rock is andalusite + cordierite + biotite + muscovite + quartz, characteristic of Zone IVa (see discussion under Stop -1-5). The andalusite in the rock shown is a little coarser grained than in most exposures in Zone IVa.



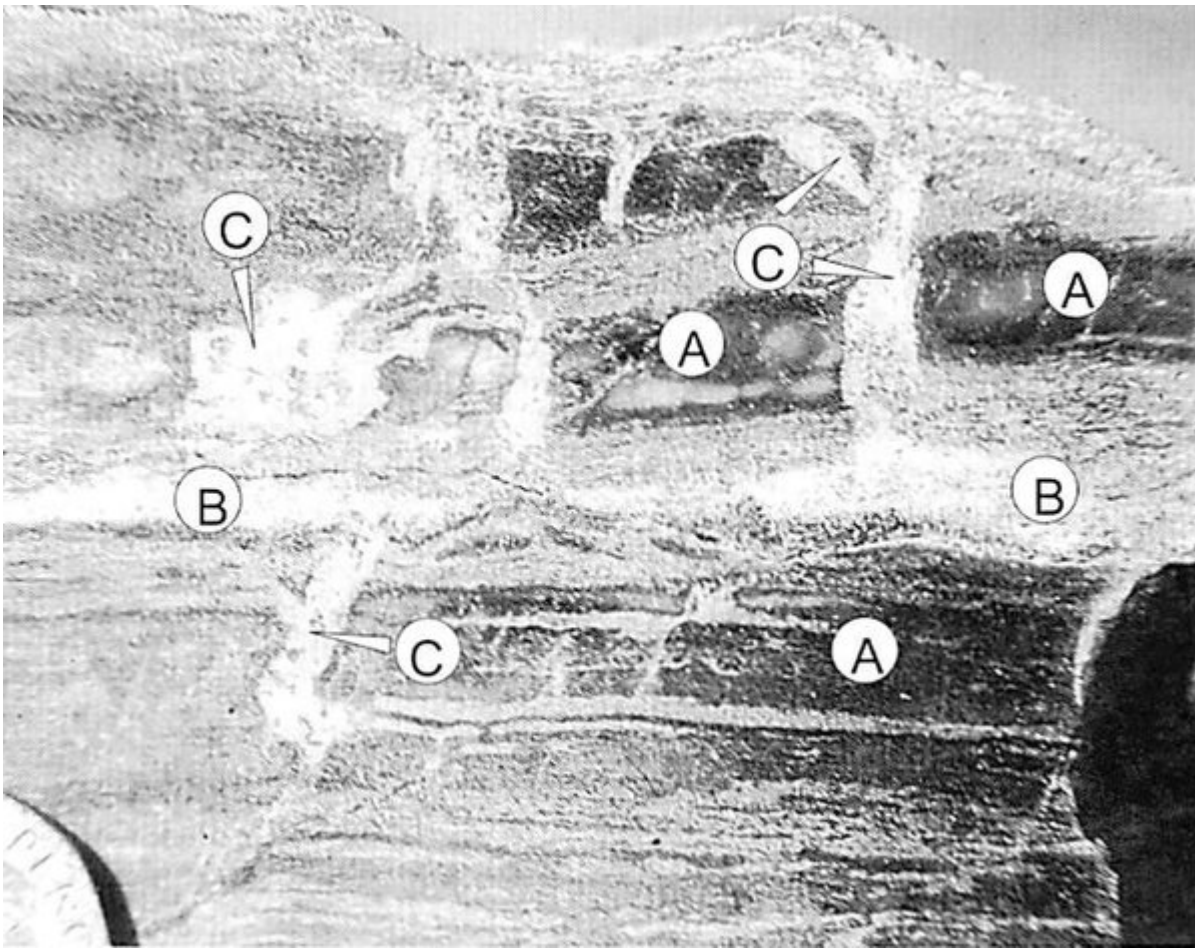
(Photo 18) Stops 5-3 to 5-6. 1-8 and 3-5. Randomly orientated andalusite prisms in a massive cordierite+K-feldspar-rich pelitic hornfels (Zone V). The photograph was taken at Stop 5-5.



(Photo 19) Stops 5-5, 1-8 and 3-5. Corundum-rich, quartz-absent pelitic hornfels of Zone Vb. The corundum is visible as abundant small, rounded 'pimples' that contrast with the more prismatic andalusite crystals seen below the pencil (compare with Photo 1S).



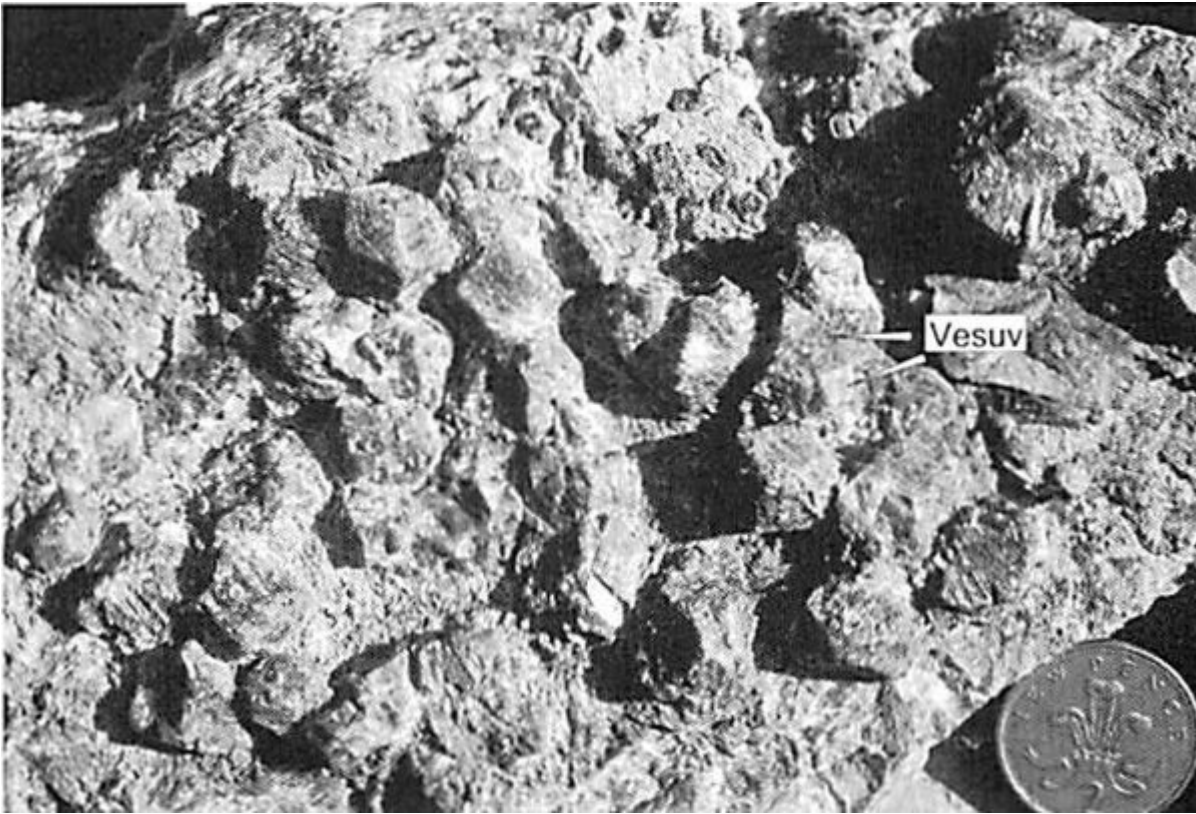
(Photo 20) Stop 5-6. Anastomosing veins rich in K-feldspar + quartz, within layered cordierite+K-Feldspar-rich pelitic and semipelitic hornfels. The prominent light coloured vein (lower left of photograph) is of granitic material from the igneous complex. See notes of Stop 5-6 (above 560 m) and Stop 1-9 for a fuller description and explanation of the veins and other features. From the ridge/plateau area around Stop 5-6.



(Photo 21) Stop 5-6. Detail of migmatitic rocks with boudin-type structures. The original lithology was of interlayered pelitic and semipelitic material and now shows rigid, pulled apart cordierite-rich hornfels (metapelite) layers (A), ductile semipelitic layers (B) and segregated Kfs+Qtz-rich leucosomes occupying the gaps between the pulled apart hornfels layers (C). Notice how the leucosome merges into the ductile semipelite, giving the impression of being extracted from it. Field of view is 5 cm across. See notes of Stop 1-9 for further explanation.



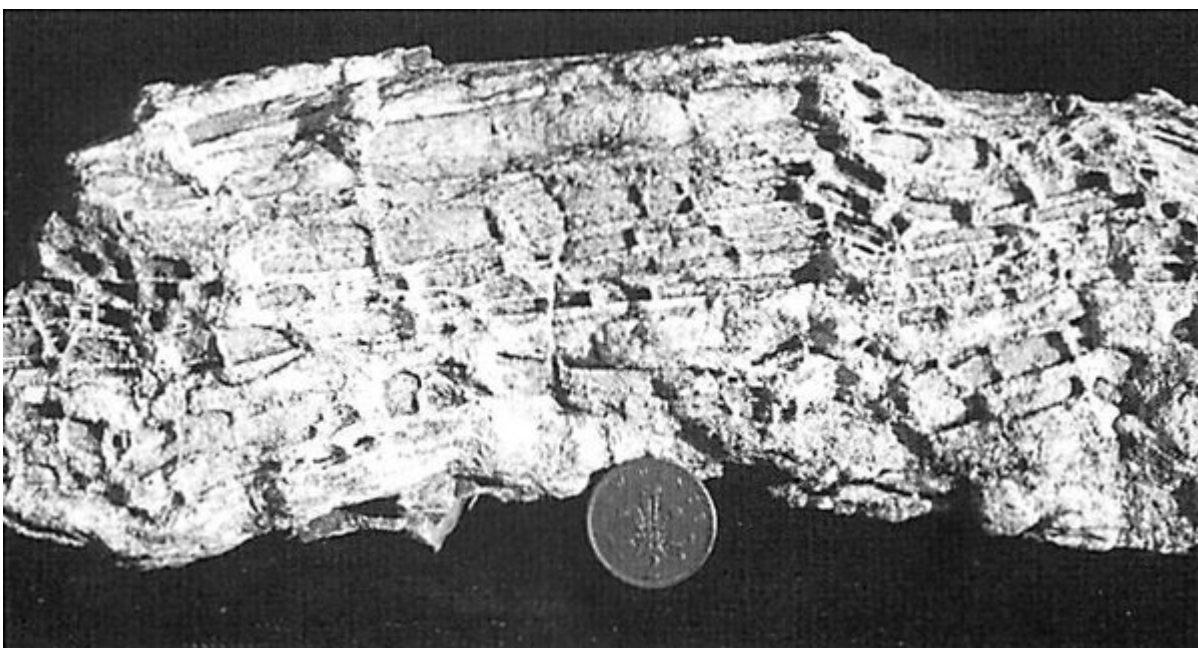
(Photo 22) (opposite, above). Stops-7. Calcite+spinel (Spl)+Forsterite-bearing dolomitic marble with folded veins of calcite and forsterite. The Forsterite is commonly, extensively altered to serpentine giving the veins a yellow-brown colour on the weathered exposure surface.



(Photo 23) Stop 5-9. Calcsilicate rock rich in grossular (equant crystals) and vesuvianite (indicated 'vesuv').



(Photo 24) Stop 5-10. 'Chocolate-tablet' migmatites. See the notes under Stop 5-10 for a description and explanation of the features visible in the top part of the photograph. Cutting across the bottom of the photograph is a lighter coloured dyke-like body of quartz-diorite, carrying many inclusions of pelitic hornfels; boundary picked out with white line.



(Photo 25) Stop 5-10. Detail of 'chocolate-tablet' migmatite. The rock consists of interlayered *petite* and *semipelite*. *Cordierite*-rich hornfels layers and broken into angular fragments in a tablet structure, with mobile leucocratic material both cross-cutting and running parallel to the layering. The mobile leucocratic material separating the hornfels fragments merges into semi-pelitic layers and does not form extensively cross-cutting veins. Compare with (Photo 10) and (Photo 21).

	Grid ref. (sheet NN)	Features		Grid ref. (sheet NN)	Features
Stop 1-1 E. of Onich	0505/6105	Panoramic overview of the igneous complex and aureole from Onich	Stop 1-1a Onich shore	0320/6130	Petrology and structure of regional biotite-grade Appin metapelites and interbedded limestones
Stop 1-2 North shore of L. Leven	0730/5950 to 0745/5945	Dalradian host rocks to the complex; the relations between metamorphic and structural development – debate between two famous geologists, Bailey and Tilley	Stop 1-1b Onich shore	0430/6105	Quartzites and semi-pelites, with bedding and cleavage structures illustrating orientation and facing of major Appin Syncline structure
Stop 1-3 North shore of L. Leven	0575/5995	Incipient effects of contact metamorphism, shown by cordierite-spotted phyllites	Stop 1-1c Onich road	0235/6150	Complementary stop to Stop 1-1B (see text)
Stop 1-4 Ballachulish Bridge	0520/5960	Xenolith-bearing quartz diorite, typical of much of the outer part of the igneous complex in the north	Stop 1-6a Gleann a' Chaolais	0310/5605	Late, fine grained microgranite
Stop 1-5 Gleann a' Chaolais	0425/5760	Monzodiorite with orthopyroxene-clinopyroxene, intruded early in the igneous complex	Stop 1-6b Gleann a' Chaolais	0345/5615	Cu-Mo mineralisation and sericitic alteration weakly developed in association with late microgranite
Stop 1-6 Gleann a' Chaolais	0375/5675	Granite, typical of the inner part of complex, and intruded at later stage	Stop 1-7a Kentallen	0215/5895	Xenolith-bearing marginal quartz diorite
Stops 1-7,	0075/5705	High-grade calcisilicate and pelitic hornfelses (with cordierite+K-feldspar ±andalusite ±corundum) and leucosome structures indicative of melting	Stop 1-7b Kentallen	0135/5845	Lit-par-lit intrusion of high-grade hornfels
			Stop 1-7c Kentallen	0105/5790	Kentallenite rock of Appinite suite

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(Table 1) a. Principal itinerary of stops for Day 1: Overview of the Ballachulish Igneous Complex, Dalradian host rocks and contact hornfelses b. Optiollal additional stops during Day 1 itinerary.

	Grid ref. (sheet NN)	Features
Stop 2-1 Glen Duror	0150/5430	Xenolith-rich quartz diorite
Stop 2-2 Parking place in Glen Duror	0425/5435	Biotite-poikilitic, two pyroxene monzodiorite, and start of the foot traverse
Stop 2-3	0410/5445	K-feldspar-porphyrific quartz monzodiorite of major apophysis of the the later 'granite'
Stop 2-4	0405/5455	Crushed and altered zone in two pyroxene monzodiorite
Stop 2-5	0395/5460 to 0390/5470	Varieties of two pyroxene monzodiorite Varieties of two pyroxene monzodiorite
Stop 2-6	0385/5485	Late stage rhyolite dyke
Stop 2-7 Edge of Sgorr Dhonuill plateau	0345/5515	Partially hydrated augite monzodiorite, showing the transition from two pyroxene monzodiorite into the hybrid transition zone
Stop 2-8	0350/5545	Pink biotite-hornblende quartz monzodiorite, representative of the hybrid transition zone
Stop 2-9	0370/5550	Pink biotite-hornblende granodiorite of the central 'granite'
Stop 2-10	0405/5555	Summit of Sgorr Dhonuill

(Table 2) Itinerary of stops for Day 2: Rock types and intrusive relationships of the igneous complex.

	Grid ref. (sheet NN)	Features		Grid ref. (sheet NN)	Features
Stop 3-1 Below (S of) A'Chruach	0140/5340	Fissile cordierite-spotted phyllites of Zone II	Stop 3-10 Above Auchindarroch	0165/5525	Hybrid granite of the igneous complex
Stop 3-2	0170/5290	Hardened cordierite-spotted phyllites of Zone III	Stop 3-11	0160/5530	Disrupted pelitic and semipelitic rocks of the 'Chaotic Zone'
Stop 3-3 Coire na Capuill	0195/5275	Massive cordierite-rich hornfels of Zone III	Stop 3-12	0160/5535	Intrusive veins and dyke cross-cutting disrupted migmatites
Stop 3-4	0210/5280	Cordierite+K-feldspar hornfels of Zone IVb with honeycomb structure	Stop 3-13	0160/5565 to 0160/5575	Many good exposures of 'Chaotic Zone' migmatites
Stop 3-5	0215/5275	Andalusite+K-feldspar hornfels of Zone Va	Stop 3-14 Above Lagnaha	0145/5590	Striped calcsilicates of the Ballachulish Limestone lithology
Stop 3-6	0225/5280	Corundum-bearing hornfels of Zone Vb	Stop 3-15	0135/5580 to 0125/5560	Marbles, calcsilicates and semipelites of the Appin Limestone/Appin Phyllite lithology
Stop 3-7	0235/5270	Different types of veins in hornfels: onset of partial melting			
Stop 3-8 Coire Dubh	0245/5265	Garnet+cordierite-bearing and spinel- bearing hornfels			
Stop 3-9 Coire Dubh	0250/5265	Biotite+hornblende quartz monzodiorite of the igneous complex			

(Table 3) Itinerary of stops for Day 3: Part 1 Fraochaidh prograde sequence. b. Itinerary of stops for Day 3 Part 2 Chaotic Zone migmatites and nearby carbonates and calcsilicates.

	Grid ref. (sheet NN)	Features
Stop 4-1 Low point of ridge	0690/5425	Quartzite and regional grade crenulated graphitic slate, Zone I
Stop 4-2	0670/5415	Incipient cordierite spotting in grey phyllites, Zone II
Stop 4-3	0655/5410	Widespread cordierite spotting in grey phyllites, Zone III
Stop 4-4	0620/5380	Cordierite-rich hornfelses, Zone III
Stop 4-5	0585/5380	Massive andalusite+cordierite hornfelses, Zone IVa
Stop 4-6	0560/5340	Massive brown-weathering andalusite-rich hornfelses and incipient melting phenomena, probable Zone V
Stop 4-7 Hill top	0545/5345	Migmatized cordierite+ K-feldspar+ andalusite+sillimanite hornfelses, Zone V, subzone of partial melting
Stop 4-8	0535/5340	Appinite and quartz diorite relations
Stop 4-9	0510/5305	Well exposed migmatites
Optional Stop 4-9A	0475/5280	Coarse andalusite and corundum
Optional Stop 4-9B	0385/5330	Orthopyroxene-garnet hornfelses

(Table 4) Itinerary of stops for Day 4: Prograde metapelitic hornfels zones in the Ballachulish Slate along the Gleann a' Fhiodh-Coire Chaorann ridge: appinite and quartz diorite relations; migmatites and Crd+Grt+Opx hornfelses.

	Grid ref. (sheet NN)	Features
Stop 5-1 Allt Giubhsachain	0625/5740	Interbedded dolostone, limestone and quartzite
Optional Stop 5-1A	0615/5745	Siliceous carbonate exposures containing isobaric invariant assemblage cal+dol+tr+di+fo
Stop 5-2	0615/5730	Interbedded pelitic and semipelitic hornfels, Zone IVb
Stop 5-3	0605/5730	Muscovite + Qtz = Andalusite + K-feldspar (Zone IV/V) isograd
Stop 5-4	0605/5720	Spectacular massive cordierite + K-feldspar ± andalusite hornfelses, Zone V
Stop 5-5	0590/5750	Corundum-bearing hornfelses, Zone Vb
Stop 5-6 Ridge top	0590/5750 to 0575/5755	Increasing range and intensity of migmatitic features going upgrade
Stop 5-7	0570/5745	Veined calcite+dolomite+spinel+forsterite(serpentine) marbles
Stop 5-8	0555/5730	Periclase-bearing marble outcrops surrounded by leucogranite
Stop 5-9	0555/5690	Layered grossular+vesuvianite-rich calc-silicates
Stop 5-10	0495/5575 to 0485/5545	Spectacular 'chocolate tablet' migmatites and xenolith-rich quartz diorite

(Table 5) Itinerary of stops for Day 5: Medium- to high-grade interbedded pelitic and calcsilicate hornfelses and marbles; various migmatites, including 'chocolate-tablet' type; summit(s) of Beinn a' Bheithir.