Shetland

Early accounts

The earliest references to the rocks of Shetland are records of the occurrence of useful minerals, ores and semi-precious stones. Thus George Low, who visited the islands in 1774, recorded the presence of talc and ‘ironstone’ (?serpentine) in Unst, fuller’s earth and copper ore in Fetlar and bog iron ore on Vaila. A record of the presence of iron ore in Dunrossness and of copper ore being mined in southern Shetland first appeared in the Statistical Account of Scotland (Sinclair 1793, Vol. V, p.186, and Vol. VII, p.393). The first attempt at a systematic account of Shetland geology is that of Jameson (1798, 1800), who commented on the dependence of the topography on the strike of the rocks and recognised that the Walls Sandstone is related to the sandstones and conglomerates seen along the coast of south-east Mainland. Jameson described many of the metamorphic minerals of Shetland and all the metallic ores, except chromite, which are known today. Further accounts of Shetland mineralogy and geology were produced by Traill (1806) and Fleming (1811 and in Shirreff 1817). These also deal with the working of copper and iron ores in south-east Mainland and the occurrence of copper in Fair Isle.

The most important of the early works on the geology of Shetland are those of Hibbert (1819–22), which include the first geological maps of the islands. Hibbert dealt with the distribution and structural relationship of the Shetland rocks, and also noted the presence of brucite and chromite. He drew attention to the great induration of the Walls Sandstone, which he called ‘primitive quartz rock’. Ami Boué’s (1820) account of Shetland geology incorporated the observations of the earlier
workers, and attempted the first correlation of the metamorphic rocks of Shetland with those of Scotland, equating the gneisses of Mainland, Yell and Unst with the Lewisian of Sutherland and the Hebrides, and the chlorite-schists and clay slates of Shetland with the Dalradian. He recognised the similarity between the sandstones and conglomerates of Shetland and the sedimentary rocks of the Moray Firth-Caithness-Orkney terrain and pointed out that the rocks of Esha Ness and Papa Stour resemble the products of extinct volcanoes. Other early works dealing with Shetland are those of MacCulloch (1821[9], 1831[10]) and Nicol (1844)[11].

Old Red Sandstone

Fossil plants of Old Red Sandstone age were first discovered at Lerwick and Bressay (Tufnell 1853[12]; Hooker 1853[13]; Murchison 1853[14], 1859[15]) and these were thought to belong to the Upper Old Red Sandstone. Later Peach and Home (1879a[16], in Tudor 1883[17], Geikie 1879[18]) found plants of Psilophyton type in the Walls Sandstone and thus proved that this formation is of Old Red Sandstone age. They also established a stratigraphic sequence in the Old Red Sandstone of east Shetland and described the Old Red Sandstone volcanic rocks of west Shetland (Peach and Home 1879a[16], 1884[19]). Fossil fish from south-east Mainland were first recorded by Flett (1908)[20] who suggested that the beds of this area may range in age from the Middle to the Upper Old Red Sandstone. Finlay (1926b[21], 1930[22]) produced comprehensive accounts of the Old Red Sandstone sedimentary, volcanic and plutonic rocks of Shetland and recorded the discovery of the important fish bed at Exnaboe in south-east Mainland. Much additional information was obtained during the mapping of the islands by the Geological Survey which took place between 1929 and 1934, the most important, perhaps, being the discovery by Knox of the Melby Fish ‘Bed’. The fauna of this ‘bed’ [The Melby Fish Bed recorded by Knox is now known to consist of two beds, separated by about 110 m of sediment (see Melby Fish Beds)] was described by Watson (1934)[23] and shown to be similar to that of the Sandwick Fish Bed of Orkney. More recently Westoll (1937[24], 1951[25]) has produced a zonal correlation of the fish-bearing east Shetland sequence with the Devonian sequences in the Baltic and East Greenland regions. The account of the Old Red Sandstone in this handbook is largely based on the recent work of Mykura (1972b[26], Mykura and Phemister 1976[27]).

Post-orogenic intrusions and mineralisation

Investigations into the plutonic and hypabyssal rocks of West Shetland by Peach and Home (1884)[19] and Finlay (1930)[28] were greatly amplified by the Geological Survey mapping. Detailed petrographic studies of the riebeckite-felsite dykes of Northmaven were made by Phillips (1926)[29] and Phemister (1950)[30]. Mykura and Young (1969)[31] and Mykura (1972c)[32] described the scapolite associated with shear zones and basic intrusions in the Sandsting Complex and in Fair Isle. Accounts of the plutonic complexes of Sandsting and Northmaven were produced by Mykura and Phemister (1976)[33] and by Pringle (1970)[34].

Metamorphic rocks

Prior to 1929 the main work on the metamorphic and synorogenic igneous rocks of Shetland was carried out by Heddle (1878[35], 1901[36]) whose primary task was the description of the minerals and mineral localities throughout the islands. Heddle recorded the presence of many rare minerals, some minerals new to science, and also the first known British occurrence of relatively common minerals such as chloritoid. He also produced detailed accounts of the geology of certain parts of Shetland and discussed the age and possible correlation of the Shetland metamorphic rocks. He suggested that the latter form a group found nowhere else in Scotland, being apparently older and more highly metamorphosed than the conglomerates, schists and gneissose rocks which overlie the Lewisian (i.e. presumably the Moinian) but not so ancient as the Lewisian gneiss.
More recent work on the metamorphic rocks of Shetland commenced with the petrographic studies of serpentines, metagabbros, epidotic granites and andalusite-schists by Phillips (1927-28), and was continued with the mapping of the entire outcrop by the Geological Survey (Summ. Prog. 1930 to 1935 [43]). As a result of this survey Read (1933 [44], 1934a [44], b [45] and c [46], 1937 [47]) published a series of classic papers dealing with the geology and polymetamorphism of Unst, the phases of retrograde metamorphism in the Valla Field Block of north-west Unst, and the development of zoned bodies from ultrabasic intrusions. Further work on the ultrabasic rocks of Unst was carried out by Amin (1952 [48], 1954 [49]), on augen gneisses by Fernando (1941) and on chloritoid—schists by Snelling (1957 [50], 1958 [51]). Our present knowledge of the stratigraphy, structure and metamorphic history of eastern Shetland is, however, based largely on the work of Flinn, who, in a series of important papers, has described and interpreted the structural and metamorphic history of Deltling (1954) and south Shetland (1967a), the nappe structure of Unst and Fetlar (1958, 1959) and the tectonic evolution of the Funzie Conglomerate of Fetlar (1956) and the Muness Phyllite of Unst (1952). In conjunction with Miller (Miller and Flinn 1966 [52]) he has produced the first integrated account of the geology of Shetland, in which the major tectonic, metamorphic and igneous events are placed in a time perspective and in which the main groups of metamorphic rocks are tentatively correlated with their possible equivalents on the Scottish mainland and in Scandinavia. May (1970) has established a sequence of metamorphic, migmatitic and structural events in the rocks of the Scalloway region, and, with Flinn (Flinn and others 1972 [53]), he has re-interpreted the stratigraphy of the East Mainland Succession. The metamorphic rocks west of the Walls Boundary fault have been described by Pringle (1970) [54], Phemister (1976) and Mykura (in Mykura and Phemister 1976 [33]).

Pleistocene and Recent

The first integrated account of the glaciation of Shetland is that of Peach and Home (1879b) [44], who suggested that the islands were first overridden by Scandinavian ice from the north-east, but that they later nourished their own ice cap. The former presence of Scandinavian ice was confirmed by the presence of an erratic of tonsbergite in south-east Mainland, which was recorded by Finlay (1926a) [57]. Robertson (1935) [58] and Flinn (1964 [59], 1967b [60]) have, however, suggested that during the last glacial maximum Scandinavian ice crossed only the extreme south and north of the Shetland Islands and that over the rest of the area a locally-nourished ice cap prevailed. The changes in sea level around Shetland since the last glaciation have been studied by Flinn (1964) [59] and Hoppe (1965) [61], and a floral sequence in the Shetland peats was established by Lewis (1907 [62], 1911 [63]). Chapelhow (1965) [64] recorded the presence of an interglacial peat deposit in north-west Mainland and Mykura has since found a similar bed in west Mainland. These peats have given 14C dates of 35 000 to 40 000 BP and Birks and Ransom (1969) [65] have suggested, on pollen analytical evidence, that they may be of Hoxnian age.

Economic geology

Records of early workings for copper and iron at and near Sand Lodge and at Garths Ness (south Mainland) appear in many accounts, the most important of which are by Traill (1806) [4], Fleming (in Shirreff 1817 [44], Heddle (1880) [46] and Dron (1908) [67]. The available data were summarised by Flett (in Macgregor and others 1920 [68] and in Wilson 1921 [69]). A description of the Sand Lodge workings in 1929 was given by O’Dell (1939) [70]. The magnetite ore at Clothister Hill near Sullom Voe was discovered by D. Haldane and the exploratory work connected with the deposit has been described by Groves (1952) [44]. The history of the chromite workings in Unst has been documented by Sandison (1948) [72]. There is also an account of the more recent explorations for this mineral by Rivington (1953) [73]. Summaries of the workings in and distribution of non-metallic minerals, such as
serpentine, talc and magnesite, have appeared in the economic memoirs of the Geological Survey (see Strahan and others 1916[74], Macgregor and others 1940[75], Wilson and Phemister 1946[76]), and in reports of the Mineral Resources Panel of the Scottish Council (1954a[77], b[78]). A detailed assessment of the talc-magnesite deposits near Cunningsburgh was carried out by Bain and others (1971)[79], and the distribution, composition and petrography of the worked and workable limestones of Shetland have been described in Geological Survey memoirs (Robertson and others 1949[80]; Muir and others 1956[81]).

Geophysics and off-shore geology

The Institute’s regional geophysical survey of the Shetland Islands was carried out by McQuillin and Brooks (1967)[82] and Sheet 16 of the IGS 1:250 000 Aeromagnetic Map of Great Britain and Northern Ireland, which includes the sea area around Orkney and Shetland, was published in 1968. Flinn (1969a)[83] has interpreted the data from this and has produced a map showing the possible geology and structure of the areas north of Scotland. Exploratory marine geophysical surveys by ‘Watts and Bott (Bott and Watts 1970[84]; Watts 1971[85]) have further added to our knowledge of the geology of the Shetland seas, and bathymetric investigations by Flinn (1964[86], 1969b[87]) have contributed to the understanding of possible pre- and post-glacial movements of the land relative to sea level.

Orkney

The earliest geological records of Orkney deal with the presence of lead ore (Speed 1666[88]) and minerals and rocks such as granite, limestone, flagstone and millstone (Sinclair 1795[89]) which were being worked on these islands. Jameson (1800)[90] noted the presence of granitic rocks, overlain by breccia and flagstones near Stromness, and recorded basalt ‘veins’ (i.e. dykes) at Yesnaby and basalt under sandstone at Shapinsay. He also described the conglomerate (‘sandstone breccia’) at Hegglie Ber in Sanday. A record of early collections of fossil fish appears in the Proceedings of the Orkney Natural History Society (1905), which tells of about 100 specimens exhibited in 1837 in the Stromness Museum.

A large collection of fossil fish by Professor Traill was identified by Agassiz (1833–43)[91] who established the correlation of the Orkney flagstones with those of Caithness. Localities from which fish were collected are mentioned by Clouston in the ‘New Statistical Account of Scotland’ (vol. 15, 1845). Widespread interest in the Orkney fish was awakened by Hugh Miller (1849[92], 1858[93]) who recorded and described several species of fish found by himself and a number of local collectors, and was able to identify forms which also occurred in the flagstones of Caithness. Murchison (1859) noted that the Old Red Sandstone of Orkney could be divided into a lower flagstone series and an upper sandstone series, and Geikie (1879)[94] recognised the unconformity at the base of the Hoy volcanic rocks, and ascribed the Hoy sandstones to the Upper Old Red Sandstone. He also regarded the sandstones of South Ronaldsay as the lateral equivalents of the similar rocks near John o’Groats and concluded that the Old Red Sandstone rocks of Orkney, Caithness, Ross and Cromarty were laid down in a great intermontane basin which he termed ‘Lake Orcadie’.

The geology of the northern islands of Orkney was first described by Heddle (1880)[95] who showed that, as on Mainland and South Ronaldsay, the flagstones are conformably overlain by a series of sandstones which are locally conglomeratic. He also noted that the strata forming these islands were folded into a well-marked syncline. Peach and Home (1883)[96] produced the first comprehensive accounts of the geology of Orkney and confirmed most of the conclusions arrived at by Geikie and Heddle. They also described the glaciation of the islands (1880). Our knowledge of the fossil fish of Orkney is largely based on the monograph by Lankester and Traquair (1868–1914)[97],
and on a series of papers by Traquair, which have also formed the basis of correlation of the Sandwick Fish Bed with the Achanarras Limestone of Caithness and the fish beds of Cromarty. Flett (1897)[98] produced the first detailed stratigraphy of Orkney, in which he recognised the Rousay Beds as a separate formation. He recognised the presence of the John O' Groats fish fauna in the Eday Beds and also described in detail the lamprophyric minor intrusions of Orkney (Flett 1900)[99]. Work on the Stromness basement rocks and the geology of Stronsay was carried out by Steavenson (1928a[100] and b[101]) and the peat deposits of Mainland and Westray were examined by Erdtman (1924–29)[102].

The Geological Survey mapped the islands between 1927 and 1929 and a descriptive memoir was published in 1935. The officers engaged in this survey were Wilson, Edwards, Jones, Knox and Stephens. The fish remains collected during the survey were determined by Watson and the plants by Lang. Much of the present account is based on this memoir. Additional work on the fish remains has been carried out by Miles and Westoll (1963)[103] and the latter has also correlated the Orkney sequence with the marine Devonian succession (Westoll 1951)[104]. More recently Kellock (1969)[105] has re-examined the alkaline igneous rocks associated with the Eday Beds. Fannin (1969[106], 1970[107]) has carried out a detailed sedimentological study in the Stromness Flags, and Dr. J M Ridgway has similarly investigated the Eday Beds. Ridgway, J.M. The Sedimentology and Palaeogeography of the Eday Group, Middle Old Red Sandstone, Orkney. Ph.D thesis, University of London (unpublished)./ref) The [GS regional geophysical survey of Orkney was carried out by McQuillin (1968)[108].

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