Jersey Volcanic Group - Jersey: description of 1:25 000 Channel Islands Sheet 2

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From: Bishop. A. C. and Bisson. G.1989. Jersey: description of 1:25 000 Channel Islands Sheet 2. Classical areas of British geology, London: HMSO for British Geological Survey.

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

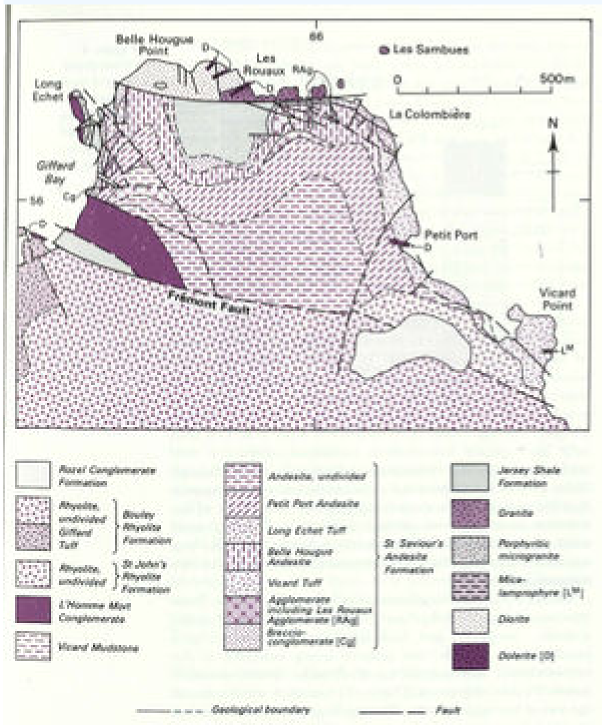

Figure 3 Sketch map of the geology south of Belle Hougue Point. Based on Thomas, 1977, fig.2.2.

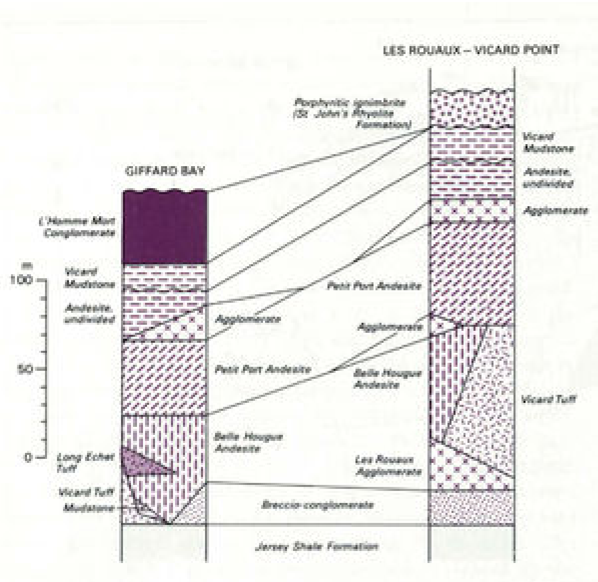

Figure 4 Generalised vertical sections at Giffard Bay and between Les Rouaux and Vicard Point. Based on Thomas, 1977.

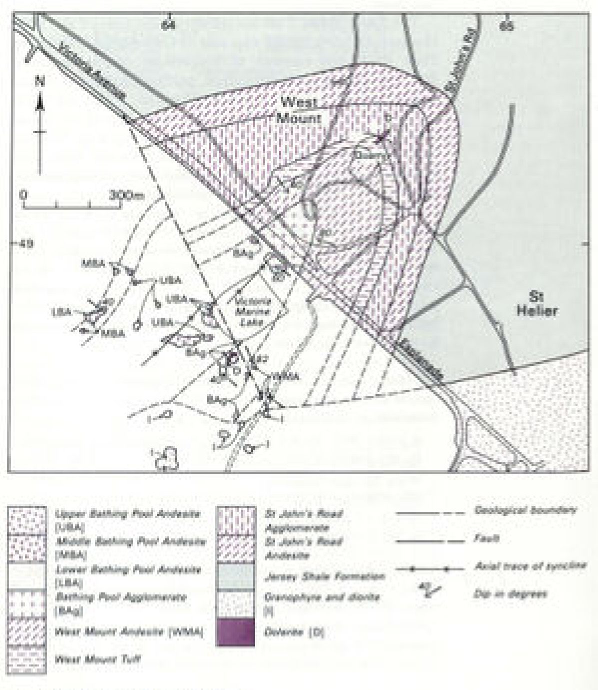

Figure 5 Geological sketch map showing the St Helier Syncline. Redrawn from Thomas, 1977, fig.3.1.

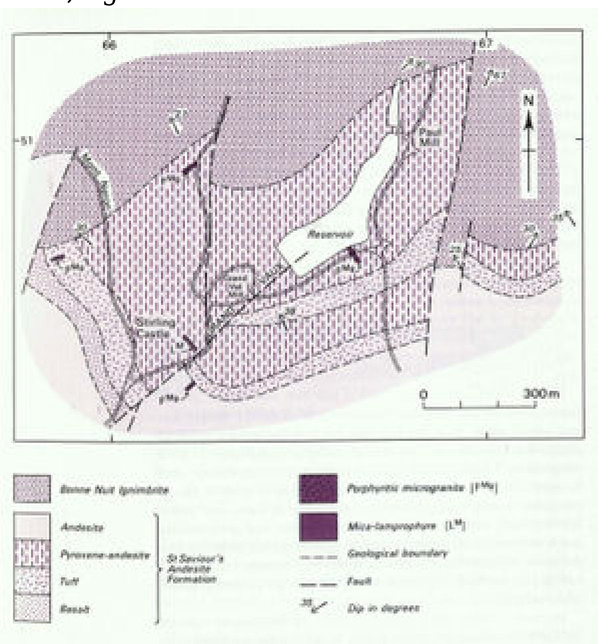

Figure 6 Sketch map of the geology around Grands Vaux Reservoir. Based on Thomas, 1977, fig.4.9.

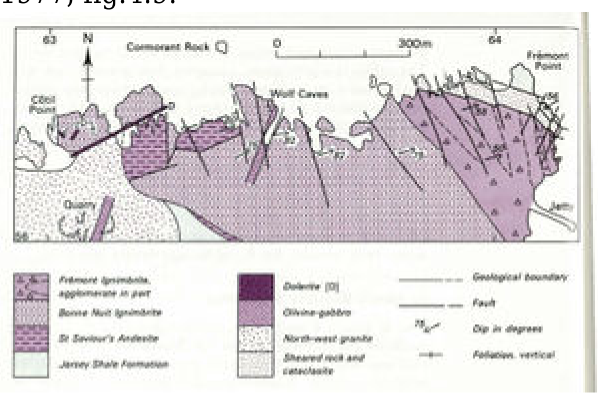

Figure 7 Geological sketch map of the coast

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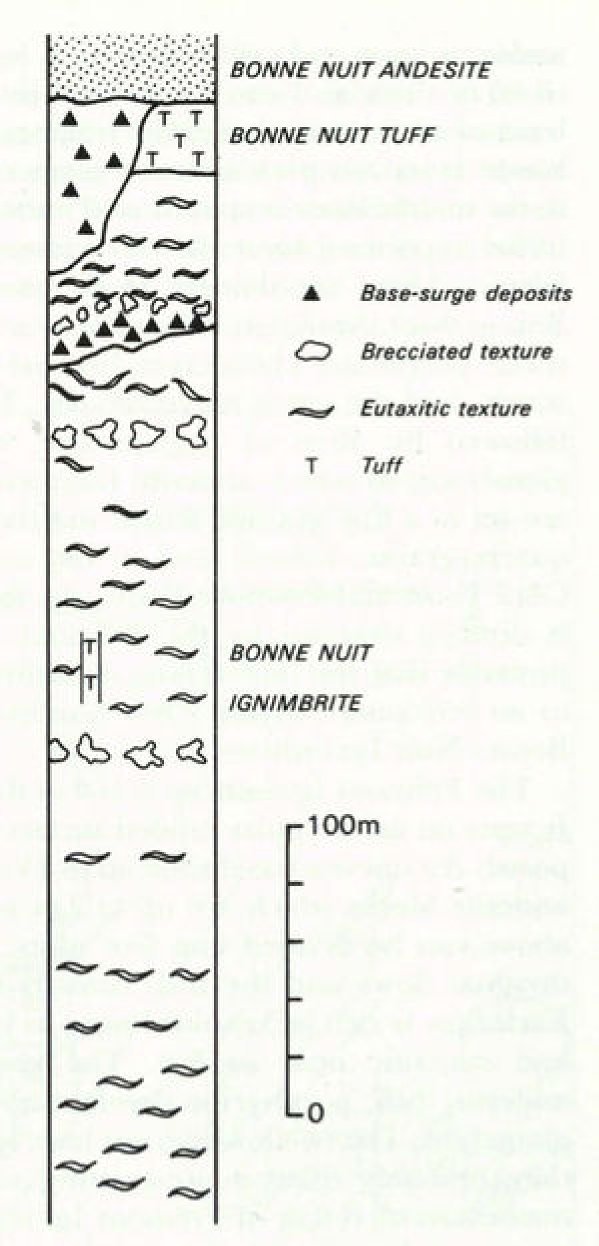

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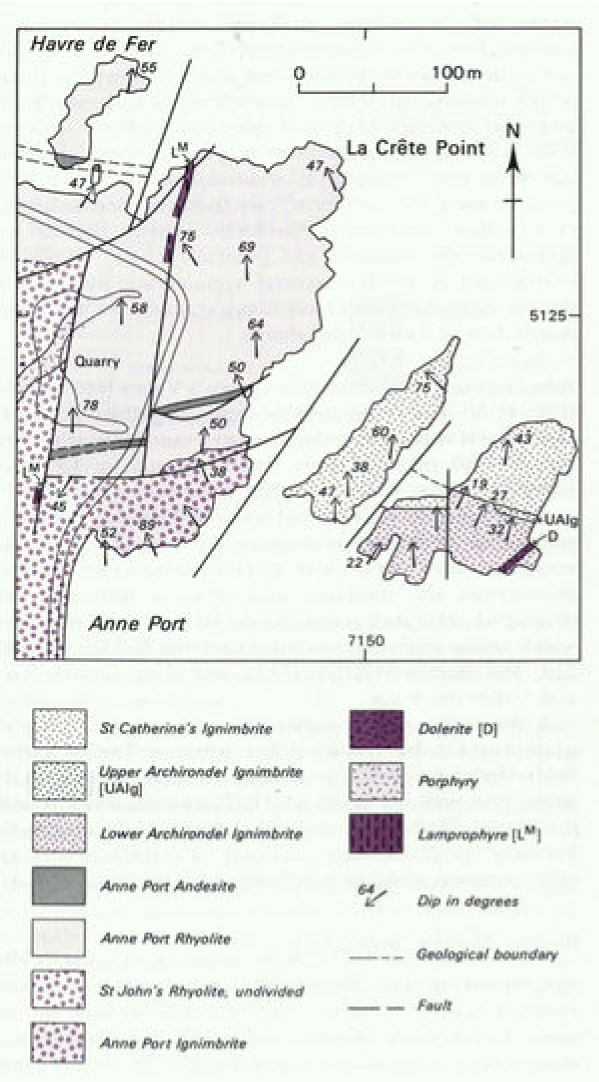


Figure 9 Sketch map of the geology north of Anne Port. Redrawn from Thomas, 1977, fig.7.7.

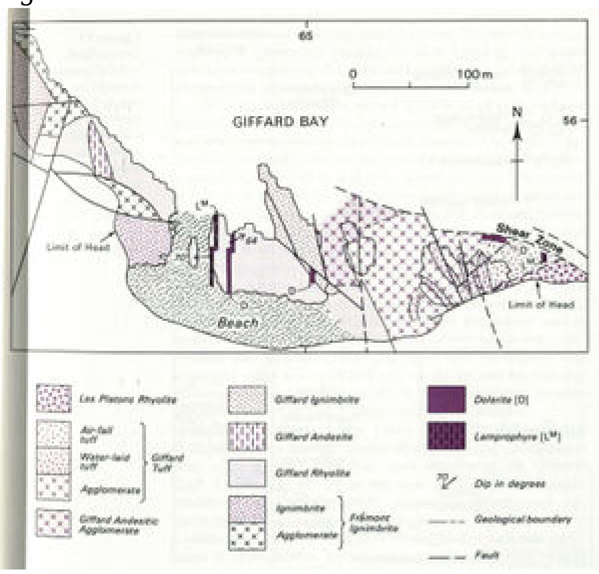
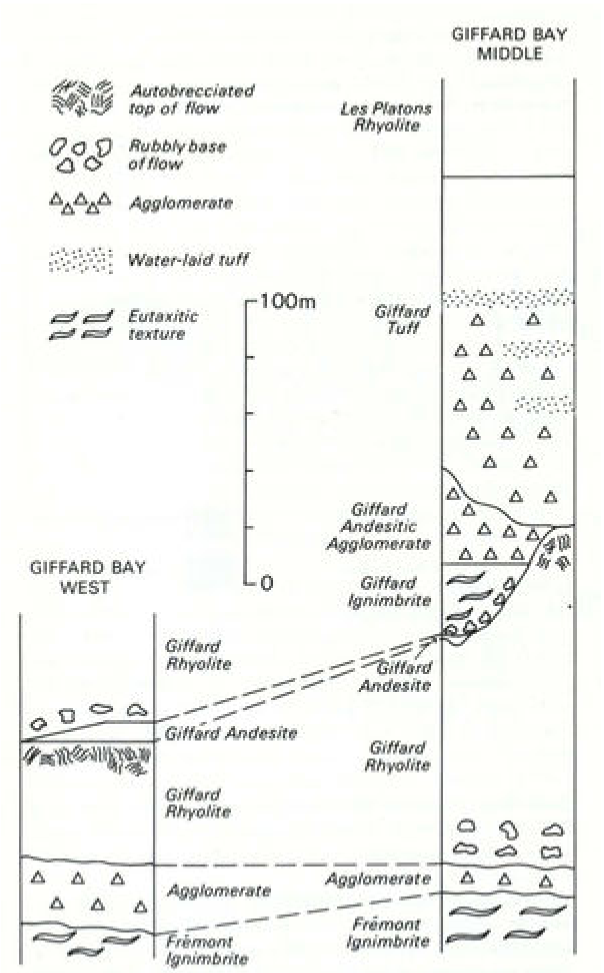


Figure 10 Sketch map showing the geology on the foreshore at Giffard Bay. Based on Thomas, 1977, fig.6.13.



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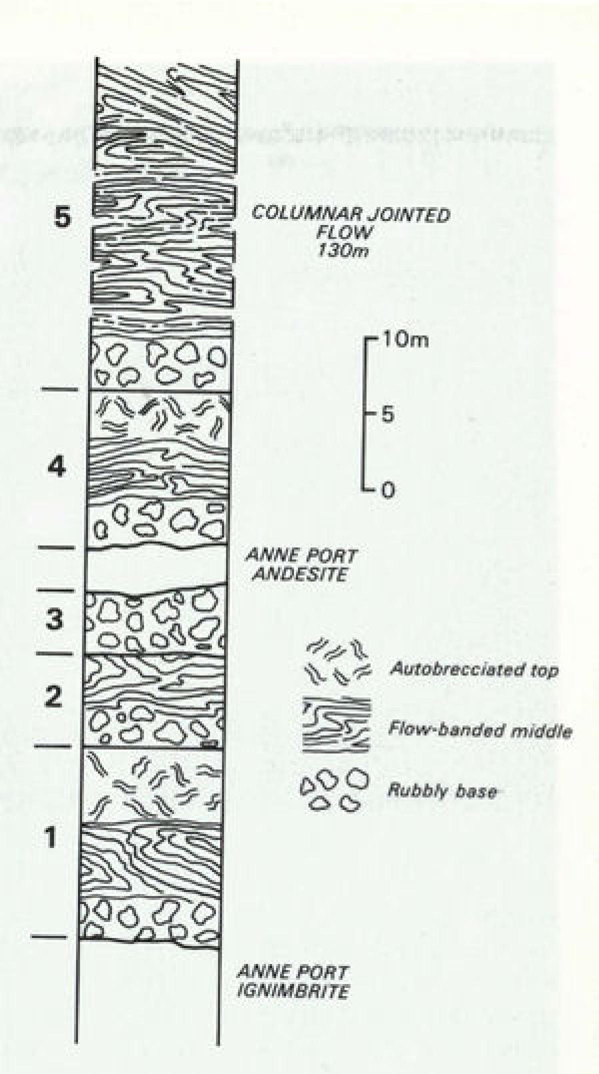


Figure 12 Vertical section through the Anne Port Rhyolite exposed on the north side of Anne Port beach. Flow 5 is not drawn to scale. Based on Thomas, 1977, fig.7.14.

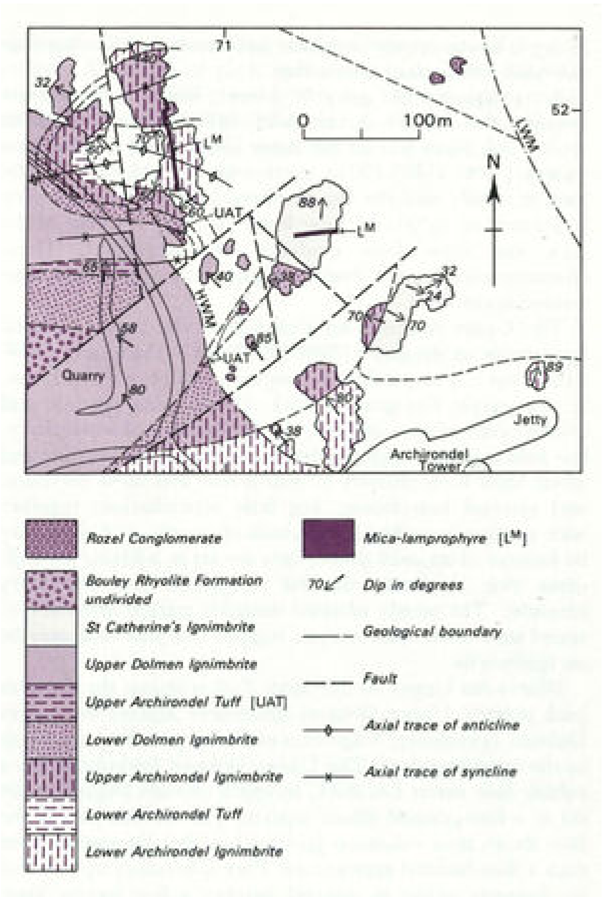


Figure 13 Sketch map showing the geology north of Archirondel Tower. Based on Thomas, 1977, fig.7.16.

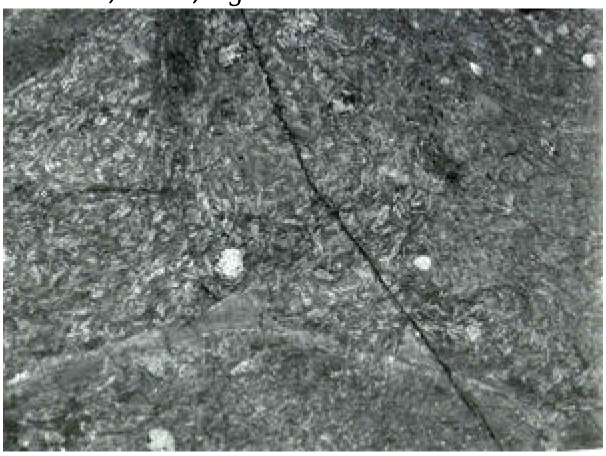
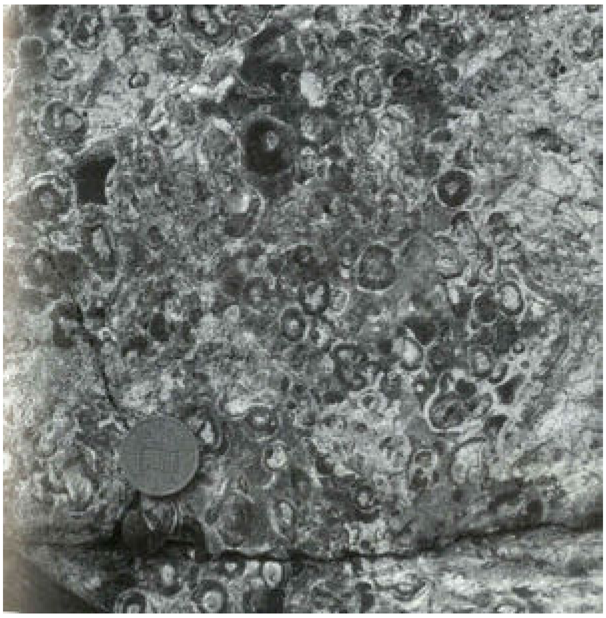


Plate 3 Lower Bathing Pool Andesite (below) and highly porphyritic Middle Bathing Pool Andesite (above) are separated by a thin mudstone bed in a reef west of the Victoria Marine Lake. Limpets show the scale. (A13718).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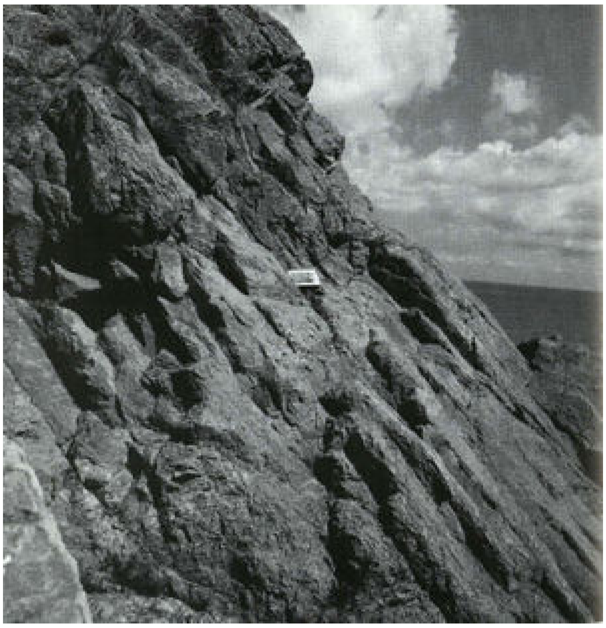
Plate 6 Columnar jointing in the Anne Port Rhyolite at Anne Port. Notebook for scale. (Photograph by Dr D. G. Helm).

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Contents

Chapter 3 Jersey Volcanic Group

The deposition of the Jersey Shale Formation was followed by the eruption and accumulation of a thick succession of volcanic and volcaniclastic rocks. The earliest volcanic rocks were andesitic in composition, and these gave way to rhyolitic rocks, porphyritic at first and then aphyric. The following sequence, with estimated thicknesses, has been recognised (Thomas, 1977), broadly following Mourant (1933):* Bouley Rhyolite Formation (aphyric) 430 m

- St John's Rhyolite Formation (porphyritic) 950 m
- St Saviour's Andesite Formation 850 m

The boundary between the Jersey Shale Formation and the St Saviour's Andesite is disconformable overall, but seems to be conformable locally (see p. 15–16, 20). Thus the volcanic rocks are probably only a little younger than the greywackes and may be of late Precambrian age. However, Duff (1978) has determined the age of porphyritic amygdaloidal andesites from the West Mount Quarry, just west of St Helier, as 533 ± 16 Ma (522 ± 16 Ma when recalculated), and has concluded that these rocks are Cambrian in age, although this opinion has been contested by Bishop and Mourant (1979; see p. 58).

The main outcrop of volcanic rocks extends from St John's Bay in the north, to Anne Port in the east. These rocks have been folded into a broad synclinorium (the Trinity Syncline; (Figure 18)), plunging NNE, and they are separated by the Frémont Fault from a smaller outcrop of andesites south of Belle Hougue Point. The andesites west of St Helier form a syncline (the St Helier Syncline) plunging SSW.

The andesitic lavas and pyroclastic rocks are typical of the deposits laid down on the flanks of volcanoes, and it is likely that there were vents to the north-east and south of the existing outcrops. However, because of their variable nature, it is possible to make only broad correlations between the sequences in different areas.

There is a marked angular discordance between the andesites and the succeeding rhyolites. This partly reflects differing modes of eruptive activity, as the andesitic volcanism formed cones whereas the rhyolitic ignimbrite flows tended to fill topographic lows; however, the presence of interformational laharic mudstones and conglomerates suggests that there was a short period of erosional activity between deposition of the formations.

Apart from a few local andesitic lavas and pyroclastic rocks, the St John's Rhyolite Formation comprises five massive ignimbrite cooling units, each containing several individual flows. There is a possible fissure feeder for the earliest member, the Jeffrey's Leap Ignimbrite, in Queen's Valley, but the source of the other ignimbrites is uncertain.

Flows of rhyolite marked the start of deposition of the Bouley Rhyolite Formation. Thin andesites occur among the rhyolites, and there is evidence of erosion at some levels in the sequence. In the eastern coastal section the rhyolites are succeeded by fairly thin aphyric ignimbrite flows with intercalated air-fall tuffs, all folded about E–W axes. A late porphyritic ignimbrite, the St Catherine's Ignimbrite, overlies the sequence with angular discordance. Ignimbrites around Bouley Bay are similar to the aphyric material from the east coast, but folded about N–S as well as E–W axes. The whole volcanic succession is unconformably overlain by the Rozel Conglomerate.

An intrusive contact between the volcanic rocks and the north-west granite is well exposed at Côtil Point [631 563]. A thermal aureole about 300 m wide features a pronounced N–S vertical foliation, granoblastic textures, and the growth of biotite porphyroblasts. Metasomatic andradite, diopside, and epidote are locally present in veins and patches, and the volcanic rocks close to the granite have been metasomatically enriched in potassium.

St Saviour's Andesite Formation

The St Saviour's Andesite Formation consists of subaerially deposited lavas, tuffs, and agglomerates of andesitic and basaltic composition. The andesites have a keratophyric mineralogy which is thought to be the result of propylitisation rather than regional metamorphism. All the lavas contain numerous plagioclase phenocrysts which, except in one basalt, have been altered to albite. The basalts all contained original olivine phenocrysts and most of the andesites original pyroxene, though in a few cases amphibole occurred instead.

Belle Hougue area

The successions found in the Belle Hougue area (Figure 3) are shown diagrammatically in (Figure 4). The breccio-conglomerate at the base is a variable deposit, up to 25 m thick, which separates the Jersey Shale Formation from the volcanic sequence. The earliest beds of the breccio-conglomerate contain fragments of Jersey Shale Formation only, but later beds have fragments of andesite and pebbles and grains of quartz in increasing amounts, producing a grit, in places conglomeratic, with thin mudstone lenses. The upper part at least of the breccio-conglomerate has the appearance of a braided stream deposit. A lens of grey-green lava 10 m long and 1 m thick is present [6540 5630] within the grits; this lava may be an altered basalt and was probably deposited in water in a river bed or shallow lake. Dips and strikes in the breccio-conglomerate nowhere show distinct divergence from those in the Jersey Shale Formation, and it is likely that the volcanic succession followed conformably on the Brioverian sedimentary rocks, though Helm (1984) has argued for a discontinuity on the grounds that the presence of a thick conglomerate at the base of the volcanic succession, which also appears to overstep some units of the Jersey Shale Formation, indicates that there was a considerable time interval between deposition of the two sequences.

The Les Rouaux Agglomerate is up to 25 m thick. In its type area it has a sharp base. Angular fragments of shale, andesite, porphyry and dark green pumice are set in a purplish grey matrix, the pumice being confined to the earliest beds. The matrix has undergone felsitic devitrification . Lenses of green tuff up to 0.15 m thick occur towards the top of the agglomerate. The top is generally distinct, but in places it merges with the overlying Vicard Tuff, the grey-purple matrix becoming bright green with the disappearance of lithic fragments.

The Vicard Tuff, consisting of grey-green to bright green and pinkish grey fine-grained tuffs, overlies the breccioconglomerate on the east side of Giffard Bay and the Les Rouaux Agglomerate farther east. It is up to 80 m thick, and at its top in the Les Rouaux area it is interlayered with the Belle Hougue Andesite. Bedding is not usually apparent, but west of Vicard Point the tuff displays crude layering and contains many bombs; these are up to 40 mm long, are usually aligned parallel to the bedding, and have disrupted the layering on their undersides only.

The Belle Hougue Andesite is exposed on the east side of Giffard Bay, where its base rests on successively lower horizons towards the south, first on the Vicard Tuff and finally on the Jersey Shale Formation; this suggests flow down an eroded palaeoslope. At Les Rouaux the Belle Hougue Andesite overlies the Vicard Tuff; in this area it has a maximum thickness of 60 m, but it thins south of La Colombiere, where it is overstepped by the Petit Port Andesite (see below). The Belle Hougue Andesite is normally purple, but it is grey-green in places where the lava was contaminated with Vicard Tuff. The Long Echet Tuff (see below) separates a basal flow 1 m thick from the rest of the andesite, and up to 5.5 m of tuffs of Vicard type within the andesite at Les Rouaux also indicate the presence of at least two flows.

The Long Echet Tuff occurs above the base of the Belle Hougue Andesite on the east side of Giffard Bay. It is up to 15 m thick and consists of megacrysts up to 2 mm in diameter of corroded plagioclase, perthite, and bipyramidal quartz, set in a felsitic matrix. Fiamme, which resemble strands of white cotton in hand specimen, are up to 15 mm long and have been devitrified to granular quartz. Near its base it contains fragments of shale and Vicard Tuff. The Long Echet Tuff, which is markedly more silicic than the surrounding tuffs and lavas, is ignimbritic.

The dark grey-green Petit Port Andesite is up to about 55 m thick at Petit Port [6625 5590], where it rests on Vicard Tuff. Farther west it overlies Belle Hougue Andesite, from which it is locally separated [6595 5625] by a lens of agglomerate up to 12 m thick. It is succeeded by agglomerate south of Belle Hougue Point, and by tuff west of Petit Port; both are overlain by undivided andesite to the north of Egypt, where exposure is poor.

St Helier Syncline

The St Saviour's Andesite Formation in the St Helier Syncline (Figure 5) comprises the following members in downward order:* Bathing Pool Andesites (Upper, Middle and Lower)

- Bathing Pool Agglomerate
- West Mount Andesite
- West Mount Tuff
- St John's Road Agglomerate
- St John's Road Andesite

The St John's Road Andesite is exposed along Old St John's Road [6475 4950] as a highly weathered limonite-stained lava. White feldspar laths and almost acicular chlorite patches are set in a greyish green groundmass. The flow is probably 30 to 50 m thick. The contact with the overlying St John's Road Agglomerate is not exposed, but 80 m of agglomerate can be examined at the western end of West Park [642 493] and 10 m at the northern end of West Mount Quarry. At the latter locality angular to subrounded andesite fragments up to 1 m across are set in a grey-green fine-grained felsitic matrix. In West Park macroscopic lithic fragments do not exceed 40 mm in diameter, and include shale and pink fine-grained quartz-porphyry as well as andesite.

The West Mount Tuff is pale green and fine grained, and is from 10 to 26 m thick. Exposures in West Park [6435 4920] indicate that the junction with the underlying agglomerate is irregular; the change from agglomerate to tuff is abrupt, and the tuff is therefore thought to have been produced by a separate eruptive event. In West Mount Quarry the tuff is intimately mixed with the lowest 15 m of the overlying West Mount Andesite, in a manner which suggests that it was originally an unconsolidated ash. The sequence appears to young to the south.

The West Mount Andesite varies in thickness from 36 m in West Park to 100 m in West Mount Quarry. In the quarry amygdaloidal porphyritic lava gives way southwards to phenocryst-poor andesite without amygdales, but the lithology reverts to a highly porphyritic and amygdaloidal type farther south [6452 4918]; therefore there are probably at least three separate lava flows of variable lateral extent within the member. Partly altered albite phenocrysts pick out a poor but recognisable fluxion banding.

The Bathing Pool Agglomerate varies laterally. Around West Park Pavilion greenish purple fine-grained tuff rests on the cracked surface of the West Mount Andesite. On the nearby beach, reefs to north and south of the Victoria Marine Lake (bathing pool) display poorly graded units of tuff and agglomerate from a few centimetres to several metres in thickness. Bedding can rarely be traced for more than a few metres and no aqueous sedimentary textures are present, indicating that it is likely to be an air-fall deposit.

The consistent similarity of all the larger andesite fragments suggests that the agglomerate was formed by the explosive disruption of a single homogeneous volcanic plug. Shale and porphyry fragments were probably derived from the walls of the volcanic conduit.

Three separate lava flows and an inter-flow sedimentary horizon have been distinguished in the Bathing Pool Andesites. The Lower Bathing Pool Andesite has corroded platy albite phenocrysts up to 10 mm long, set in a grey fine-grained groundmass, commonly in clusters and showing no particular orientation. Amygdales up to 20 mm long are abundant, and are orientated parallel to the surface of the flow. In a reef [6378 4879] west of the bathing pool the top 7 m of the Lower Bathing Pool Andesite are overlain by olive-brown mudstone up to 0.3 m thick and by the basal 25 m of the Middle Bathing Pool Andesite (Plate 3). Blocks from the underlying andesite occur near the base of the Middle Bathing Pool Andesite, and fragments of the mudstone are distributed throughout its exposed thickness.

The Middle Bathing Pool Andesite is highly porphyritic and fluxion-banded. The rock is readily identified by the abundant greenish white platy feldspar laths which are set parallel to the banding in a greyish green fine-grained groundmass. A few amygdales up to 3 mm across are lined with epidote and have penninite centres.

The Upper Bathing Pool Andesite, the youngest member of the local andesite sequence, is probably about 100 m thick. It forms the core of the St Helier Syncline. On the western limb of the fold it follows the Middle Bathing Pool Andesite, but on the eastern limb the two lowest members of the Bathing Pool Andesites have been overstepped by the youngest lava, which rests directly on tuffs at the top of the Bathing Pool Agglomerate. The base can be examined on a reef [6418 4869] south of the bathing pool. Fluxion banding in the Upper Bathing Pool Andesite is picked out by pinkish white albitised plagioclase laths.

Trinity Syncline

The largest outcrop of andesitic rocks in Jersey is situated inland, around the main synclinorium. The boundary between the Jersey Shale Formation and the andesites is exposed at several places. At West Hill [6435 5052] highly weathered exposures show a vertical junction between shales and tuffs; an agglomerate layer 0.2 m thick lies within the shales, and the andesites here are considered to be conformable upon the shales. Faulted junctions have been seen at Chestnut Farm [6465 5000], Clos de Paradis [653 498] and Wellington Road [6612 4925].

At Côtil Point (Figure 7) andesite has been intruded by granite (p. 52) and is overlain by ignimbrite. Just north-east of the site of the former Mont Mado Quarry, outcrops of andesite are terminated to the north by a pre-granite E–W sinistral wrench fault. These andesites have been affected by thermal metamorphism; they contain pink alkali feldspars rather than plagioclase, but display no megascopic foliation.

Between Handois Reservoir and Mont à l'Abbé [650 503] the andesites consist of albite phenocrysts in a dark grey-green fine-grained felsitic groundmass rich in plagioclase microliter and commonly fluxion-banded. Mafic phenocrysts have been replaced by chlorite, quartz, epidote and iron ore, but recognisable pseudomorphs after pyroxene occur. Apatite needles are scattered throughout the rock.

In the quarry [6536 5037] behind Homestead Cottage, in Vallee des Vaux, two lava flows can be recognised. Dark green blocky andesite at the north end is distinct from the light green highly amygdaloidal andesite, which contains pyroxene phenocrysts and fewer albite laths, in the rest of the quarry. The distribution of amygdales and rubbly texture in these lava flows suggests that the sequence may be inverted. Tuffs resembling the Vicard Tuff are exposed elsewhere in Vallee des Vaux. Two exposures [6534 5053] north of Homestead Cottage are in altered basalt, with white platy labradorite phenocrysts and pseudomorphs after poikilitic olivine crystals set in a purple-green fine-grained ground-mass. In Grands Vaux valley (Figure 6) grey-green keratophyric pyroxene-andesite is interlayered with tuff and agglomerate, and near Stirling Castle [659 506] basalt similar to that noted in Vallée des Vaux is exposed.

The Trinity Hill Andesite, greenish purple andesite rich in platy feldspar laths, is exposed on New Trinity Hill. Dips on the fluxion banding indicate that the flow is folded into a WNW–ESE-trending syncline, the axis of which lies near the junction with Old Trinity Hill.

Around St Saviour's Hill the succession recognised north of the faulted boundary with the Jersey Shale Formation is, in downward order:

Grey-green pyroxene-andesite with tuff horizons	95 m
Agglomerate	7 m
Purple amygdaloidal andesite	27 m
Grey andesite	16 m

Grey andesite around St Mark's School [6581 4956] has sericitised albite laths set in a fluxion-banded groundmass of plagioclase microlites, interstitial feldspar and finely divided magnetite. The lava is rich in amygdales towards its top, and is overlain by purple Trinity Hill Andesite with a sharp irregular contact. Agglomerate was seen at only one place [6587 4948], just above the purple andesite, and presumably is not extensive. Similarly, an old quarry [6602 4968] in the grounds of Government House provides the only exposure of tuff in the vicinity, the rock being silvery grey, fine grained and compact.

In Swiss Valley the succession north of the granite contact [671 490] consists of tuff, overlain by pyroxene-andesite with two further tuff horizons; agglomerate overlies the uppermost tuff. The andesites resemble those found in Grands Vaux and at St Saviour. A conglomerate up to 7 m thick forms an outcrop just east of Beau Désert [6718 4960]; pebbles of pyroxene-andesite in the conglomerate are of local type and up to 60 mm in diameter, set in a matrix of fine andesite debris. This conglomerate is presumably the product of inter-flow erosion, possibly along a stream bed or gulley. The sporadic occurrence of tourmaline (schorlite) in volcanic rocks between St Saviour's Parish Hall [663 498] and south-east of Francheville [6850 4949] has been recorded (Mourant, 1933; Thomas, 1977); this mineral is assumed to have resulted from pneumatolysis, though the origin of the fluids is uncertain.

An inlier of andesitic rocks around Blanche Pierre [667 524], west of Le Grès, has the form of an eroded dome (D1; see p. 72); the rocks comprise pyroxene-andesite, agglomeratic tuff and tuffite, all surrounded by ignimbrite. The tuffite is a grey-green, compact, fine-grained rock with graded units up to 40 mm thick; quartz grains are present near the base but do not persist to higher levels. The rock appears to have been deposited in quiet lacustrine conditions, and field relations favour association with the andesites rather than the ignimbrites.

A triangular area of purple amygdaloidal lava [699 531] south of Rozel Manor was termed andesite by Mourant (1933), but was identified as altered basalt by Thomas (1977). This inlier provides evidence for the presence of a major fault beneath the Rozel Conglomerate (see p. 77).

St John's Rhyolite Formation

The St John's Rhyolite Formation follows the St Saviour's Andesite unconformably, but the discontinuity between the two may reflect overstep rather than a genuine break in the eruptive events. Interformational sediments include the Vicard Mudstone and the L'Homme Mort Conglomerate.

The name Vicard Mudstone is given to a purple and green mudstone found at Vicard Bay (where it is 60 m thick, inverted, and dips steeply to the north) and also above Giffard Bay. This mudstone exhibits a 'flow' fabric, and was thought by Thomas (1977) to be laharic in origin. A conformable andesite 2.5 m thick, which is present within the mudstone, is distinct in that it contains no phenocrysts. Just to the north of this andesite a vertical junction between mudstone and ignimbrite is exposed [6646 5567]. The ignimbrite here has the rubbly, brecciated texture characteristic of the base of a flow, and the cross-cutting relationship confirms that the boundary is unconformable.

Conglomerates on Long Echet (formerly called the Long Echet Conglomerate) and in the south-east corner of Giffard Bay are now both termed L'Homme Mort Conglomerate. They overlie andesite and the Jersey Shale Formation in unconformable relationship. Pebbles of andesitic and sedimentary rock types are predominant, with lesser amounts of granite, porphyry, rhyolite, vein-quartz, and metamorphic rock. The rhyolitic debris resembles material in the Long Echet Tuff (p. 17), rather than in the main rhyolite sequence, and it is likely that this conglomerate is older than the main acidic volcanism. The L'Homme Mort Conglomerate is cut by the Frémont Fault, whereas the nearby outlier of Rozel Conglomerate is not, showing that the two deposits are of different ages.

The St John's Rhyolite Formation includes five ignimbrite cooling units, which are distinguishable by their field appearance. These ignimbrites have internal base-surge horizons, pumiceous horizons, and a vertical variation in phenocryst content, all indicating that they were compound cooling units containing numerous individual flows. In many cases erosional features are present between flows in a single ignimbrite. All the ignimbrites display eutaxitic textures and many individual fiamme show axiolitic devitrification. Corroded quartz phenocrysts and perthite laths are ubiquitous, and albite laths are abundant in the two oldest ignimbrites, the Jeffrey's Leap Ignimbrite and the Bonne Nuit Ignimbrite. All the ignimbrites contain fragments of country rock derived from either the magma chamber or the conduit and concentrated in base-surge horizons; shale and andesite are common, acidic volcanic material generally rare. In the Jeffrey's Leap Ignimbrite, assimilation of andesite has led to the growth of amphibole and biotite phenocrysts. An abundance of aphyric rhyolitic fragments in the Anne Port Ignimbrite, the last member of the St John's Rhyolite Formation on the east coast, demonstrates that such material had previously been erupted, but no outcrop is known.

North coast

The St John's Rhyolite crops out along the north coast from Côtil Point to La Crête. The sequence between Côtil Point and Frémont Point (Figure 7) has been displaced by a sinistral tear fault at the south-west corner of Bonne Nuit Bay and is repeated between Bonne Nuit jetty and La Crete.

The Bonne Nuit Ignimbrite (Figure 8), at the bottom of the succession, is grey to black where fresh, and weathers to a pale pinkish cream colour. The base is only exposed in the aureole of the north-west granite. Andesite blocks are common near the base and are generally aligned parallel to it. In higher levels the ignimbrite is characterised by many angular siltstone xenoliths, few of which exceed 20 mm in diameter; quartz, perthite, and albite phenocrysts are present in variable amounts. Fiamme make up 3 to 10 per cent of the rock; they are no longer glassy, some having been replaced by trails of granular quartz and feldspar, others displaying axiolitic devitrification. Several autobrecciated horizons are believed to represent the tops of individual flows. The thickness of the Bonne Nuit Ignimbrite is estimated to range from 550 m to 900 m between Côtil Point and Frémont Point, but in Bonne Nuit Bay the thickness varies from 400 m to 650 m and field evidence indicates that the upper surface was deeply eroded.

The Bonne Nuit Tuff, comprising light grey fine-grained tuff, overlies the Bonne Nuit Ignimbrite, and is succeeded by andesitic lavas and agglomerates. A lower agglomerate is up to 65 m thick and can be divided into three layers on the basis of its contained andesite fragments; the andesite in the lowest layer has pink albitised plagioclase phenocrysts, that in the middle layer is aphyric and microlitic, and the andesite in the uppermost layer has white phenocrysts. The matrix is felsitic. These are thought to be base-surge deposits. The Bonne Nuit Andesite, 60 m thick, overlies the pyroclastic rocks; plagioclase phenocrysts become fewer and smaller upwards, and the top is amygdaloidal. The andesite is in turn followed by 50 m of agglomerate, the Bonne Nuit Agglomerate, in which andesite fragments up to 1.5 m across are set in a fine-grained felsitic matrix rich in small angular quartz grains. Inland, and in the coastal section between Côtil Point and Frémont Point, the Bonne Nuit Ignimbrite is directly overlain by the Frémont Ignimbrite, and it is probable that the intervening andesitic rocks were confined to an erosional canyon a few hundred metres wide in the Bonne Nuit Ignimbrite.

The Frémont Ignimbrite is 160 m thick at Frémont Point. It rests on an irregular eroded surface and its top is not exposed. An uneven basal zone up to 15 m thick contains many andesite blocks which are up to 2 m across. The ignimbrite above can be divided into five units; four of these are individual flows and the fifth consists of several thin flows. Each flow is rich in xenoliths near its base but xenolith-poor and eutaxitic near its top. The xenoliths include shale, andesite, tuff, porphyritic rhyolite, aphyric rhyolite and agglomerate. The two lowest units have lenticular outcrops and they probably filled a pre-existing valley. At La Crete a maximum of 100 m of Frémont Ignimbrite is exposed, in a westward-dipping block separated from the eastward-dipping sequence to the south by a NW–SE fault; this block is deemed to be overturned on the evidence of the distribution of its xenolithic and eutaxitic horizons.

At Vicard Bay, north of the Frémont Fault, the Vicard Mudstone and Vicard Tuff are succeeded unconformably by ignimbrite 7 m thick, followed by 13 m of sedimentary breccia and by a further 65 m of ignimbrite. Both ignimbrites are grey-green and fine grained, and resemble the Frémont Ignimbrite. The sedimentary breccia consists of angular fragments of green shale and green tuff in a green fine-grained matrix of quartz and clay minerals; this breccia is probably an inter-flow scree-type deposit.

East coast

Along the coast between Petit Portelet [716 504] and Anne Port [714 508] the foreshore reefs are formed of Jeffrey's Leap Ignimbrite; the limits of this member are obscured by beach deposits but the thickness exposed is about 200 m. The groundmass of the ignimbrite is generally felsitic, with grain-size less than 0.01 mm, but in places poorly defined areas show much coarser felsitic devitrification. Fiamme are generally difficult to discern, but where present they pick out a eutaxitic texture which dips at about 40° to just east of north. Xenoliths are abundant in areas poor in fiamme, and consist of sedimentary rocks probably derived from the Jersey Shale Formation, andesite, and salmon-pink porphyry containing albite, perthite and quartz phenocrysts in a felsitic matrix; the largest shale and andesite xenoliths and most of the porphyry blocks are concentrated in the top 20 m or so, making a distinctive band. Phenocrysts of quartz, perthite, albite and altered mafic minerals occur throughout this ignimbrite; the mafic minerals may have been biotite and amphibole.

On the northern side of Anne Port (Figure 9) the Anne Port Ignimbrite is exposed. The flow is about 50 m thick. The lowest part visible is eutaxitic and passes up into almost parataxitic ignimbrite containing large xenolith-rich patches. Few of the fiamme are axiolitic. The top of the flow is rich in undeformed shards and pumice. The groundmass is fine grained and felsitic, and is stained and replaced by hematite, particularly towards the top of the flow. The combination of secondary hematite and microcrystalline quartz has given rise to jasper. Bipyramidal quartz and perthite phenocrysts in the ignimbrite vary from euhedral to angular or corroded. Xenoliths of andesite, aphyric rhyolite and ignimbrite are common and generally small. Within the central part of the flow several agglomeratic patches with sharply defined margins have many xenoliths set in a felsitic matrix free of fiamme and shards.

Inland exposures

Ignimbrite in Queen's Valley [6935 4964] to [6959 4969] is indistinguishable from the Jeffrey's Leap Ignimbrite. It may be that the elongated outcrop of ignimbrite that extends from Queen's Valley to south of Le Bourg represents a fissure which fed the ignimbrite eruption.

An old quarry [6937 5110] south of Le Côtil Farm is in porphyritic ignimbrite containing a few small sedimentary xenoliths, and albite and quartz phenocrysts; perthite phenocrysts are abundant and eutaxitic texture is well developed. This rock resembles the Bonne Nuit Ignimbrite, which is also commonly exposed between St Manelier [674 510] and Augrès Mill [652 515], and along Grands Vaux and Vallee des Vaux.

A distinctive purple tuffaceous rock crops out on the north-east side of Grands Vaux between Trinity playing fields [660 535] and Rue Coutanche [654 546], and also along Trinity Road [6610 5375]. The location of this rock, the Trinity Ignimbrite, suggests that it is younger than the Frémont Ignimbrite, but it cannot be correlated with any other member of the St John's Rhyolite Formation.

Bouley Rhyolite Formation

Ignimbrites in the Bouley Rhyolite Formation around Bouley Bay are similar to the aphyric material from the east coast, but they are thicker, and several are demonstrably compound cooling units composed of two or three separate flows. Textures in all these ignimbrites are similar to those of the older ignimbrite flows, but xenoliths are acidic rather than andesitic or sedimentary, and spherulitic devitrification is commonly spectacular.

On the north coast, in Giffard Bay (Figure 10), a thin porphyritic ignimbrite and a thick sequence of pyroclastic rocks are sandwiched between rhyolite flows. Some of the pyroclastic rocks were deposited in pools of standing water and some were reworked by streams.

Giffard Bay

The boundary between the St John's Rhyolite Formation and the Bouley Rhyolite Formation is exposed on the south-east corner of La Crête headland. At the base of the overturned succession (Figure 11) agglomerate is followed by the Giffard Rhyolite with an irregular eroded contact; the basal rhyolite is about 40 m thick, autobrecciated at the top, and followed by the thin (8 m) Giffard Andesite and then more rhyolite. This sequence is separated by a fault from the succession in the middle of Giffard Bay, where the dip is to the east; the lower rhyolite is about 100 m thick and the upper flow is missing through erosion or non-deposition. The andesite is preserved in small patches at the bottom of a contemporaneous gulley cut into the lower rhyolite. Later ignimbrite and andesitic agglomerate fill the gulley and the whole succession is overlain by a suite of acidic tuffs and agglomerates, and lastly by the Les Platons Rhyolite.

The Giffard Rhyolite is dark purple and fine grained, with contorted flow banding picked out in pale pink layers composed of outward-growing fans of fibrous feldspar. Trains of small pink spherulites parallel the flow banding, and small corroded megacrysts of quartz and perthite are present. The groundmass has undergone felsitic devitrification.

The Giffard Andesite is up to 8 m thick, dark grey and fine grained; it contains a few albitised plagioclase phenocrysts and albite microliths set in a felsitic matrix. The Giffard Ignimbrite succeeded the andesite in the gulley; it has a maximum thickness of 25 m and a flat upper surface. The matrix is fine grained and felsitic, and eutaxitic fiamme show axiolitic devitrification similar to that of the Frémont. Ignimbrite. The base contains numerous xenoliths of rhyolite and andesite, and shale xenoliths and quartz and perthite phenocrysts are scattered throughout the flow. The Giffard Andesitic Agglomerate, also in the gulley, is 15 to 40 m thick. It consists of irregular blocks of porphyritic andesite, up to 0.4 m across, set in a fine-grained tuffaceous matrix which is felsitic, with small fragments of rhyolite and quartz. Casimir and Henson (1955) suggested that the deposit was produced when a flow of andesite broke up and became incorporated into an ash over which it was moving; Thomas (1977) preferred to call it 'Agglomeratic Andesite'.

Air-fall pyroclastic debris, partly water-laid, followed the Giffard Rhyolite and the Andesitic Agglomerate with a sharp base in western Giffard Bay, and constitutes the Giffard Tuff. Green air-fall tuff at the base is followed by purple mudstone, agglomerate, tuff, purple mudstone, and agglomerate. The purple mudstones were interpreted by Casimir and Henson (1955) as blocks of Precambrian sediment incorporated in the agglomerate, but Thomas (1977) regarded them as lacustrine sediments deposited on the irregular surface of the air-fall tuff, with local mixing and slumping. The agglomerates in the sequence contain mudstone, andesite and rhyolite debris, as well as albite, perthite, quartz, pumices, and shards, all set in a pale green fine-grained felsitic matrix. Towards the top of the succession the agglomerates grade into air-fall tuffs which have a similar matrix but fewer and smaller lithic and crystalline fragments and more pumiceous material.

Fluvially -deposited volcaniclastic rocks of limited spread and thickness occur in the lower agglomerates. The most extensive of these is 35 m above the base of the pyroclastic sequence, 30 m across and 5 m thick; graded units are up to 0.3 m thick, and purple mudstones up to 15 mm thick occur at the top of most. Reverse grading, braiding, ripple marking, and contemporaneous microfaulting and slumping, all testify to deposition in a high-energy environment, probably a braided stream.

Water-laid tuffs characterised by alternating green and purple colouration occur at four levels in the air-fall pyroclastic rocks. Pumice, shards, and minor lithic fragments are set in a fine-grained felsitic matrix. There is some grading of pumices, but there appears to be no relationship between grading and colour. Accretionary lapilli that occur in some of the purple bands may be the 'elliptical… bombs' described by Casimir and Henson (1955). The shapes of these bodies of banded tuff suggest that they were deposited in pools of standing water.

The pink Les Platons Rhyolite overlies the tuffs in the south-east corner of Giffard Bay with a sharp junction. The basal 5 m has poor banding and contains pieces of tuff; flow banding is well developed above this. Spherulites up to 30 mm across are concentrated in bands parallel to the flow; they are composed of radiating fans of fibrous feldspar separated by films of hematite. The few pink perthite megacrysts present in the rock usually form the cores of spherulites. A brecciated horizon, 3 m thick, indicates that more than one flow occurred. The matrix is granular quartz with small open feldspar spherulites.

Bouley Bay

In north-west Bouley Bay the reddish Vicard Point Ignimbrite is about 25 m thick. It contains several rubbly horizons and has an autobrecciated top; these combine with the flow-banded appearance of the rest of the unit to suggest a number of rhyolite flows. The overlying Lower Bouley Ignimbrite is about 80 m thick; its pale green colour is distinctive, but pink patches around Bouley Bay jetty are due to disseminated secondary hematite. Shards, pumice, crystal and lithic fragments, and spherulites are set in a fine-grained felsitic matrix. Locally—for example, at the roadside [6692 5468] 150 m south of Bouley Bay jetty—concentrations of spherulites form up to 80 per cent of the rock, their bright red colour contrasting strongly with the green matrix (Plate 4). The spherulites are built up of concentric shells of radiating fibrous feldspar formed during successive stages of growth and separated by granular quartz in some cases. Spherulites reaching 10 cm in diameter are present in the crags of Les Hurets; these spectacular rocks have been described by Mourant (1932; 1933). Spherulites and perlitic cracks are high-temperature features which distinguish the deposit as an ignimbrite. Above the Bouley Bay Ignimbrite, the Les Hurets Tuff is found only on the west side of Bouley Bay [6688 5463], where it is up to 35 m thick. It is distinguished by corroded bipyramidal quartz and pink perthite phenocrysts, and by a lack of xenoliths. Fiamme seen in thin section demonstrate its ignimbritic nature.

The reddish purple Middle Bouley Ignimbrite is exposed at the shoreline and on the heights above west Bouley Bay, at L'Islet, and at La Tête des Hougues. At the first and third of these localities numerous patches of large spherulites are set in brecciated material with a poorly defined eutaxitic texture, and the base is commonly brecciated. At L'Islet the ignimbrite displays superb parataxitic texture (Plate 5), giving it the appearance of a flow-banded 'rhyolite' ; the underlying green Lower Bouley Ignimbrite has been affected by this intense welding. This spatial distribution suggests a section across a flow, the margins having cooled more rapidly than the interior, producing primary spherulitic growth, and the middle being more strongly welded.

Salmon-pink Upper Bouley Ignimbrite lies above the darker Middle Bouley Ignimbrite at La Tête des Hougues and at L'Islet, and can also be recognised in isolated exposures south-west of Bouley Bay jetty. It is up to about 200 m thick and consists of two flows. The lower of these has a brecciated base and top, and is highly welded and compacted near its base. The main part of the flow is eutaxitic, with fiamme ranging from 0.05 to 30 mm in length and roughly one tenth as thick, and feldspar xenocrysts replaced by sericite and microcrystalline quartz. The eutaxitic ignimbrite gives way upwards to pumiceous ignimbrite. The upper flow has a sharp, undulatory, brecciated base which shows little compaction. Parataxitic textures are present 25 m above the base. Fiamme reach 0.4 m in length, giving a flow-banded appearance. Most of the groundmass has undergone spherulitic devitrification. The top of the flow is not seen.

East coast

The Anne Port Rhyolite is a sequence of five rhyolite flows which overlies the Anne Port Ignimbrite on an irregular, slightly eroded surface (Figure 12). In the ideal flow a rubbly base passes upwards into massive flow-banded lava with columnar jointing (Plate 6), and the top is autobrecciated, but inter-flow erosion has removed the upper part of some of the flows. Of the five flows, the top four are present in Anne Port Quarry [713 512] and roadside exposures to the south of it. The Anne Port Andesite provides a thin marker horizon between the third and fourth flows. The columnar uppermost rhyolite is repeated by faulting in Havre de Fer, its top being hidden by the Archirondel breakwater.

The rubbly base of each flow contains numerous angular rock and mineral fragments up to 2 m across, set in a fine-grained felsitic matrix patchily rich in finely divided secondary hematite. Flow banding is picked out by an alternation of dark purple spherulitic bands and pink quartz-rich bands. Many of the purple bands display a continuous median layer of magnetite.

The Anne Port Andesite is similar to the lavas in the St Saviour's Andesite Formation; it also resembles the Giffard Andesite, with which it is tentatively correlated. Its lower and upper surfaces are irregular, and its thickness ranges from 1 to 3 m. The andesite is dark grey and fine grained, with albite phenocrysts and chlorite pseudomorphs after an unidentified mafic constituent, set in a matrix of microlites, magnetite and feldspar.

The succession north of the Archirondel breakwater is folded about E–W axes (Figure 13). Lower Archirondel Ignimbrite crops out just north of the breakwater, which conceals its base. The salmon-pink aphyric ignimbrite is about 55 m thick. Eutaxitic texture is present everywhere, but particularly in exposures farther north [7094 5204]. Macroscopic pink spherulites, which weather white, occur in patches, and quartz and perthite megacrysts are randomly scattered in the devitrified matrix.

Near the Dolmen Dr J. T. Renouf has pointed out that the 'Dolmen' marked on the topographical base-map is in fact an 18th century gun platform. [7092 5197] the Lower Archirondel Ignimbrite is succeeded by pink Lower Archirondel Tuff, the exposed thickness of which is up to 1.95 m. The base is concealed by beach deposits and the top is irregular. Pale green to white pumice and rhyolite, andesite, quartz and albite fragments are set in a fine-grained felsitic matrix, much of which has been replaced by hematite from which it derives its colour. Well-developed sorting distinguishes these deposits as air-fall tuffs rather than flow-pyroclastics, and the thin fine-grained graded upper parts of some beds suggest posteruptional dust settling above an air-fall deposit, rather than water-sorted debris.

Elsewhere the Lower Archirondel Ignimbrite is directly followed by the purple Upper Archirondel Ignimbrite, which is up to 28 m thick. The basal 5 m or so are rubbly, and rich in pumice and rhyolite blocks, some of which are more than 1 m in diameter. The rubbly base passes up into fragment-rich eutaxitic ignimbrite where the flow is thicker, but it is followed by autobrecciated material where the flow is thinner. Spherulites up to 5 mm in diameter, showing up to six growth stages, are set in granular quartz showing perlitic cracking. The matrix varies from felsitic to spherulitic, eutaxitic texture is poor, and fiamme, which do not exceed10 by 0.7 mm, provide the only indication that this is an ignimbrite rather than a lava flow.

The salmon-pink aphyric Lower Dolmen Ignimbrite overlies the Upper Archirondel Ignimbrite; it thickens southwards from 4 m on the shore [7095 5194] to 30 m in a quarry [7090 5183] 250 m north-west of Archirondel. The base is rubbly and the top autobrecciated. Aligned pumice fragments up to 80 mm long form up to 40 per cent of the rock and show little evidence of compaction. These characteristics suggest that the deposit was originally a non-welded ignimbrite.

The Upper Archirondel Tuff follows the Lower Dolmen Ignimbrite on the shore [7096 5190] and in the quarry [7090 5189], but it is impersistent, ranging up to 14 m in thickness. It is a purple fine-grained rock, rich in pink perthite and quartz phenocrysts, and has the appearance of a porphyry, but field evidence suggests that it was extrusive. Perthite and albite laths form clusters 10 mm across and show corrosion and internal brecciation, but little sericitisation; together with embayed cracked bipyramids of quartz, and what may be fiamme of unusual shape, they are set in a felsitic ground-mass rich in finely divided magnetite and secondary hematite. The poorly axiolitic eutaxitic texture and the corroded state of the phenocrysts suggest that this rock may be an ignimbrite.

Where the Upper Archirondel Tuff is absent the purplish pink aphyric Upper Dolmen Ignimbrite follows the Lower Dolmen Ignimbrite, fragments of the latter being caught up in the overlying flow. The Upper Dolmen Ignimbrite has a rubbly base about 4 m thick, in which rhyolite fragments are set in a fine-grained felsitic matrix. The median part of the flow shows poor columnar jointing and fine fiamme give the rock a flow-banded appearance. Pink spherulites up to 4 mm in diameter occur in aligned patches a few metres long, which contain no fiamme.

The St Catherine's Ignimbrite is probably the youngest of the Jersey volcanic rocks. At Anne Port [7160 5112] it dips to the north over an irregular surface, below which a near-vertical boundary between Lower and Upper Archirondel Ignimbrites can be seen, and north of Archirondel Tower it rests on Upper Archirondel Ignimbrite in one exposure [7114 5183] and on Lower Dolmen Ignimbrite in another [7107 5189]. Thus considerable erosion occurred prior to the deposition of the St Catherine's Ignimbrite.

At Anne Port the lowest 5 m of the St Catherine's Ignimbrite are rich in ellipsoidal black fiamme, which reach 0.5 m diameter and 25 mm thickness. This horizon has a distinctive green fine-grained groundmass and pink perthite phenocrysts, and is not seen elsewhere. The rest of the ignimbrite (80 m) is characterised by eutaxitic texture and by a dull grey flinty groundmass. Fiamme rarely exceed 0.2 m in length. Xenoliths of pink ignimbrite (possibly Lower Archirondel Ignimbrite), up to 26 m by 3 m, are aligned near the top of the flow. Corroded shattered bipyramidal quartz and perthite phenocrysts reach 3.5 mm in diameter.

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