Metamorphic rocks of Shetland: Yell, Unst and Fetlar

From Earthwise

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Introduction
Geological sketch-map of Shetland.
P915566.

Geological sketch-map of Unst and Fetlar.
P915571.
The northern isles of Shetland contain two major geological units. The western unit (P915566) comprises the whole of Yell, the western half of Unst and the most westerly peninsula of Fetlar. It consists of highly metamorphosed and, to a large extent, intensely migmatised metasedimentary gneisses which have some characteristics in common with the migmatised lower divisions of the East Mainland Succession. The eastern unit comprises the eastern half of Unst and most of Fetlar and is separated from the rocks to the west by a major thrust zone. It consists of a number of shear-bounded blocks of serpentinite, metagabbro and phyllite which are part of two major nappes that were emplaced at a high structural level. The tectonised phyllites between and below the nappes consist of slices or ‘schuppen’ of rock cut from the basement and from the nappes, and of newly-formed sediments derived by erosion from the nappes and the basement. These rocks were converted to their present phylilitic state at the time of nappe emplacement by retrogressive metamorphism of the slices of gneiss, hornblende-schist and metagabbro and by prograde metamorphism of the newly deposited sediments. The western metasediments of the northern isles are collectively termed the Basement and the eastern nappes are called the Nappe Pile (Flinn...
Basement (and Saxa Vord Block of Unst)

Yell

The greater part of Yell consists of garnetiferous mica-plagioclase-gneiss which has been tentatively correlated with the Yell Sound Division of Shetland Mainland. Its foliation trends north–north–west in the north of the island, roughly north—south in the centre and north-north-east in the south. The clip of the foliation is generally steep and its overall inclination is to the west, but in the south-east corner of the island it is vertical or steeply inclined to the east.

The north-eastern coastal strip of Yell, the island of Hascosay and the southeastern corner of Yell are underlain by striped granulitic oligoclase-gneiss which contains large masses of hornblende-gneiss, some bands of calc-silicate rock and a band of gneiss with augen of microcline. These outcrops form part of a strip of rock which seems to be separated from the main mass of Yell by a major dislocation which could be a branch of the Nesting Fault. It may well form part of the structural unit which includes the western (foreland) blocks of Unst and Fetlar.

West of the eastern coastal strip of Yell a sequence of six poorly defined lithological units can be recognised, but none of these form continuous belts throughout the length of the island. The most easterly belt exposed on the east coast between Basta Voe (HU 53 95) and Mid Yell Voe (HU 52 91) consists of mica-schist with small lenticular masses of siliceous granulite. This is followed westwards by a more massive gneissose rock with many veins of pegmatite, which in turn succeeded by flaggy siliceous and semipelitic schists which form the Hills of Lussetter (HU 52 90) and Vatsie (HU 52 88) south of Mid Yell Voe. The centre of the island is traversed by silvery garnetiferous mica-schists (semipelite) which contain a thick lenticular quartzite. The latter gives rise to the highest ground in Yell, which includes the Hill of Arisdale (HU 50 85) and the Ward of Reafirth (HU 51 88). West of this horizon there is a wide belt of garnetiferous oligoclase-mica-gneiss (semipelite) which is in places intensely migmatised and contains many coarse red granite and oligoclase-pegmatite veins. This migmatised belt takes in the northern and north-western parts of Yell and contains some areas in which sillimanite and tourmaline are developed. The western coastal cliffs of Yell consist mainly of evenly foliated muscovite-biotite-gneiss together with some silvery mica-schists, but the stretch between West Sand Wick and the Ness of Sound (HU 45 82) contains, in addition, lenses of hornblendeic and siliceous gneiss and very abundant dykes of pegmatite.

Unst

The western part of Unst consists of two principal tectonic units or ‘blocks’ known as the Valla Field and Saxa Vord blocks (Read 1934c). These are separated from each other and from the Nappe Pile to the east by major shear zones full of lenticular rock-slices. The Saxa Vord Block is not strictly part of the Basement and is included under this heading only for ease of description. The principal lithological units of these blocks are set out below (see also P915571).

The Valla Field Block forms the hilly western part of Unst and is bounded on the east by a belt of dislocation, which is now followed by the prominent valley, marked by a string of lochs, that extends southwards from the head of Burra Firth to Belmont. The foliation of the rocks in this block has an overall north-north-easterly trend and is generally inclined at varying angles to the east-south-east. Most of the outcrop is thought to form part of the eastern limb of a major north—south trending antiform, the axial trace of which passes through the outcrop of the Westing Group. The rocks forming the block are mostly of sedimentary origin, but at Lunda Wick (HU 56 04) there are some
zoned ultrabasic bodies which grade outwards from a core of antigorite to actinolite, chlorite and biotite. The rocks have been extensively migmatised and intruded by a network of sills and sheets of granite and pegmatite and later by dykes and sills of spessartite.

**Valla Field Block**

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Burra Firth Group</td>
<td>Pelitic, siliceous and feldspathic gneiss, with belts of garnet-staurolite-tourmaline-gneiss and rare calc-silicate rocks.</td>
</tr>
<tr>
<td>East</td>
<td>Pelitic gneiss, passing eastward from coarse biotite-permeation-gneiss with lenses of hornblende-schist in the west into staurolite-kyanite-garnet-gneiss with thin siliceous and semipelitic bands.</td>
</tr>
<tr>
<td>2 Valla Field Group</td>
<td>Pelitic, calcareous and hornblendic gneisses, containing the thick Westing Limestone, a crystalline limestone rich in calc-silicate minerals.</td>
</tr>
</tbody>
</table>

**Saxa Vord Block**

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Norwich graphitic schists</td>
<td>Pelitic schist with chloritoid, kyanite, staurolite and garnet, some bands of quartzo-feldspathic rock.</td>
</tr>
<tr>
<td>4 Norwich hornblendic schists</td>
<td>Siliceous and quartzo-feldspathic flags with subordinate mica-schists.</td>
</tr>
<tr>
<td>East 3 Saxa Vord Schists</td>
<td>Pelitic, siliceous and feldspathic gneiss, with belts of garnet-staurolite-tourmaline-gneiss and rare calc-silicate rocks.</td>
</tr>
<tr>
<td>2 Queyhouse Flags</td>
<td>Pelitic gneiss, passing eastward from coarse biotite-permeation-gneiss with lenses of hornblende-schist in the west into staurolite-kyanite-garnet-gneiss with thin siliceous and semipelitic bands.</td>
</tr>
</tbody>
</table>

West 1 Westing Group

The Saxa Vord Block forms the high hills of northern Unst just east of Burra Firth, but thins southward from there to form (according to Read) a narrow irregular belt between two shear zones which converge just south of the Loch of Watlee (HU 60 05). In the northern part of the outcrop the main rock types are dark grey chloritoid-kyanite-schists (the Saxa Vord Schists) and quartzo-feldspathic flags (the Queyhouse Flags). The schists must be of considerable thickness and their foliation clips at a moderate angle to the east-south-east. Further south the various lithological units are close together and each unit may be a separate tectonic lens (see Structural synopsis). The rocks of the Saxa Vord block are not migmatised and pegmatite veins are confined to the Queyhouse Flags. The metamorphic history of the block, based largely on evidence from the Saxa Vord Schists,
falls into three episodes (Key 1972). The first of these was a phase of prograde metamorphism throughout the block, which produced staurolite, biotite and garnet. The second led to the partial destruction of these earlier minerals and the formation of kyanite, chloritoid, paragonite and chlorite. The third phase was characterised by the production of chlorite and the destruction of minerals produced by both the earlier episodes. The effects of the first and second metamorphisms are seen throughout most of the block, but those of the third metamorphism are confined to areas adjacent to boundary dislocations. Spessartite sills and dykes were intruded at some time between the second and third metamorphisms. There was also a late localised phase of thermal metamorphism, which produced sillimanite and new chloritoid.

**Fetlar**

In Fetlar the Basement forms most of the Lamb Hoga Peninsula and has been termed the Lamb Hoga Block. Like the Valla Field Block of Unst it comprises high-grade staurolite-sillimanite-kyanite-gneisses and garnet-bearing migmatitic gneisses which have been subjected to extensive retrograde metamorphism characterised by the development of chlorite and muscovite and by the localised growth of porphyroblasts of chloritoid. The rocks consist of two belts of pelitic gneiss separated by a broad belt of siliceous and semipelitic gneisses. In the eastern pelitic gneiss there are bands of metamorphic limestone, and both pelites contain lenses, sills and veins of granite, pegmatite and quartz. At Moo Wick, at the south-east corner of Lamb Hoga, a 100 m-wide band of siliceous gneiss is intensely kaolinitised and there is here a small deposit of pure kaolin derived from this gneiss. The Lamb Hoga Block is separated from the rocks to the east by the Lamb Hoga Fault.

**Nappe pile**

**Unst**

East of the zone of movement which limits the Saxa Vord and, further south, the Valla Field Block, there are a number of tectonic blocks of metamorphosed igneous and sedimentary rocks. The major blocks in this area are as below:

- Skaw Granite Block
- Clibberswick Block
- Main Serpentine and Greenstone Block
- Mu Ness Serpentine and Greenstone Block
- Muness Phyllitic Block

The serpentinites give rise to hills with ochre-brown-weathering rock outcrops which form such a characteristic feature of the landscape of Unst. The Main Serpentine and Greenstone Block has a number of compositional zones which trend parallel to its western and north-western margin. These consist, from west to east, of the following rock types: (1) peridotite-serpentinite; (2) dunite-serpentinite; (3) pyroxenite, and (4) metagabbro (‘greenstone’). This block appears to be part of a tilted weakly metamorphosed igneous mass whose lower (western) ultrabasic part may have been differentiated in situ, but whose upper, basic, part was possibly intruded slightly later. The serpentinite contains pockets of chromite which were formerly quarried (see Other non-ferrous ores). The ultrabasic rocks are altered along the thrusts bounding the blocks, and along certain dislocations within them, into antigorite-serpentinite, talc and, locally, chlorite-schist. Talc of commercial quality occurs at Queyhouse just east of Loch of Clift and also along the margin of the Clibberswick Block at Clibberswick (see Talc).
The Skaw Granite Block is bounded on the west by a major shear zone. It consists of a pink foliated augen-granite, the augen being red potash-feldspars which reach a length of 8 cm and are set in a granulitic base of quartz and mica. Over most of its outcrop the augen-granite contains large and small xenoliths of metasediment, mostly siliceous granulites and ghosts of pelite. According to Read (1934c, p.677) the foliation of the granite, the orientation of the feldspar phenocrysts and the attitude of the stratification of the xenoliths are all coincident, and have an overall north-easterly to easterly strike. Some of the xenoliths contain feldspar porphyroblasts which are similar to the large feldspars in the granite.

The Muness Phyllitic Block forms a large outcrop of phyllite with rare bands of schistose conglomerate. The rocks within it are of low metamorphic grade, and they have not been subjected to an earlier high-grade metamorphism. The phyllites have a typical ‘woody’ fibrous structure which is due to intense microfolding combined with a linear fabric. Later kink-folding of the lineation is common. In addition to the blocks enumerated above there are two small tectonic blocks composed of hornblendic and graphitic schists and phyllites in the Norwich area. The individual blocks of Unst are in places separated by very fine-grained silvery phyllonites, which are parts of the schuppen-zones and are essentially mylonitised pelitic gneisses.

**Fetlar**

The greater part of Fetlar consists of a number of shear-bounded thrust blocks of serpentinite, metagabbro and phyllite which bear a complex structural relationship to each other (P915571). There are three serpentinite blocks termed from west to east the Hamars Ness Black (serpentinite and metagabbro), the Vord Hill Block (peridotite-serpentinite) and the Hesta Ness Block. The serpentinites are generally ochreous-weathering but contain varying amounts of bastite which produces a rough-weathering rock. As in Unst the serpentinite is altered to antigorite-serpentinite and locally to talc close to the bounding shear planes. The small Hesta Ness Block in north-east Fetlar is completely altered to antigorite and steatite and contains bands of pure talc which have been exploited commercially in the past. In addition to the serpentinite blocks there are a number of highly complex shear-bounded zones which consist of varying proportions of phyllite, strongly lineated graphite-schist, phyllitised metagabbro (‘greenstone’-phyllite) and schistose conglomerate with small, highly elongated pebbles. These zones also contain small masses of serpentinite, metagabbro and migmatitic gneiss. Of particular interest are the schistose conglomerates which are best seen along the coast at Uriesetter west of Vord Hill and which contain cigar-shaped pebbles of metagabbro (indistinguishable from that in the Hamars Ness Block), quartz-albite-porphyry, granophyre and material derived from the underlying sediment.

Most of the eastern peninsula of Fetlar is occupied by a great thickness (at least 1200 m) of conglomerate. This conglomerate, known as the Funzie Conglomerate, consists of strongly deformed pebbles of quartzite with subordinate biotite-albite-granite, granophyre, quartz-albite-porphyry and, locally, basic igneous rock, and rare pebbles of marble. These are set in a phyllitic matrix which is rich in elastic quartz and also contains chlorite, epidote and sericite of metamorphic origin. The pebbles are most strongly deformed in the south-west of the outcrop, close to the faulted western margin of the conglomerate, where they appear as somewhat elongated discs (P535973). Farther east the pebbles are almost cigar-shaped and strongly elongated along the regional lineation.

**Structural synopsis**

Flinn (1958) has put forward an interpretation of the complex structure of Unst and Fetlar and the following summary is based on his work. The ‘Basement’ is formed of the metamorphic rocks of the Valla Field and Lamb Hoga blocks, together with the migmatitic gneisses which underlie the whole
of Yell and part of Shetland Mainland. The Valla Field and Lamb Hoga rocks have been tentatively correlated with the Scatsta Division of Mainland (Flinn and others 1972, fig. 1). The Saxa Vord Block of Unst, which is separated from the Valla Field Block by a major shear zone, could be either an early nappe of the Nappe Pile, or could have been emplaced separately at a much earlier date. The schists forming the greater part of this block bear a strong mineralogical resemblance to the Dunrossness Phyllites of Mainland. The Nappe Pile consists of two major nappes separated from each other and from the basement by schuppen or imbricate zones. The Lower Schuppen Zone extends along the central depression of Unst from Queyhouse southward to Belmont and includes Read’s narrow southward extension of the Saxa Vord Block (P915571). This belt contains tectonic slices of phyllite, limestone and hornblende-schist which, as far as can be observed, dip at 45° to 90° to the east. The zone is not exposed in Fetlar, where it is apparently cut out by the Lamb Hoga Fault. The Lower Nappe is represented by the Main and Mu Ness serpentinite blocks of Unst and by the Hamars Ness and Hesta Ness serpentinite blocks in Fetlar. In the greater part of Unst the lower surface of the nappe dips steeply eastwards. In south-east Unst and in Fetlar, however, parts of the nappe reappear to the east of tectonically higher rocks, suggesting that here the nappe is folded into a south-south-west-plunging synform, (P915572). The Middle Schuppen Zone overlies the lower nappe. In Unst it is represented in the north by the small tectonic blocks of phyllitic, graphitic and hornblendic rocks around Norwich, and in the south by the Muness Phyllite. In Fetlar it forms all but one of the small blocks of phyllite, graphite-schist, metagabbro, migmatite, etc. exposed in the central section of the island. On the west and east sides of Vord Hill these are conspicuously overthrust by the Vord Hill Serpentine. Similarly, the schuppen-zone of Norwich in Unst is overthrust by the Clibberswick Serpentine. The Upper Nappe is best seen in Fetlar, where it is represented by the extensive outcrop of the Vord Hill Serpentine. This appears to occupy the core of a synform and is separated from the underlying rocks of the Middle Schuppen Zone by an inward-dipping thrust plane, exposed both in the east and west. Though the evidence is not conclusive, it is assumed that this thrust has a synclinal shape and is continuous below the entire serpentinite outcrop. On Unst the upper nappe is represented by the Clibberswick Block, which is lithologically identical with the Vord Hill Block. On Fetlar the remains of an Upper Schuppen Zone may be preserved. They form a small outcrop of hornblende-schist, serpentinite and phyllite which is exposed at Aith Ness on the south side of the island and which overlies the Vord Hill Serpentine. The Funzie Conglomerate appears to be an integral part of the Nappe Pile but its relationship to the latter’s structural units is not clear.

The nappes appear to have been cut from an ultrabasic and basic layered intrusion which had suffered low-grade metamorphism prior to the formation of the nappes. The lower nappe is in places several kilometres thick and the upper nappe has a thickness of over 1½ km. As the Middle Schuppen Zone contains low-grade metasediments and hornblende-schists which do not occur in either the basement or the nappes, it is likely that the upper nappe, at least, has moved a considerable distance to its present position. The phyllites of the Middle Schuppen Zone also contain much material which appears to be derived by subaerial erosion and re-deposition from the rocks which now form the nappes. This suggests that the lower nappe was exposed at the surface and being actively eroded before the upper nappe was emplaced, and that both nappes were formed at a very high tectonic level. After the emplacement of the nappes the whole nappe-pile was folded into a great synform plunging to the south-south-west with limbs dipping at 45° or more.

Garson and Plant (1973) have suggested that the ultrabasic rocks of the Nappe Pile are the remnants of an ophiolite complex and that the thrusts bounding the individual nappes have acted as subduction shear planes. They have correlated the Unst—Fetlar subduction zone with that extending along the Highland Boundary Fault of the Scottish Mainland. Plant and others (in press) have carried out a detailed investigation into the distribution of trace quantities of metal ores within the complex.
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