# Jersey Shale Formation - Jersey: description of 1:25 000 Channel Islands Sheet 2

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Jersey (Channel Islands Sheet 2). 1:25 000 series - Classical areas of British geology

Plate 1 Jersey Shale Formation strata (on the left) are in contact with north-west granite (on the right) in a disused quarry at L'Etacq, St Ouen. Notebook for scale. (Photograph by Dr D. G. Helm).

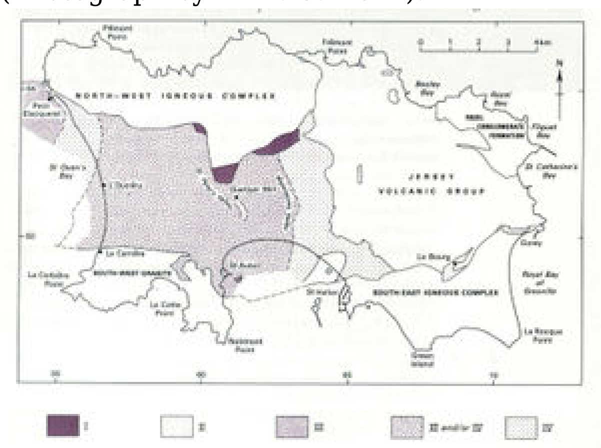


Figure 2 Sketch map showing the distribution of facies associations in the Jersey Shale Formation. Redrawn from Helm and Pickering, 1985, fig.15.

Plate 2 Intertidal reefs near Petit Etacquerel show Jersey Shale Formation medium to thick amalgamated sandstones with thinly bedded sandstones (bottom left). A chaotic bed occurs just above the notebook. The cliffs in the background consist of north-west granite. (Photograph by Dr D. G. Helm).

Plate 15 Jersey Shale Formation beds of Association III in intertidal reefs opposite the Slip de L'Ouest at the northern end of St Ouen's Bay showing large-scale singly plunging D1 folds ith a parasitic old pair. Photograph by R. D. G. Helm).

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## Contents

# Chapter 2 Jersey Shale Formation

The oldest rocks exposed in Jersey belong to the Jersey Shale Formation, formerly known as the Jersey Shales. Both names are unsatisfactory, firstly because the sequence consists of siltstones, sandstones and conglomerates as well as mudrocks, and secondly because the rocks have undergone low-grade regional metamorphism and have been affected by tectonic processes. However, the name Jersey Shale Formation has been adopted to retain continuity with the older nomenclature.

No radiometric dates have been obtained from the Jersey Shale Formation, though it is clearly younger than 1100 900 Ma, the minimum age of the Pentevrian at St Brieuc, and older than the oldest Jersey granite, which gave a date of 570 Ma (recalculated from 580 Ma of Adams, 1976). A younger age of 522 Ma (originally 533 Ma), calculated by Duff (1978) for the Jersey Volcanic Group that overlies the Jersey Shale Formation, has been challenged by Bishop and Mourant (1979; see p. 58).

On general petrological and stratigraphical grounds Graindor (1957) correlated the Jersey Shale Formation with the Upper Brioverian of Normandy. The discovery of *Sabellarites*-like trace fossils led Squire (1973) to suggest an age of about 750 Ma, but Downie (in Bishop and others, 1975) preferred a late Proterozoic (latest Precambrian) Vendian age of between 680 and 570 Ma. However, Bland and others (1987) have shown that the supposed Precambrian fossils described by Squire are actually attributable to modern polychaetous annelids, probably *Polydora* sp., which made U-form tubes along pre-existing joint planes and veins.

# Outcrop distribution and exposure

The main outcrop of the Jersey Shale Formation (Figure 1) occupies a roughly rectangular area extending eastward from St Ouen's Bay to just beyond St Helier, southward to St Aubin's Bay, and northward to La Ville ès Viberts [598 538] and Handois [636 538]. The eastern margin of the outcrop is marked by the disconformable base of the overlying volcanic rocks. The Jersey Shale Formation is bounded to the north by the north-west granite (St Mary's and Mont Mado types; (Plate 1)) and in the south-west by the south-west (Corbière type) granite; at St Helier, the contact (mainly concealed) is with the granophyre of Fort Regent and the south-east (Longueville type) granite.

East of the main outcrop there are two inliers, one centred on Le Bourg [6876 4910] and another extending for about 0.75 km inland from Gorey Harbour on the east coast [702 503] to [712 503], where the Jersey Shale Formation is in contact with the granite of La Rocque type. Smaller outcrops occur at, and to the south of, Frémont Point [6406 5636]; [634 559]; [639 552], in Giffard Bay [6525 5589], and at Long Echet [6533 5620] and Les Rouaux [6570 5620].

The most extensive exposures of the Jersey Shale Formation occur in St Ouen's Bay Owing to a printing error on the 1:25 000 geological map, an area [561 516] south-west of L'Ouzière has been coloured as dolerite: except for two narrow dolerite dykes it should be shown as Jersey Shale Formation., where a band of intertidal reefs about 1 km wide and 4 km long extends almost continuously from near Le Pinacle [5445 5545] to south-west of L'Ouzière [5646 5182]. After an exposure gap of less than 1 km the formation reappears opposite Le Braye [5651 4996]. Most of the other coastal exposures are good, although less extensive, but inland exposure is limited to isolated quarries and road cuttings.

## Lithology

The Jersey Shale Formation, which has an estimated minimum thickness of 2500 m (Helm and Pickering, 1985), mainly consists of fine- to medium-grained sandstones with subordinate conglomerates, siltstones and mudstones, each with variable amounts of diagenetic calcite.

The sandstones range from quartz-wacke to greywacke containing between 10 and 20 per cent of matrix. The framework grains consist of up to 70 per cent quartz, 10 to 15 per cent feldspar (mainly microcline and plagioclase), and about 2 per cent accessory minerals including magnetite, ilmenite and hematite. Carbon flakes up to 10 mm across, of unknown origin, have been recorded by Mourant (1940), Robinson (1960) and Squire (1974), and Dr J. T. Renouf (personal communication) found carbon flakes in greywackes exposed [5835 5198] beside the Val de la Mare Reservoir at the time when the dam was being built.

A varied suite of heavy minerals, including apatite, rutile, zircon, epidote, sphene, almandine, spessartine, glaucophane, sillimanite and staurolite, suggests a diverse provenance of acid and intermediate plutonic igneous rocks, basic subvolcanic rocks, and medium- to high-grade metamorphic rocks; Squire (1974) was unable to detect any significant variation in lateral or vertical distribution of the heavy minerals.

Further evidence that the source area was lithologically mixed comes from pebble to cobble conglomerates; these consist mainly of Jersey Shale Formation intraclasts, but also contain fragments of granite, syenite, andesite, rhyolite, basalt, gneiss and schist. The conglomerates occur at the northern end of St Peter's Valley near La Ville ès Viberts [598 538], between Gargate Mill [605 519] and St Anastase [608 524], and around Carrefour Selous [6232 5326] and Quetivel Mill [6317 5323], but exposure is poor.

## Metamorphism

The sediments have been regionally metamorphosed to low greenschist facies, with the conversion of the clay matrix to chlorite. In addition, wherever the formation has been intruded by granite it has undergone contact metamorphism. At the northern end of St Ouen's Bay, a zone of chlorite spotting extends from the La Bouque Fault [545 545] for 500 m north towards the north-west granite, where it passes into a zone of cordierite-biotite-hornfels 5 to 10 m wide. Similar contact aureoles occur elsewhere; for example, at the southern end of St Ouen's Bay, in Gorey Harbour [713 503], where greywacke has been altered to hornblende-hornfels, and at the northern end of St Peter's Valley, where the metasedimentary clasts and originally muddy matrix of the conglomerates show extensive chlorite spotting and local growth of biotite.

## Sedimentology

Squire (1974) concluded that the Jersey Shale Formation represented a 'eugeosynclinal submarine fan' (a deep-water, fan-shaped 'delta') formed in a sedimentary basin associated with a subduction zone. Helm and Pickering (1985) supported Squire's general inference, and in addition their work enabled them to recognise several distinct depositional environments within the fan. They described six facies and grouped them into four associations (Figure 2), each of which characterised a particular depositional environment. Association I crops out at three places on the southern margin of the north-west granite. It consists mainly of disorganised clast-supported pebble to cobble conglomerates, which suggest deposition from flows in which the clasts were partly supported by the cohesive strength of the matrix of mud and water, and partly by collisions between each other. No direction of palaeocurrent flow has been determined for this association.

The graded, medium- to fine-grained sandstones and rare cross-bedded, medium-grained, lenticular sandstones of Association II form a lenticular body exposed only at isolated localities near the southern end of St Peter's Valley [610 516]. This association is characterised by a high ratio of sand to shale, amalgamation and splitting of beds, and cross-bedding, together suggesting deposition in channels that cut or grade laterally into rocks of Association III. Limited palaeocurrent data suggest that flow was towards the east or south -east .

Association III, best seen on the foreshore and intertidal zone west of Grand Etacquerel [5470 5480] (Plate 15), is composed mainly of ripple-laminated, very fine-grained sandstones, and graded medium- to fine-grained sandstones (Plate 2). These show the sequence of internal structures typical of deposition from relatively high-density turbidity currents (Bouma, 1962), and also display the effects of soft-sediment, post-depositional liquefaction and flow in the form of distorted cross-laminae and cross-cutting sedimentary 'dykes'. A local facies variant, consisting of granule-grade sandstone with both normal and inverse grading, occurs by the slipway north-north-east of Petit Etacquerel [5480 5470].

Palaeocurrent observations from current ripples indicate flow towards the north-north-west, though some imply flow in the opposite direction. Flute casts (asymmetrical scours) on the bases of sandstone units consistently signify flow towards the north.

Association IV is the most important of the associations in terms of area and volume. It consists of laminated mudstone, ripple-laminated very fine-grained sandstone, graded medium- to fine-grained sandstone, and cross-stratified medium-grained sandstone. The best exposures are in the central and northern parts of St Ouen's Bay. Characteristically, the thickness and coarseness of sandstone beds in the sequences comprising Association IV increase upwards and are accompanied by an increase in the ratio of sand to shale; for example, on the foreshore opposite La Saline [555 540] and at Grand Etacquerel [547 547]. Similar sequences, which also display evidence of folding and sliding in soft sediments, occur on the west side of St Aubin 's Bay [607 484]. Palaeocurrent data suggest that flow was generally towards the north.

## Environment of deposition

The sedimentary structures and facies suggest that the Jersey Shale Formation accumulated in an aqueous environment below wave-base. The facies associations are interpreted by analogy with the submarine fan model (Mutti and Ricci Lucchi, 1972; Normark, 1978; Walker, 1978, 1984).

Most ancient and modern submarine fans display a number of distinguishing morphological features directly related to their mode of formation. In the classic submarine fan model it is envisaged that a delta-shaped pile of sediment, usually supplied from a single submarine canyon, is banked against the continental slope. As additional sediment is supplied, the fan spreads over and merges with the basin plain.

Submarine fans may be divided into: an inner (or upper) fan, with a single deep channel or canyon; a mid-fan, with migrating depositional channels that become shallower away from the inner fan; and a topographically relatively smooth outer (or lower), non-channelled fan, containing mounds of sediment (lobes) deposited at the mouths of channels, which grades into a more or less featureless basin plain. The margins or fringes of the major divisions of the submarine fan are gradational. Overall, radially outwards from the main feeder channel, there is a decrease in sandstone thickness, a general reduction in the amount of channelling, an increase in the ratio of muddy to sandy sediment, and a general reduction in grain-size.

Associations I and II are considered to have been deposited in the axial parts of submarine channels, the coarser grain-size of Association I suggesting that it is nearer to its source of supply than is Association II. Association I appears to have accumulated in a canyon or canyons in the inner fan, whereas Association II seems to have affinities with typical mid-fan deposits (e.g. Pickering, 1983). Association III has the characteristics of sedimentation in shallow ephemeral channels with some interchannel and/or fan-fringe deposits, i.e. in the lower part of the mid-fan to outer-fan environment. Association IV has many of the attributes of a typical outer fan (Mutti and Ricci Lucchi, 1972; Pickering, 1981), characterised by lobe, lobe-fringe and fan-fringe deposits.

## The regional setting

Helm and Pickering (1985) found that the Jersey Shale Formation youngs overall to the east. From the general distribution of the facies associations (Figure 2) and the limited palaeocurrent data, they concluded that the submarine fan was constructed from mainly northerly-directed. sediment gravity flows.

Thomas (1977) recorded that the Jersey volcanic rocks (Chapter 3) display a calc-alkaline compositional trend (typical of island-arc volcanism); that volcanic activity of comparable age was widespread in south Britain and north Brittany; and that ancient metamorphic rocks form the basement beneath thick sedimentary successions of Longmyndian and Brioverian age in Anglesey and north-west France respectively. These considerations led him to suggest, in the light of plate-tectonic reconstructions by Dewey (1969) and Mitchell and Reading (1971), that the Jersey volcanic rocks (and by inference the Jersey Shale Formation) accumulated on continental basement about 500 km south of a subduction zone dipping to the south associated with an Andean-type continental plate margin.

Helm and Pickering (1985) concluded that the Jersey Shale Formation probably represents submarine-fan deposition on a continental margin. The shape and size of the deep-water sedimentary fan complex was difficult to assess because of the isolation and small size of Jersey. However, the sedimentology of the Jersey Shale Formation, its relationship to the overlying volcanic rocks, and the inferred regional setting, are all consistent with deposition in a basin perched on a continental slope adjacent to a volcanic arc above a subduction zone.

## Authors and contributors

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