

# Southern Highland Group, Grampian Caledonides

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[Jump to navigation](#) [Jump to search](#)

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## Southern Highland Group



Block diagram of major structures in the Grampian Highlands. P915427.

The group is made up mainly of turbiditic rocks, typically coarse-grained, poorly sorted metagreywackes with subordinate fine-grained slates and phyllites. Albite-schists and minor intercalations of pelite with limestone occur locally. Volcaniclastic 'green beds' are widespread at several levels, notably in the basal part of the group, and there is one thick local development of basic lavas. In general character the turbidites are similar to those of the preceding Argyll Group. Sedimentary structures are common and environments such as fan channels, overlapping fan lobes, overbank deposits and basin plains have been inferred (Harris et al., 1978; Anderton, 1985). The sedimentary rocks are markedly more chloritic than those of the underlying Argyll Group, partly due to the generally lower metamorphic grade, but probably also reflecting the volcanic input. They are also more feldspathic, with high-grade metamorphic and granitic rock fragments, suggesting a less-mature source area.

Although several local successions have been established, detailed correlations are seldom possible over any distance. The general persistence of turbidite facies, both laterally and vertically throughout the group, means that there are few reliable stratigraphical marker bands. Green beds are useful locally, but the slate facies is probably highly diachronous. Correlations are further complicated by across-strike changes in metamorphic grade which significantly alter the appearance of the rocks and have led to different names for units which are probably equivalent stratigraphically. Green beds and slate/phyllite units are typically concentrated in the lower part of the group and coarse-grained turbidites predominate in the upper part. However, it is not at present practical to divide the group, other than locally, and consequently no subgroups are recognised. Indeed, in terms of thickness and uniformity of facies the whole group is comparable to a subgroup in other parts of the Dalradian succession.

The Southern Highland Group can be traced from County Mayo in western Ireland to the north-east Grampians. Although the group is probably no more than 7000 m thick in Scotland, much of its outcrop occurs in areas of gentle regional dip such as the Flat Belt of the Tay Nappe (see Chapter 6).

Consequently its outcrop covers a wide area of some 4900 km<sup>2</sup>. A small outlier occurs in the core of the Loch Awe Syncline, but the main outcrop is a belt, up to 34 km wide, extending along the whole south-eastern edge of the Grampian Highlands from the Mull of Kintyre to Stonehaven and Aberdeen. In the north-east the group occupies the broad core of the Turriff Syncline and a small outlier on the east coast around Collieston.

In the core of the Loch Awe Syncline, the Tayvallich Volcanic Formation is overlain by up to 1100 m of chloritic graded gritty psammites, green slates and subordinate black slates, calcareous in parts, which together comprise the *Loch Avich Grit*. The succeeding *Loch Avich Lavas* consist of 300 to 500 m of basaltic pillow lavas with no significant sedimentary intercalations (Borradaile, 1973).

In the part of the main outcrop of the Southern Highland Group to the south-west of Loch Lomond, the Loch Tay Limestone is succeeded to the south-east by a typical, predominantly metagreywacke sequence (McCallien, 1929; Roberts, 1966). The basal part of this sequence is known locally as the *Glen Sluan Schist* and consists of up to 500 m of schistose pelitic turbidites, lithologically similar to the main part of the succession but separated from it by the *Green Beds*. The latter form a well-defined stratigraphical unit up to 1000 m thick in the South-west Highlands. Metagreywackes, siliceous psammites and fine-grained quartzites are interbedded with the predominant well-foliated green schists containing abundant chlorite, epidote, biotite and albite porphyroblasts. These lithologies become hornblende-schists at higher metamorphic grades. Within the green schists, lenses of obvious detrital material, pebbles of quartz and graded bedding indicate a sedimentary origin. The beds probably represent an influx of detrital basic volcanic material, a feature reflected in their chemistry and mineralogy (Phillips, 1930; van de Kamp, 1970). Metabasic sheets within the unit represent shallow intrusions and the whole assemblage may be contemporaneous with the Loch Avich Lavas. The Green Beds are best regarded as a persistent volcanoclastic development in the lower part of the main sequence of turbidites which are known in this area as the *Beinn Bheula Schist*. This unit consists predominantly of fine-grained metagreywackes with lenticular developments of schistose psammites, commonly pebbly. Green slates and siltstones, and albite-schists occur locally, but black slates are rare.

Much of the Southern Highland Group outcrop lies on the inverted limb of the Tay Nappe which, in the South-west Highlands, is folded into the broad late Cowal Antiform. Consequently, the lower parts of the group are again exposed on the south-eastern limb of this fold. On the Cowal Peninsula the Green Beds are represented mainly by metabasic igneous bodies, but they are not present elsewhere on this limb. The Beinn Bheula Schist passes stratigraphically downwards into the *Dunoon Phyllite* (equivalent to the Glen Sluan Schist) which extends from Bute to Loch Lomond. This unit consists of dark bluish grey and greenish grey slates and phyllites with subsidiary graded metagreywacke units. Thin limestone beds and lenses are locally associated with the black slates. Near Luss, the slates have been quarried for roofing tiles. On the eastern side of Kintyre, the lower parts of the group are represented by the *Skipness Schist*. This comprises siliceous schists, many gritty and conglomeratic, with only subordinate bands of slate and phyllite so that they are difficult to distinguish from the Beinn Bheula Schist.

The Dunoon Phyllite lies within the complex hinge zone of the Tay Nappe which takes the form of a downward-facing (i.e. synformal) anticline known as the Aberfoyle Anticline farther to the north-east. Consequently the rocks which crop out to the south-east, between the phyllites and the Highland Boundary Fault Zone, are regarded as younger than the phyllites and broadly equivalent to the Beinn Bheula Schist (Anderson, 1947; Roberts, 1966; Paterson et al., 1990). Marked decreases in structural complexity, development of cleavage and grade of metamorphism occur towards the Highland Border. It is thus difficult to correlate lithologies across the regional strike. The *Bullrock Greywacke* succeeds the Dunoon Phyllite to the south-east and hence must be broadly equivalent to the Beinn Bheula Schist. It consists mainly of pink-weathering pebbly and gritty metagreywackes

with greenish grey siltstone interbeds. Black slates and dark grey limestones occur locally. In Cowal and Bute, coarse pebbly psammities with conglomerates and more persistent limestones and black slates have been placed in a separate lithostratigraphical unit, the *Inellan 'group'*, broadly equivalent to the Bullrock Greywacke. In north Arran (Richey, 1961) a similar synformal anticline structure exists, with the *Loch Ranza Slate* occupying the core of the anticline and the *North Sannox Grit* on each limb.

In the Southern Highlands to the north-east of Loch Lomond, the Southern Highland Group consists predominantly of rocks of turbiditic greywacke facies which, throughout most of this area, are referred to as the *Ben Ledi Grit* (Mendum and Fettes, 1985). Green beds and metabasic intrusions are widespread at various horizons in the lower part of the succession. Detrital sodic feldspar is common in the psammities and a redistribution of sodium during metamorphism has given rise to many porphyroblastic albite-schists in the pelitic units (Bowes and Convery, 1966; Watkins, 1983). North-eastwards from the Killin area the basal part of the Southern Highland Group is dominantly pelitic and is termed the *Pitlochry Schist*. Garnetiferous mica-schists are the characteristic lithology, but quartzose psammities and graded metagreywackes are common (Johnstone and Smith, 1965). The Pitlochry Schist grades stratigraphically upwards and laterally into the Ben Ledi Grit.

Correlations of grit and slate/phyllite units of the upper part of the Southern Highland Group in the 'steep belt', which forms the south-eastern part of the outcrop near the Highland Boundary Fault, are more complex than previously supposed (Harris, 1962; 1972; Harris and Fettes, 1972). Boundaries between grit and slate units are demonstrably diachronous. Hence, although the slates generally occur in the cores of downward-facing anticlines, neither the local slate units nor the fold axes are likely to be continuous along the whole length of the Highland Border. In both the Aberfoyle and Callander areas, fold hinges are occupied by dark bluish grey to grey-green and purple slates with subsidiary laminated siltstones, silty greywackes and bands of coarse gritty greywackes. In both areas these slate sequences are referred to as the *Aberfoyle Slate*. On the south-east limb of the major synform the *Leny Grit* is equated with the Ben Ledi Grit on the north-west limb. Adjoining the Leny Grit on its south-eastern margin is a unit of blue-grey slates and phyllites which are commonly calcareous and contain thin limestones (Harris, 1962; Francis et al., 1970). These have been referred to as the *Leny Limestone and Shales*. The fossiliferous limestone of the nearby Leny Quarry is probably part of this unit (Harris, 1969) but outcrops of both limestone units may be fault-bound and their stratigraphical affinity is uncertain (see Chapter 9). Around Dunkeld the hinge of the Tay Nappe is truncated by the Highland Boundary Fault and consequently there is no equivalent of the Aberfoyle Anticline. The whole succession in this part of the steep belt consists of *Birnam Grit* (oldest), *Birnam Slate* and *Dunkeld Grit* (youngest) and youngs to the north-west.

North-east from the Dunkeld area the general stratigraphical relationship of a lower, more pelitic metagreywacke sequence to the north-west passing into an upper, more psammitic metagreywacke sequence to the south-east persists to the east coast between Aberdeen and Stonehaven (Anderson, 1942). The Pelitic 'group' of Anderson forms an outcrop continuous with the Pitlochry Schist of the Glen Shee area and contains similar lithologies, dominated by garnet-mica-schists but passing into slates or sillimanite-gneisses depending upon metamorphic grade. In the Glen Clova area recent mapping has recognised a basal unit termed the *Longshank Gneiss*. This unit shows a marked facies change from dominantly pelitic in the south-west to dominantly psammitic in the north-east and is characterised by strongly magnetic beds throughout (Chinner, 1960). Green beds are abundant between Kirkmichael and Glen Clova but are notably absent north-east from Glen Clova. The younger graded metagreywackes and schistose psammities are continuous with the Ben Ledi Grit to the south-west and this name has been retained throughout the area by Anderson (1942).



D1 recumbent fold in dominantly inverted gritty and pelitic metagreywackes. Collieston Formation, Southern Highland Group, Devil's Study, near Whinnyfold, Aberdeenshire. P002878.

Around upper Glen Esk, an extensive right-way-up sequence was assigned by Harte (1979) to the Tarfside Nappe, a major recumbent structure below the Tay Nappe. Alternative interpretations involving later large-scale tight folding of the Tay Nappe on gently dipping axial planes can also explain the distribution of units. Within the Tarfside Nappe the sequence consists of an intimate association of pelites, semipelites and psammities of typical Southern Highland Group metagreywacke type. A lower unit, the *Glen Effock Schist*, passes upwards into the higher *Glen Lethnot Grit*, characterised by bands of pebbly psammite, and hence a broad correlation is suggested with the Pitlochry Schist and Ben Ledi Grit of the Tay Nappe (Harte, 1979). Munro (1986) has suggested that part of the Aberdeen Formation to the south of Aberdeen may be equivalent to the Glen Effock Schist.

To the north of Aberdeen, low-grade turbiditic rocks occur in an eastward-younging sequence on the coast between Collieston and Cruden Bay and for a few kilometres inland (Read and Farquhar, 1956; Munro, 1986). These rocks are assigned to the *Collieston Formation* which is predominantly a psammitic sequence of graded metagreywackes with characteristic 'knotted' pelites containing andalusite and cordierite ([P002878](#)). Thin lenses of calc-silicate rock are common and minor thin limestones occur south of Collieston. Metadolerites and amphibolites, which represent intrusive sheets, also occur locally. Contacts with adjoining units are not exposed, but the deformational pattern has much in common with the older, higher grade Stuartfield division and Ellon Formation to the west.

In the Turriff Syncline a sedimentological transition from the Argyll Group into the Southern Highland Group is well seen. On its western limb, the base of the Southern Highland Group is drawn at the base of the first massive meta-greywacke above the calcareous beds of the Boyne Limestone Formation, but below the horizon in the middle of the former Whitehills 'group' chosen by Harris and Pitcher (1975). The succession consists of some 2000 m of siliceous psammities with subordinate pelites (Read, 1923; Sutton and Watson, 1955), now renamed the *Whitehills Grit Formation*. On the eastern limb a similar transition is observed from the calcareous succession noted in the Kinnairds Head 'group' and the Strichen Formation into the non-calcareous metagreywackes and pelites of the *Rosehearty 'group'* and *Methlick Formation* (Read and Farquhar, 1956). In the core of the syncline the Southern Highland Group is represented by the *Macduff Slate Formation* (1700 m), a finer-grained, more distal turbidite facies with slump deposits, clean channel sandstones and subsidiary greywackes (Sutton and Watson, 1955). A more persistent semipelitic facies to the south-west has

been termed the *Clashindarroch Formation*, which has been quarried extensively in the past for roofing slate in an east-west-trending belt to the north of the Inch and Boganloch intrusions. Boulders and pebbles of igneous and metamorphic rocks, some of extrabasinal origin, occur in some of the highest exposed parts of the Macduff Slate Formation immediately to the east of Macduff. These were interpreted as a product of ice rafting by Sutton and Watson (1954). Hambrey and Waddams (1981) have confirmed this interpretation and have described a 20 m-thick sequence of tillites culminating in a possible lodgement till deposited from a grounded ice sheet. However, the evidence is not conclusive and other workers prefer a less contentious mudflow hypothesis.

Considerable changes in metamorphic grade occur across the Turriff Syncline and several lithological units were originally defined using criteria which have subsequently been recognised as metamorphic features. Thus the *Boyndie Bay 'group'* on the western limb of the syncline, which is characterised by andalusite schists, is now regarded as equivalent to the lower part of the lower grade Macduff Slate Formation. Similarly, to the south-east, the Macduff Slate and Roseheartly 'group' grade downward into the *Fyvie Schist*, which is characterised by andalusite and cordierite porphyroblasts giving a 'knotted' appearance; it is now placed in the Methlick Formation. The closure of the syncline can be traced to the south of the Inch basic mass, in the Correen Hills. Here, the Southern Highland Group is represented by the *Suie Hill Formation* which consists dominantly of semipelites and impure gritty psammites with prominent pelite units. The base is taken at a distinctive, magnetite-bearing pelitic schist which forms a regional magnetic anomaly. Similar magnetic units occur on the western limb of the syncline and elsewhere in the basal part of the group and may indicate an influx of detrital magnetite due to a change in provenance or the unroofing of a new source.

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[Category:](#)

- [Grampian Highlands](#)

## **Navigation menu**

### **Personal tools**

- Not logged in
- [Talk](#)
- [Contributions](#)
- [Log in](#)
- [Request account](#)

### **Namespaces**

- [Page](#)
- [Discussion](#)

## Variants

## Views

- [Read](#)
- [Edit](#)
- [View history](#)
- [PDF Export](#)

## More

## Search

## Navigation

- [Main page](#)
- [Recent changes](#)
- [Random page](#)
- [Help about MediaWiki](#)

## Tools

- [What links here](#)
- [Related changes](#)
- [Special pages](#)
- [Permanent link](#)
- [Page information](#)
- [Cite this page](#)
- [Browse properties](#)

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