



The Dalradian rocks of the Shetland Islands, Scotland

Derek Flinn^{a,1}, Philip Stone^b, David Stephenson^{b,*}

^a formerly The Jane Herdman Laboratories of Geology, University of Liverpool, Liverpool, United Kingdom

^b British Geological Survey, Murchison House, West Mains Road, Edinburgh EH9 3LA, United Kingdom

ARTICLE INFO

Article history:

Received 12 December 2011
 Received in revised form 8 July 2012
 Accepted 14 July 2012
 Available online 22 November 2012

Keywords:

Geological Conservation Review
 Shetland Islands
 Dalradian Supergroup
 Lithostratigraphy
 Structural geology
 Metamorphism

ABSTRACT

Metasedimentary and metavolcanic rocks to the east of the Walls Boundary Fault on Shetland have lithological similarities to those of the Dalradian Supergroup of the Scottish mainland. In particular, the middle part of the succession, termed the Whiteness Group, includes numerous metalimestones and associated pelites in a shallow-marine succession that recalls the upper parts of the Appin Group and the Argyll Group of mainland Scotland. Metavolcanic rocks within the deeper water turbiditic sequence of the succeeding Clift Hills Group might be broadly coeval with those of the Southern Highland Group of Scotland. Beyond that, correlations with the established Dalradian succession are tenuous and are not possible at formation level. A local succession immediately west of the Walls Boundary Fault is of even more-dubious Dalradian affinity.

The dominant structure is the regional-scale, downward- and east-facing East Mainland Mega-monocline. This has a vertical western limb, which youngs to the east, and an eastern top limb that dips to the north-west at 20–30°. Strata on the eastern limb are inverted on Mainland, Whalsay and Out Skerries but are right way up on the west side of Unst, having been folded around the tight Valla Field Anticline. The Shetland Ophiolite-complex has been thrust over the inverted limb of the Valla Field Anticline on the east side of Unst. The regional monocline folds earlier small- to medium-scale, tight to isoclinal folds with associated planar and linear structures, which are all assigned to a single 'Main Deformation'. It also post-dates the regional metamorphism, which ranges from chlorite to garnet grade, with localized development of staurolite-kyanite, gneissose fabrics, and the emplacement of schistose granitic sheets in the Colla Firth Permeation Belt.

The GCR sites have been selected mainly to be representative of the East Mainland Succession with its associated structures and metamorphism. Highlights include well-preserved sedimentary structures, high-grade gneisses permeated by granitic material, basaltic pillow lavas and serpentized ultramafic rocks. Some of the latter contain enigmatic skeletal pseudomorphs after olivine and have been interpreted as former high-magnesium lavas.

© 2012 Natural Environment Research Council. Published by Elsevier Ltd on behalf of The Geologists' Association. All rights reserved.

Contents

1. Introduction (D. Flinn, P. Stone and D. Stephenson)	394
1.1. West of the Walls Boundary Fault	394
1.2. East of the Walls Boundary Fault	394
1.3. The Dalradian of Shetland	394
1.4. Tectonics and metamorphism	396
2. Scalloway (HU 396 389–HU 389 408) (D. Flinn and P. Stone)	399
3. Hawks Ness (HU 447 477–HU 458 491–HU 458 473) (P. Stone and D. Flinn)	402
4. Cunningsburgh (HU 439 280–HU 421 274–HU 432 264) (D. Flinn, P. Stone and D. Stephenson)	405
Acknowledgements	409
References	409

* Corresponding author. Tel.: +44 131 667 1000.
 E-mail address: dst@bgs.ac.uk (D. Stephenson).

¹ Deceased.

1. Introduction (D. Flinn, P. Stone and D. Stephenson)

The Shetland Islands lie about 165 km north-east of the Scottish mainland, and are almost half way between Scotland and Norway. The islands comprise an inlier of Caledonian and pre-Caledonian metamorphic rocks, which is completely surrounded by Devonian (Old Red Sandstone) and younger rocks (Fig. 1). Correlation of the metamorphic rocks with those of the Scottish mainland has been based on lithological similarities, aided by some radiometric dating. For general summaries of the geology see Mykura (1976) and Flinn (1985).

The Walls Boundary Fault, a likely northward continuation from the Scottish mainland of the Great Glen Fault (Flinn, 1961) (Fig. 1) divides the metamorphic rocks of Shetland into two mutually uncorrelatable successions associated with two distinct sets of post-metamorphic granites.

1.1. West of the Walls Boundary Fault

To the west of the Walls Boundary Fault, the overall tectonic arrangement is a series of structural slices, separated by thrusts and shear-zones that interleave pre-Caledonian basement gneisses with metasedimentary cover sequences (Flinn et al., 1979; Flinn, 1985). Many of the component slices exhibit similarities to parts of the Lewisian, Moine and Dalradian sequences of the Scottish mainland and Western Isles. Quartzofeldspathic orthogneisses contain hornblende gneisses that have yielded radiometric ages up to c. 2900 Ma and have been correlated with the Lewisian Gneiss Complex. The orthogneisses are in contact to the east with a belt of predominantly schistose psammites containing zones of coarse hornblende gneisses, which are locally blastomylonitized. The psammites have been tentatively correlated with the Morar Group of the Moine Supergroup, whereas the hornblende gneisses might correspond to the inliers of Lewisianoid rocks that are common in the Morar Group. A blastomylonite shear-zone, which separates the Moine-like rocks from the orthogneisses, has been correlated with the Moine Thrust. GCR sites to represent these units are described in the Lewisian, Moine and Torridonian rocks of Scotland GCR volume (Mendum et al., 2009). The Moine-like rocks, with their Lewisianoid inliers, are limited to the east by the Virdibreck Shear-zone, along which low-grade phyllitic to schistose metasedimentary and metavolcanic rocks of possible Dalradian affinity (the Queyfirch Group) have been thrust westwards.

1.2. East of the Walls Boundary Fault

On the mainland of Shetland, to the east of the Walls Boundary Fault, a dominantly metasedimentary sequence has been correlated with the Moine and Dalradian successions of the Scottish mainland and is referred to as the East Mainland Succession. This succession has been split into four major, lithostratigraphically distinct 'divisions', now formally defined as groups (Figs. 1 and 2; Flinn et al., 1972).

The oldest part of the East Mainland Succession, the Yell Sound Group, crops out in the west, where it has been truncated obliquely by the Walls Boundary Fault. It has a maximum exposed width of 10 km and possibly half as much again allowing for sea cover. It is composed of variably gneissose quartzofeldspathic psammites, alternating with major lenses of mica schist and quartzite. It also contains layers of garnet-studded hornblende schist together with half a dozen Lewisianoid inliers. This lithological assemblage distinguishes the Yell Sound Group from the rest of the East Mainland Succession and has allowed it to be correlated with the Loch Eil and Glenfinnan groups of the Moine Supergroup in Scotland (Flinn, 1967; Flinn, 1992).

The Yell Sound Group is separated from rocks to the east by the 70 km-long and c. 1 km-wide Boundary Zone that extends across the islands of Mainland, Yell and Unst. The western margin of the Boundary Zone is marked by occurrences of a microcline-megacryst augen gneiss, the Valayre Gneiss (Flinn, 1992, Flinn in Mendum et al., 2009), and its eastern margin by the Skella Dale Burn Gneiss. Between these two augen gneisses the Boundary Zone contains lenses of locally blastomylonitized Lewisianoid hornblende gneisses, basic metavolcanic rocks and a variety of other gneissose psammites and semipelites together with a metalimestone.

To the east of the Boundary Zone, the rocks of the East Mainland Succession have very general lithological similarities with the Dalradian succession of mainland Scotland and are the subject of this paper. They extend the length of Shetland from north to south and have been divided into three groups. From west to east and older to younger these are the Scatsta, Whiteness and Clift Hills groups.

Along part of the south-east coast of the Mainland, the Dalradian rocks have been overthrust, from the east, by a tectonic nappe containing gneisses and various metasedimentary lithologies. The nappe overlies an imbricate zone, containing some serpentinite that was termed a tectonic *mélange* by Flinn (1967). Some of the constituent rock types are similar to Dalradian lithologies seen farther west within the East Mainland Succession (e.g. in the *Scalloway* GCR site) but, despite these similarities, the tectonic style is distinct and this south-eastern fringe is recognized as the separate Quarff Nappe Succession. The emplacement of the 'Quarff Nappe' probably took place late in the Caledonian Orogeny, during the Scandian Event. Farther north, part of an Early Palaeozoic ophiolite crops out on the islands of Unst and Fetlar (Fig. 1). This, the Shetland Ophiolite-complex was tectonically emplaced at about 500 Ma above rocks of likely Dalradian affinity; its geology has been summarized by Flinn (2001, in press) and its GCR sites are described in the Caledonian Igneous Rocks of Great Britain GCR volume (Stephenson et al., 1999). Elsewhere, across much of the east and south of Shetland's Mainland, the Dalradian rocks are unconformably overlain by sedimentary and volcanic rocks of the Old Red Sandstone Supergroup and are intruded by late-Caledonian granites.

1.3. The Dalradian of Shetland

Dalradian rocks crop out over an area of more than 400 km² on the Mainland of Shetland, but also form smaller islands to the east of the Mainland and parts of Unst and Fetlar (Fig. 1). Their lithostratigraphy, structure, metamorphism and tectonic implications have been the subject of a comprehensive review by Flinn (2007). On most of the Mainland, the succession is continuous, with a total thickness of 10–12 km, is unfolded except for minor folds, dips vertically and strikes north–south. To the south of Scalloway, the western parts of the succession (Scatsta Group) are increasingly hidden by the sea. To the north of Scalloway the Scatsta Group crops out along strike for 30 km but the eastern parts of the succession (Clift Hills Group) pass eastward beneath the sea.

The Scatsta Group is between 1 and 2.5 km wide. It is dominantly composed of quartzites and impure quartzites, planar laminated by muscovite partings and with lensoid layers of schistose kyanite- and staurolite-bearing aluminium-rich pelites (chloritoid-bearing at lower grade). There is evidence of soft-sediment slumping.

The Whiteness Group is 6–7 km thick and is composed dominantly of planar laminated psammites with some granofelsic psammites and micaceous psammites, all of biotite grade. It contains four major metalimestones, up to 500 m thick, and several thinner beds. It also contains a 1 km-thick unit of gneisses,

Download English Version:

<https://daneshyari.com/en/article/4734705>

Download Persian Version:

<https://daneshyari.com/article/4734705>

[Daneshyari.com](https://daneshyari.com)