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# 10 Kymah Burn

[NJ 2881 2304]–[NJ 3008 2236]

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## 10.1 Introduction

The Kymah Burn is a major headwater tributary of the River Livet, which cuts through the Ladder Hills providing a cross-section through the Ladder Hills Formation and overlying Kymah Quartzite Formation of the Islay Subgroup. The section illustrates the varied nature of the stratigraphy at the base of the Argyll Group and the overall fold structure. It is the type section for the Kymah Quartzite Formation. Thin pillow-lava units show that periodic basic volcanism took place during sedimentation.

The Ladder Hills Formation is laterally equivalent to the metadiamictite-bearing Auchnahyle Formation, which lies some 16 km to the south-west and is described in the *Muckle Fergie Burn* GCR site report. It consists mainly of interbedded psammite, semipelite and pelite, much of it showing grading and other bedding features typical of turbidite deposition. It also includes some mottled grey, green and cream 'fragmental' units rich in chlorite and epidote, possibly representing tuffaceous units, and rare cream metadolostone beds. Along strike to the south, similar lenticular metadolostone beds are associated with metadiamictite units but no metadiamictites have been reported from the Kymah Burn section. To the south-east, towards Glen Buchat, the upper part of the Ladder Hills Formation passes laterally into a more-pelitic and calcareous unit, the Nocht Semipelite and Limestone Formation. The overlying Kymah Quartzite Formation consists mainly of quartzite and psammite, but includes thin amphibolitic metavolcanic units, which locally show vesicular textures and pillow structures. Basic sheets also intrude the quartzite, and although they are now foliated and metamorphosed to amphibolite, discordant relationships are still visible in places.

The succession has been folded into a kilometre-scale refolded fold, repeating the stratigraphy. As the beds themselves show only low to moderate strain, the structure can be determined from bedding and cleavage measurements and observations, taking cognizance of relatively abundant way-up indicators (grading, cross-bedding, pillow lavas).

The area was first mapped by L.W. Hinxman for the Geological Survey in 1892–3 and it was he who recognized the presence of basic sheets in the quartzite. No further work was done until the area was resurveyed by the British Geological Survey in the mid 1980's as part of the revision of 1:50 000 Sheet 75E (Glenbuchat, 1995).

## 10.2 Description

The Kymah Burn runs through an incised gorge in the Ladder Hills, where relief ranges from 150–230 m in the lower part, overlooked by the crags of The Eachrach, to c. 100 m in the higher parts of the section. Although there is a reasonable coherent bedrock section along the burn, the sides of the gorge are mostly scree covered or are obscured by slipped material. To the north of the gorge section, the outcrop of the Kymah Quartzite Formation terminates where it has been intruded and hornfelsed by a small microgranite body. This is part of the immediately adjacent Glenlivet Granite Pluton, which crops out in the lower part of the burn.

The burn section traverses obliquely across the overall strike of the Ladder Hills and Kymah Quartzite formations, which here are disposed in a complex, large-scale, refolded fold pattern (Figure 6.20). The Ladder Hills Formation consists of cream to fawn and pale-grey, thin- to medium-bedded, typically flaggy to blocky, micaceous and feldspathic psammities interbedded with dark-grey pelites and mid-grey semipelites. The psammities commonly show grading, in parts from gritty psammite bases up to semipelitic or even pelitic tops. Graded bedding, load structures, cut-offs and cross-bedding are all

seen, indicative of turbiditic conditions during deposition. Locally, deformed thin psammite dykelets occur, indicating dewatering during compaction, and implying rapid deposition of the sand and silt sequence. Beds of graphitic pelite are thin in this section, but elsewhere such units can attain 20 m in thickness. The base of the Ladder Hills Formation is not exposed in the Kymah Burn but is seen some 3 km to the south-west by Ladderfoot (at [NJ 2663 2066]), where there is a transition from the graphitic pelites and semipelites of the underlying Glenfiddich Pelite Formation up into thinly interbedded semipelites and psammites.

Good exposures of the typical Ladder Hills Formation occur in the Kymah Burn between the tributary burns of Caochan Domhain and Caochan Ranaich ((Figure 6.20)a). Although cleavages are developed in the pelitic lithologies the beds are not schistose. Here, chloritic material occurs in the basal parts of some psammite beds and amphibole + plagioclase feldspar-bearing 'fragmental' units up to 2 m thick are also present. These mottled grey-green-fawn amphibole-bearing units weather irregularly to a pale-brown colour and are invariably altered to chloritic and biotitic material. Examples of these probable volcanoclastic 'green beds' are seen at [NJ 2988 2245] and, adjacent to a 10–25 cm-thick lenticular metadolostone bed, at [NJ 2994 2244]. The upper parts of the formation are seen between [NJ 2936 2263] and [NJ 2958 2257]; there, amphibolite units are interbedded with micaceous and feldspathic psammite, semipelite, minor quartzite and amphibole-bearing psammite. In one instance, exposures of a variably bluish to purplish grey, fine-grained, knobby weathering amphibolite are seen. This amphibolite unit is several metres thick, apparently concordant, finely cleaved, and notably pyritic.

The transition up into the Kymah Quartzite Formation is marked by the incoming of thicker quartzite units, commonly with gritty bases. The boundary is faulted in the Kymah Burn section, but as the beds dip moderately to steeply to the east-south-east, probably only a small part of the succession is missing. The lowest exposures stratigraphically (at [NJ 2942 2262]) consist of blocky to massive, thick-bedded, gritty quartzites and feldspathic quartzites with thin pelitic interbeds and laminae. Grading and bottom structures show that the beds are inverted and young to the west. The succeeding lithologies are interbedded quartzites and 5–20 m-thick units of grey-green to purplish grey amphibolite. More-indurated, massive to blocky, cream to white quartzite beds, locally showing gritty bases, are present downstream.

Where the Dry Stripe enters the main gorge at [NJ 2927 2268], a c. 10 m-thick, greenish grey metabasalt sheet passes laterally into a c. 4 m-wide dyke, which transects the quartzite beds adjacent to a small SE-trending fault. This intrusive sheet is massive, sparsely feldspar-phyric and is a member of a suite of early-Caledonian metadolerite intrusions (see Interpretation)

The middle and higher parts of the Kymah Quartzite Formation are folded into a tight downward-facing antiform (where the beds young downwards). The white to cream quartzites are well bedded, locally gritty and show good cross-bedding and some grading. On the eastern limb of the antiform, the beds dip very steeply to the south-east and the change in dip that marks the antiformal hinge-zone corresponds with the change in burn orientation from north–south to ESE–WNW at around [NJ 2912 2312]. Downstream, the beds first dip very steeply to the west and young eastwards, but west of The Eachrach they dip steeply eastwards and young westwards, i.e. they define a downward-facing synform ((Figure 6.20)b). The bedding is difficult to discern in these massive to blocky quartzites. Where the burn turns northwards, several amphibolitic beds are interbanded with the quartzites. At [NJ 2882 2324] a several metre-thick unit of purplish and greenish grey, pyritic amphibolite shows vesicular textures and pillow structures. Tuffaceous units are also present. In thin section these basic metavolcanic rocks consist of plagioclase feldspar, chlorite, hornblende, biotite, quartz, ilmenite, and titanite. Epidote is locally abundant in some units. Two fine but penetrative cleavages can be discerned in parts of the metavolcanic outcrops. The quartzite downstream dips steeply eastwards and shows cross-beds in parts. It is generally indurated and becomes hornfelsed with chlorite and pyrite veining adjacent to the microgranite intrusion.

The outcrop of the Kymah Quartzite Formation diminishes in width to the south-south-west where it lies in the core of the earlier tight syncline that is refolded by the later upright antiforms and synforms in the Kymah Burn section ((Figure 6.20)a, b). The Ladder Hills Formation and its lateral equivalent, the Nocht Semipelite Formation, underlie most of the Ladder Hills area, where their c. 3–5 km-wide outcrop is a result of a similar refold structure to that defined by the main quartzite unit in the Kymah Burn section.

## 10.3 Interpretation

The distinctive stratigraphy of the Islay Subgroup rocks in the Ladder Hills shows that a several kilometre-thick turbiditic sand-silt-mud succession developed locally in this area. The resultant Ladder Hills Formation and Nocht Semipelite Formation were probably deposited relatively rapidly from density currents in a small fault-bounded marine basin, accompanied by periodic basic volcanicity. Metadiamictite units and associated metadolostones occur within the Ladder Hills Formation farther south around [NJ 242 177]. The occurrence of thin metadolostones and tuffaceous units in the Kymah Burn section suggests that either diamictites were not deposited here, or that they were deposited and eroded prior to deposition of the overlying sediments. However, it is clear that the deposition and volcanicity here were coeval with the occurrence of shallow marine ice sheets elsewhere in Scotland and Ireland (see the *Muckle Fergie Burn*, *Tempar Burn* and *Garvellach Isles* GCR site reports).

The concordant and interbedded nature and pillow-lava features of several of the amphibolitic units show that they were originally deposited as sub-marine basaltic lavas. Unequivocal metavolcanic rocks occur in the uppermost parts of the Ladder Hills Formation and at the lower and middle levels of the Kymah Quartzite Formation. Tuffaceous units occur close to lavas in the Kymah Quartzite Formation and scattered through the Ladder Hills Formation. The metavolcanic rocks show two penetrative cleavages locally, suggesting that they have undergone the same structural history as the adjacent metasedimentary rocks. Other mafic units might represent subvolcanic basic sheets, but the thicker sheets with relict metadolerite textures were probably intruded during a later period of basic intrusion approximately coeval with the emplacement of the nearby Morven–Cabrach Pluton at c. 470 Ma (Dempster *et al.*, 2002). These early-Caledonian basic sheets and related dykes are very abundant on upper Donside around Corgarff and in the eastern part of the Ladder Hills.

The structure of the area can be readily interpreted as the product of two phases of ductile deformation. Two distinct penetrative cleavages are seen in pelitic and mafic lithologies and a later crenulation cleavage is present locally in the some of the pelitic units. The Kymah Quartzite Formation is little deformed internally, thus preserving original sedimentary features. However, the formation acted as a more-competent layer and has provided the focus for the large-scale refold structure. The quartzite was originally disposed in a tight, anticline-syncline fold-pair, overfolded to the north-west and with an axial plane dipping gently to moderately south-east. The mapping of bedding and way up, combined with limited cleavage observations, shows that upright tight folds have refolded this primary structure, with an antiform prominent in the Kymah Burn section. It is difficult to know whether the original basin architecture has had any control on the subsequent structural development, but such phenomena are common in more-recent basins subject to tectonic compression and inversion.

The rocks of the Kymah Burn and surrounding area do not preserve their full metamorphic history. Here, later retrogression to greenschist facies has altered many of the earlier amphibolite-facies assemblages in both the metasedimentary and meta-igneous rocks. In particular, the high-pressure kyanite assemblages recorded to the north and west from nearby Glen Fiddich and Glen Livet by Beddoe-Stephens (1990) are absent (see the *Auchindoun Castle* GCR site report). Additional, later fluid-related alteration is linked to the presence of NNE-trending faults and related breccia zones that are present in this area.

## 10.4 Conclusions

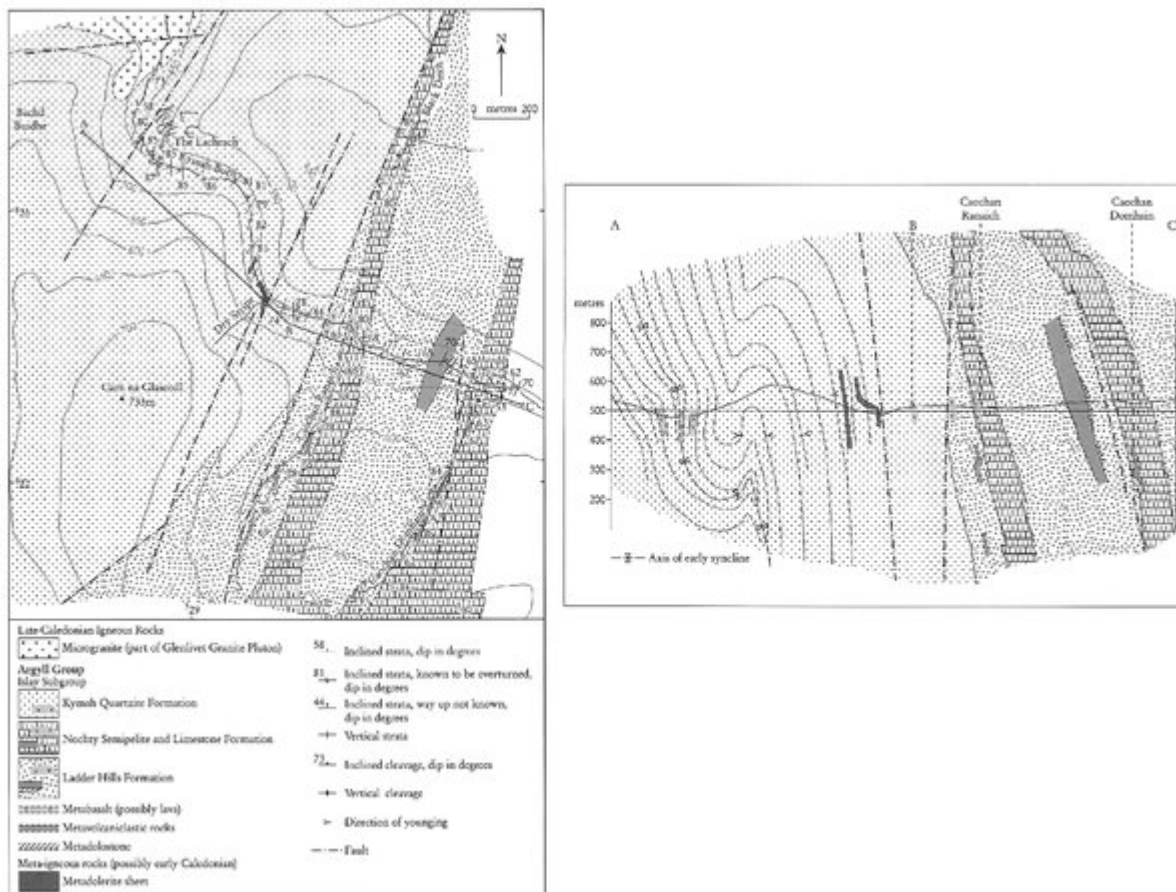
The Kymah Burn GCR site provides a spectacular cross-section through a large-scale refolded fold affecting the lowest units of the Argyll Group. By careful observation of bedding and cleavage orientations, combined with sedimentological way-up evidence, it is possible to recognize an early near-isoclinal syncline-anticline fold-pair whose axial plane originally dipped gently to the south-east. These NW-verging folds have been refolded by more-obvious tight upright folds, giving rise to a large-scale interference structure that is transected by the Kymah Burn.

The site is representative of three major formations and is a type section for one. The Ladder Hills Formation is a sequence of turbiditic psammites, semipelites and pelites over a kilometre thick that formed in a small local basin coeval with the deposition of tillites and related glacial deposits over a wider area of Scotland and Ireland. It includes minor metabasalt units with pillow structures, altered basic volcanoclastic units and thin lenticular metadolostone beds. Laterally it passes south-eastwards into the Nocht Semipelite and Limestone Formation. Both formations are overlain by the

Kymah Quartzite Formation, marked by the incoming of thicker purer sands, typically showing cross-bedding and gritty bases to the beds. Basaltic lavas and possible tuffaceous units are also recognized in this formation. Metadolerite sheets and rare dykes have also intruded the whole sequence during the Caledonian Orogeny. Although the beds have been metamorphosed to amphibolite facies, later retrogression has partly altered the original peak metamorphic mineral assemblages to greenschist facies.

The site is of national importance as it documents some unique stratigraphical variations in the Islay Subgroup, displays good evidence of basic volcanism coeval with the widespread mid-Dalradian glaciation, and provides a valuable insight into the overall structure of this part of the North-east Grampian Highlands.

## References



(Figure 6.20) (a) Map of the Kymah Burn section, Glen Livet, based upon British Geological Survey mapping, 1982–88. (b) Cross-section along the line A–B showing the major fold interference structure in the Kymah Burn section.