Plutonic igneous rocks - Jersey: description of 1:25 000 Channel Islands Sheet 2

From Earthwise

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

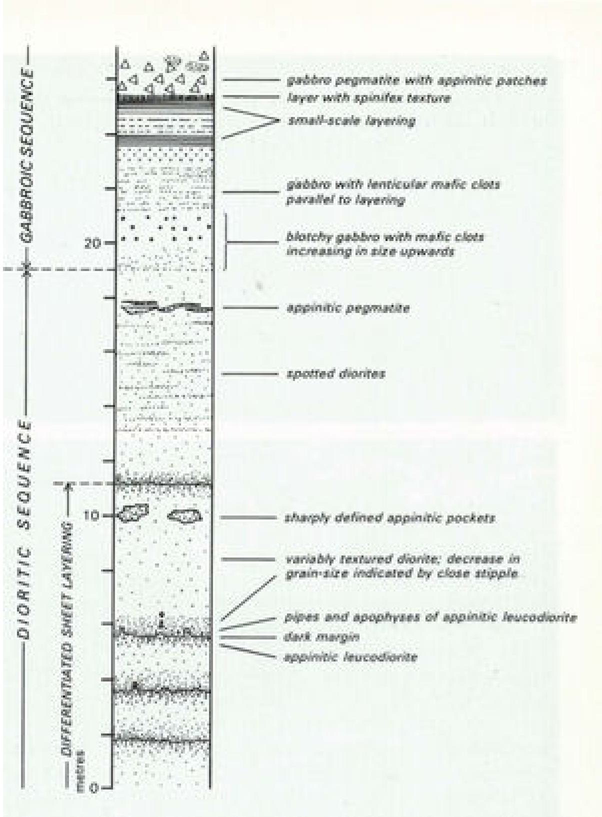

Figure 14 Vertical section through part of the layered gabbro-diorite sequence exposed at Le Nez Point. After Bishop and Key, 1983, fig.2.

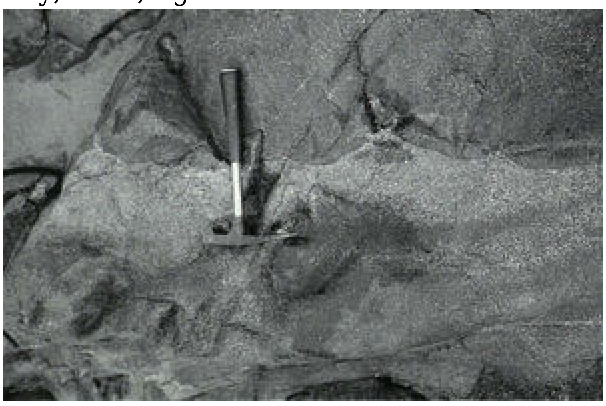

Plate 9 Differentiated sheet layering in diorite at Le Nez Point, St Clement. (Photograph by Dr A. C. Bishop).

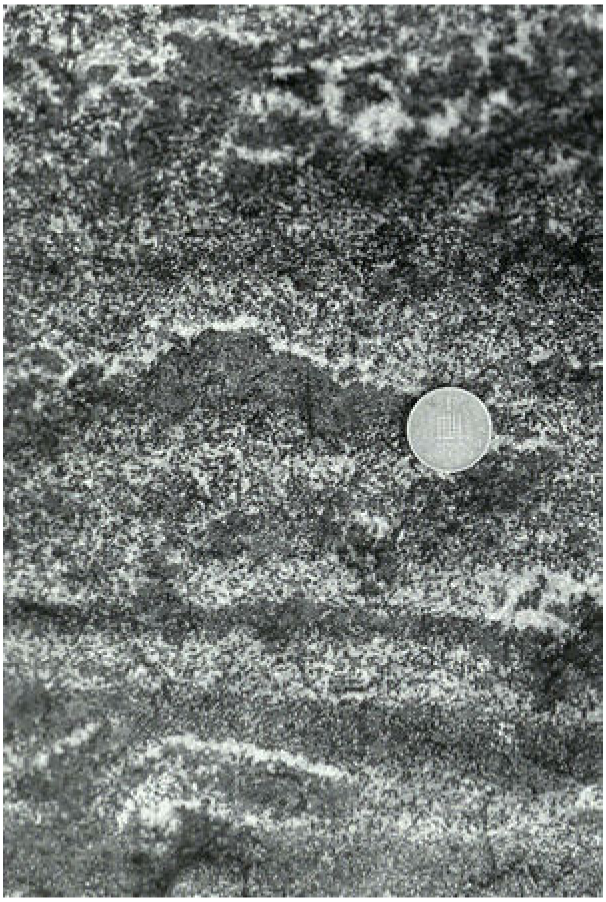
Plate 10 Thin alternating layers of pale and dark diorite at Le Nez Point, St Clement. (Photograph by Dr A. C. Bishop).

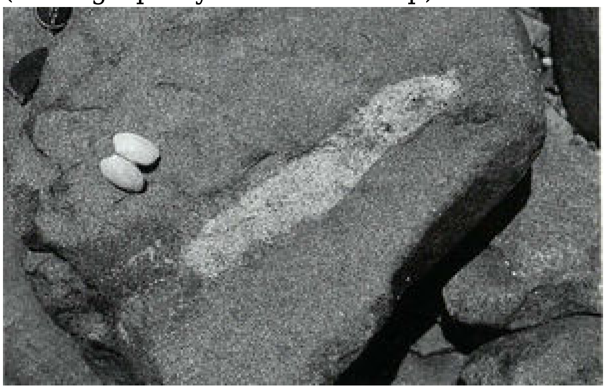
Plate 11 A pipe of pale quartz-diorite in darker diorite, exposed in a reef near Seymour Tower. (Photograph by Dr A. C. Bishop).

Plate 12 Skeletal amphibole crystals in appinite at Le Nez Point, St Clement. (Photograph by Dr-A. C. Bishop).

Contents

Chapter 5 Plutonic igneous rocks

There are three principal plutonic rock complexes in Jersey, situated in the north-west, south-west and south-east of the island. In addition there is a smaller outcrop at Belle Hougue Point on the north coast, and a small, isolated, poorly exposed mass of diorite inland at Les Augrès in Vallée des Vaux, east of Becquet Vincent [647 521]. All the main masses comprise several granites which differ in texture, but the south-west complex is different from the others in lacking gabbroic and dioritic rocks. The plutonic complexes are post-tectonic, having been emplaced after the folding and low-grade regional metamorphism (low chlorite grade) of the Jersey Shale Formation and of the overlying volcanic rocks during the late Precambrian Cadomian earth movements.

Gabbro and diorite are everywhere older than the accompanying granites; nowhere in Jersey or the other Channel Islands are plutonic masses of diorite or gabbro intruded into granite, although some basic dykes, notably that at Wolf Caves [6347 5616], are gabbroic. The granites are of calcalkaline type and are I-type granites (Chappell and White, 1974) typical of andinotype tectonic regimes. The granitic plutons disrupted the layered basic rocks, so that the latter are now preserved only as tilted remnants, some of considerable size.

Adams (1967, 1976) determined the isotopic ages of the Jersey granites, and with others (Bishop and others, 1975) discussed their regional setting. Duff's (1981) study of the palaeomagnetic patterns in the diorites showed complex magnetisation unrelated in a simple way to the original crystallisation period but probably resulting from recrystallisation and block rotation. Briden and others (1982; see also Chapter 9) have used geophysical data to show that the granitic complexes are continuous beneath the sedimentary and volcanic rocks of much, and probably all, of the island.

Gabbro and diorite

Gabbro and diorite are exposed near the eastern end of the north-west granite and extensively in the south-east complex. In addition, dioritic rocks make up a large part of the Belle Hougue mass, as well as the small outcrop at Les Augres. The oldest plutonic rocks are layered gabbros (Figure 14), but most of the gabbros have been made over into diorites by interaction with the subsequent granites and by the metasomatic action of the fluids emanating from them. In the main diorite exposures in south-east Jersey, the layered diorites extend from the intertidal reefs at La Grève d'Azette to Havre des Fontaines, a distance which, taking account of the present dip of the layers (below) and possible repetition by later faulting, indicates an original layered sequence about 1 km thick. Further layered diorites occur near Seymour Tower [725 454], at the south-eastern tip of the island.

The contacts between gabbro and country rock have not been observed, apart from that of the Les Augrès mass. Exposures here are poor, but in the inter-war years a contact with andesitic rocks was visible and appeared not to be faulted (Dr A. E. Mourant, personal communication).

The original gabbroic mineralogy is preserved at Sorel Point [612 570] and, less extensively, at Le Nez Point [6783 4625] in the south-east complex; the layered structure is also preserved, though it is no longer in its original sub-horizontal attitude. The layering at Sorel Point and Ronez is inclined at about 40° to the south, whereas at Le Nez Point the inclination is 70° or more towards the north-east, and near Seymour Tower the general dip of the layering is about 30°, also towards the north-east.

The gabbroic rocks at Sorel Point essentially comprise serpentinised olivine, clinopyroxene, and calcic plagioclase (labradorite), with accessory opaque minerals. Variation in the proportions of feldspar and pyroxene has produced layers that are, on average, about 1 m thick. Most of the rocks show progressive alteration of clinopyroxene, first to kaersutite and then to green hornblende, with an accompanying change of feldspar composition from labradorite to oligoclase/andesine. A little of the kaersutite may also be primary. The labradorite persists as cores of grains mantled with more sodic rims and, as the proportion of sodic plagiocase and hornblende increases, the texture changes from ophitic/poikilitic to one in which amphibole has increasingly idiomorphic outlines. Where recrystallisation reached this stage, the rocks became mobile and flowed, and megacrysts of potassic feldspar, in every way identical to those in the nearby granite, began to appear in the diorites. These neomagmatic rocks intruded their more rigid neighbours, resulting in a complex sequence of alteration, flow and intrusion.

From south-east Jersey, Bishop and Key (1983) have described another kind of layering–differentiated sheet layering–which is more widely distributed than gabbroic layering and has the same attitude and orientation. The differentiated sheet layering (Figure 14) comprises a succession of sheets, usually from 1 to 2 m thick, each formed of a lower dark member that grades upwards into more leucocratic diorite or quartz-diorite which is in sharp contact with the basal dark diorite of the overlying sheet (Plates 9 and 10). The uppermost, leucocratic quartz-diorites commonly contain slender amphibole crystals,- many of which are aligned parallel to the contact. Numerous pipes, veins and apophyses of leucodiorite that penetrate upwards into the overlying dark diorite are usually no more than 30 mm across, and some are a metre or more long (Plate 11); they are all roughly perpendicular to the plane of the layering, and indicate that the meladiorite was sufficiently plastic to permit intrusion and that the rocks were in a near-horizontal attitude when these structures formed. Bishop and Key (1983) suggested that the differentiated sheet layers developed from gabbroic layers during dioritisation, and that progressive recrystallisation, mobilisation and flow led first to the modification of the sheets and later to the production of homogeneous diorites.

The Jersey diorites are of variable mineralogy, grain-size and texture. They show all gradations in composition from slightly altered gabbro, through hornblende-gabbro, to diorite and granodiorite. There are diorites which border on the lower limit of coarse-grained rocks but most are coarser than this, and pegmatitic diorites also occur. Most of the diorites are equigranular, with amphibole tending to show idiomorphic outlines against other minerals, particularly in the more siliceous and quartzose varieties. Some of the diorites, usually those of more basic composition, contain large equant poikiloblastic crystals of hornblende; such crystals are particularly abundant near Le Nez and at Ronez and Sorel points. Other diorites contain markedly elongate, prismatic amphiboles, many with cores of feldspar and quartz (Plate 12). Wells and Bishop (1955) drew attention to coarse-grained appinitic rocks of this kind at Le Nez Point, but the texture is typical of many leucodiorites and quartz-diorites, and it occurs in other mafic rocks as well. It is most probably the result of rapid crystallisation, possibly induced by loss of volatiles as a result of venting to the surface (Key, 1977).

Everywhere, veins of more felsic material abound in the diorites, and inclusions of diorite occur within more granitic rocks. These veins and inclusions are locally sharply bounded and show little or no evidence of reaction. Elsewhere they merge into the surrounding rocks, indicating that there was considerable interaction between the intrusive and host rocks. This veining and brecciation are most probably not the result of a single event, but of repeated episodes of intrusion.

Fine-grained diorites, particularly those which occur close to granite contacts, commonly contain ocelli, up to 5 mm or so across, of quartz, or quartz and potassic feldspar, rimmed by amphibole. Rocks containing these structures are known to the quarrymen at Ronez as 'bird's eye' and similar rocks abound in dioritic complexes elsewhere. Angus (1962), for example, described such rocks from Tyrone in Northern Ireland, and ascribed their origin to the crystallisation of quartz as a consequence of interaction of granitic magma and more basic rocks.

Most of the diorites appear not to be the products of primary crystallisation of dioritic magma, but to have been derived from gabbro. The alteration of gabbro resulted from changes in the composition of both felsic and ferromagnesian minerals in response to falling temperature. The change from calcic to sodic plagioclase has already been mentioned. Initially, cores of labradorite, generally clouded by minute rods of iron oxide, became . mantled with oligoclase/ andesine, which encroached on and replaced the cores, many of which were replaced by 'sericite' or prehnite. It is unusual to find a diorite with fresh feldspars; most have been sericitised to some extent. Parallel changes have affected the mafic minerals; the primary pyroxene of the gabbros has been replaced in a complex and intricate way by the brown, titanium-bearing amphibole kaersutite and by green hornblende.

Kaersutite itself was replaced by green amphibole—usually a magnesio-hornblende—in places marginally and along cleavages, but more usually in an irregular fashion. In southeast Jersey it was commonly green amphibole that first replaced pyroxene, kaersutite being only rarely found. Here, however, as crystallisation of secondary amphibole proceeded and it outgrew pyroxene grain boundaries to form robust porphyroblasts, it was accompanied by a change in colour from green, though brownish green, to brown. This brown amphibole is a brown hornblende, however, and not kaersutite. More advanced alteration resulted in the patchy replacement of both brown and green hornblende by pale green actinolite and colourless tremolite, and by the crystallisation of chlorite, some of which also replaced hornblende and biotite directly.

At this stage, quartz became an important constituent and, in some rocks, was accompanied by potassic feldspar which usually occurs either as euhedral to subhedral pink megacrysts of orthoclase perthite, commonly mantled by a rim of white oligoclase in medium-grained diorites, or as an interstitial mineral, along with quartz, in coarser-grained diorites.

The accessory minerals of the gabbros and diorites include opaque iron and iron-titanium oxides; the latter probably contributed titanium to the kaersutite. Apatite occurs in two habits: it forms rather robust crystals in the gabbros, but is more prominent in the diorites, where acicular crystals are abundant. These elongated apatites span quartz/feldspar and feldspar/hornblende boundaries but are never found in the relict labradorite cores of feldspars; they appear to have formed during the dioritic recrystallisation.

The changes in composition of both the mafic and the felsic minerals resulted in an increase in the content of SiO_2 and CaO in the later rocks. As labradorite was progressively replaced by more sodic plagioclase, and as pyroxene was altered to amphibole, CaO was released. The appearance of sphene ($CaTiSiO_5$) as a common accessory mineral probably resulted in part from such changes. At low temperatures, when Ca-bearing amphibole was replaced by cummingtonite/anthophyllite and chlorite, further CaO must have been released, and such diorites contain many low-temperature Ca-Al silicates. The most common of these is epidote, much of which replaces feldspar or accompanies quartz as a late-stage cavity infilling. In many parts of Jersey, however, dioritic rocks have undergone more general epidotisation and have been partially replaced by epidote deposited from migrating fluids. Other low-temperature minerals which occur in diorites are prehnite, calcite and zeolites.

It is possible that the north-west and south-east granites were closely preceded by separate intrusions of gabbro, but the circumstantial evidence from the layering, the isotopic age determinations and the observation that nowhere in the Channel Islands has gabbro intruded granite argue that the major phase of gabbro emplacement was earlier.

Duff (1981) studied the natural remanent magnetisation (NRM) of the Jersey gabbros and found that the scattered but stable NRM could be accounted for by a model involving the disruption of a continuous, near-horizontal layered gabbro with a uniform NRM direction carried by titanomagnetite. The layered gabbro was intruded by granite, and during the ensuing dioritisation a variable, multicomponent NRM was imposed on the basic rocks, either by remagnetisation of the original gabbroic titanomagnetites or by the addition of a separate NRM component carried by magnetite which crystallised during dioritisation. Stoping, subsidence and rotation of masses of diorite within the granite caused dispersion of the pre-stoping NRM, and was the principal cause of the observed palaeomagnetic scatter. The Jersey gabbros, therefore, may once have formed part of a layered intrusion emplaced into Brioverian sedimentary and volcanic rocks and subsequently intruded by granitic plutons; it was probably related to and may have been joined to similar rocks in Guernsey and Alderney.

North-west granite

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).

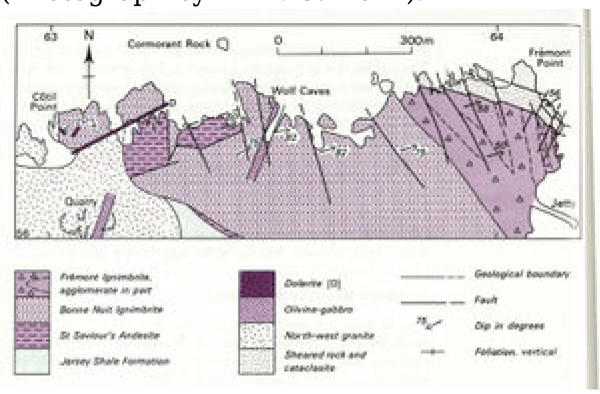

Figure 7 Geological sketch map of the coast between Côtil Point and Frémont Point. Based on Thomas, 1977, fig.6.2.

The north-west granite—comprising the granite of St Mary's type and the aplogranite of Mont Mado type—is the largest of the three principal masses in Jersey. Isotopic dating has shown it to be the youngest of them, with a Rb:Sr whole-rock isochron age of 480 Ma (recalculated from 490 Ma of Adams, 1976; Bishop and others, 1975). Intrusive contacts are exposed in several places: with sediments of the Jersey Shale Formation at L'Etacq [5580 5435] and Le Pulec [5475 5495]; with diorites in the area around Sorel and Ronez points; with rhyolite and andesite at the easternmost end of the outcrop in the vicinity of Côtil Point [631 562].

Hornfelsed Brioverian sediments are exposed close to the granite along its concealed southern and eastern margins; only in St Peter's Valley and at Handois does the margin appear to be faulted.

In general the thermal effects of the granite are rather weak. The contact of granite and sediment is sharp, with relatively little brecciation, and there are few xenoliths of sediment in the granite. Veins of granite and aplite penetrate for some distance into the sediments, but there has been no extensive permeation by granitic fluids. Near L'Etacq [5580 5435] the granite makes a sharp contact with the sediments (Plate 1), the zone of thermal alteration being terminated at the La Bouque Fault. The more pelitic members of the Jersey Shale Formation are altered at the contact to cordierite-biotite-hornfelses, and thermal spotting is visible in some places.

The contact with volcanic rocks in the east is similar. At Côtil Point (Figure 7) sharply bounded veins of aplogranite have intruded ignimbrite and basic dykes within it. The granite and ignimbrite are so similar in composition that there is little evidence of thermal metamorphism, but the effects of K-metasomatism are shown by the presence of muscovite flakes coating joint surfaces in the ignimbrite. A little farther east [6318 5620] the granite has veined and brecciated the St Saviour's Andesite Formation, and garnets, probably of hydrothermal origin, have been recorded in the andesites in this area (Oliver, 1958).

The contacts between granite and sedimentary and volcanic rocks contrast markedly with those between granite and diorite. The former are sharp, simple and show little evidence of reaction; the latter are complex, and extensive reaction between granite and diorite is the rule. The greater reactivity of granite with diorite compared with other rocks cannot be ascribed simply to residual heat from the original crystallisation of the gabbro, for it appears that the gabbro was emplaced well before the oldest of the granites, the Dicq granite of south-east Jersey dated at about 570 Ma (see pp. 56–57). It is necessary, therefore, to argue either that the gabbros were especially prone to react with granite–a feature common in these rocks elsewhere–or that the gabbros associated with the north-west granite were emplaced separately from and later than those of south-east Jersey; the latter explanation seems unlikely.

Most of the north-west granite is coarse-grained–the St Mary's granite–consisting of rather tabular crystals of orthoclase or orthoclase perthite, with subordinate and smaller plagioclase, abundant quartz, and biotite and hornblende; zircon and apatite are common accessory minerals. Texture varies from place to place, but in general the St Mary's granite is of uniform appearance. From La Saline [6300 5615] to Les Mouriers Valley [605 562] the granite is a fresh pink, but along most of the rest of the north coast it is a rather greyish pink, owing to the presence of small, chloritised biotite crystals. It was formerly worked for road metal and building stone in several small quarries, notably at L'Etacq [563 542] and La Perruque [6280 5605]. Inclusions become noticeable in the granite east of Plémont Point [563 569], and are particularly abundant in the dioritic area around Ronez and Sorel points.

At the eastern end of the granite there is a marginal band, up to about 300 m wide, of aplogranite–the Mont Mado aplogranite. This is a handsome pink rock, poor in coloured minerals, and comprising orthoclase perthite and quartz. It was, in the past, widely used as a building stone, but the quarry at Mont Mado [637 556] has now been filled and the once-thriving industry has ceased, apart from a small quarry [6305 5602] above Côtil Point. A contact between the Mont Mado aplogranite and the coarser St Mary's granite is exposed here, and is marked by about 1 m of granite rich in mafic minerals. The aplogranite has been traced southwards to Handois, where it was once exploited as china-stone (see pp. 106–107). Handois Quarry has now been dammed and is used for water storage.

Belle Hougue igneous complex

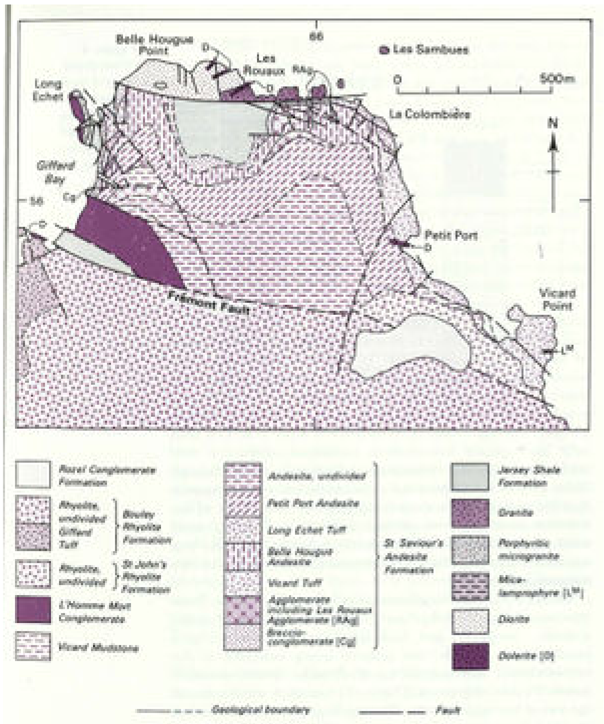

Figure 3 Sketch map of the geology south of Belle Hougue Point. Based on Thomas, 1977, fig.2.2.

The Belle Hougue complex forms the headland of that name (Figure 3). It consists mainly of altered diorite, veined and brecciated by granite. The dioritic and granitic rocks are mineralogically like those at Ronez and Sorel points. Similar rocks are exposed on Les Sambues reef [663 565] to the north-east, and neither the submarine extent of the mass, nor its relationship with the north-west granite, is known. On Belle Hougue Point itself there is a large inclusion of Jersey Shale Formation [6553 5637] within the diorites. On the south side of the mass the Les Rouaux Fault has brought the plutonic rocks against the St Saviour's Andesite Formation on Belle Hougue Point and east of Les Rouaux, whereas in the small bay of Les Rouaux [657 563] they abut against the Jersey Shale Formation *(see* p. 78). The fault is probably of considerable magnitude, for specimens collected from the complex all show the effects of cataclasis. The weathered and altered appearance is due in the main to cataclasis and accompanying mineralogical changes. The diorites contain ragged green amphibole, altered plagioclase and abundant epidote. The granitic rocks are traversed by fissures and the constituent minerals are broken and comminuted, so much so that in places the rocks have a mortar structure. The rocks vary both in the proportion of potassic feldspar to plagioclase and in the amount of quartz present. Most are adamellites but local deficiency in quartz makes some of the rocks monzonitic. Others, however, are rich in potassic feldspar and quartz, and have a granophyric texture.

It seems likely that the Belle Hougue mass is related to the north-west granite and has been separated from it by faulting.

South-west granite

The south-west granite was emplaced into the Jersey Shale Formation. Radiometric age determinations have given a Rb:Sr whole-rock isochron age of 553 ± 12 Ma (recalculated from 565 ± 15 Ma of Adams, 1976; Bishop and others, 1975), showing that it is older than most of the other Jersey granites. From the coast near La Carrière [5636 4948] eastwards almost to Pont Marquet [593 495] the contact between the granite and the Jersey Shale Formation is covered with blown sand, but thence to Belcroute Bay [6065 4800] it can be traced with some certainty, being markedly lobate, with tongues of granite extending into the Brioverian sediments which are baked against it. The degree of hornfelsing of the country rocks is everywhere slight and there is no marked aureole surrounding the south-west granite. The attitude of the sediments at St Aubin and elsewhere has not been greatly affected by the emplacement of the granite, though veins of granite up to 20 cm wide occur in the sediments near the contact. The form of the granite was studied by Henson (1956), who also noted that the granite becomes grey as the contact is approached, in contrast to the more usual pink. This band of grey, rather crushed and contaminated granite is about 100 m wide in Belcroute Bay, and contains large crystals of quartz and feldspar up to 1 cm in diameter in an even-grained matrix; sedimentary xenoliths decrease in size and abundance away from the contact. This grey porphyritic marginal facies is exposed at several places inland, in each case within a few metres of the contact.

The marginal facies apart, the south-west granite has three main types: a coarse-grained equigranular granite—the Corbiere granite; a porphyritic granite with megacrysts of potassic feldspar set in a finer-grained matrix—the La Moye granite; and an aplogranite–the Beau Port granite. The three are arranged roughly concentrically.

The coarse-grained Corbière granite has the largest outcrop. It passes in a short distance into the La Moye porphyritic granite which forms a band some 200 m wide between the other two types. The groundmass of the La Moye granite is very similar to the Beau Port aplogranite which is exposed around St Brelade's Bay. The Corbière granite contains abundant blocky crystals of orthoclase perthite, together with plagioclase, quartz, mica and hornblende. The granite forms spectacular, murally jointed cliffs along much of the south-west coast of the island, and weathers to a pale red colour. Inclusions are rare and are most abundant at the granite margins. Biotite and hornblende are everywhere associated, and accessory zircon, apatite, iron oxides, fluorite and allanite occur.

The La Moye porphyritic granite is variable in texture, composition, and size and abundance of the megacrysts. It grades on the one hand into the Corbiere coarse-grained granite, and on the other, into the Beau Port aplogranite where the megacrysts are fewer in number. Intrusive contacts between the various granite types are unknown and do not provide evidence on which to assign relative ages to them. In places, for example in the extreme south-west of Portelet Bay [5965 4670], the porphyritic granite has a banded appearance, caused by concentrations of biotite and opaque minerals. Such bands occur close to the aplogranite, and between them the granite is markedly porphyritic. The banding is a local phenomenon apparently produced as a result of interaction between the aplogranite and the porphyritic granite.

The Beau Port aplogranite differs from the other members of the complex in its texture and in its deep red weathering. It is uniformly even grained and, compared with the other granites, fine grained, though its grain-size averages 1 mm. The principal minerals are quartz, perthite, and plagioclase (oligoclase An_{12-16}), with small amounts of biotite, iron oxides and hornblende.

The La Moye granite was interpreted by Henson (1956) as Corbière granite modified by the emplacement of the later Beau Port aplogranite. However, A. M. Bland (1984) has shown that there are marked chemical differences between the Beau Port aplogranite on the one hand and the Corbière and La Moye granites on the other, as well as considerable differences in age.

The Corbière and La Moye granites were formerly quarried in several places, but this activity has now ceased.

South-east granite

The south-east granite is the most complex of the three principal plutonic masses. As in the north-west complex, the first rocks to have been emplaced were gabbros which were altered to diorites as a result of interaction with granitic material.

The Dicq granite forms an intrusive complex with diorite, which is well exposed on the intertidal reefs of La Grève d'Azette, and the emplacement of this granite was responsible for much of the alteration of gabbro to diorite. The Dicq granite contains megacrysts, usually up to 2 cm long, of pink to grey orthoclase perthite, commonly with a white rim of plagioclase, set in a coarse-grained matrix of quartz, potassic feldspar, plagioclase, biotite and hornblende. Xenoliths are abundant in this granite; some are clearly of diorite but others, usually rather rounded and about 10 cm long, are more fine grained; the latter commonly contain megacrysts of mantled potassic feldspar identical to those in the granite. Adams (1976) obtained an imprecise Rb-Sr isochron for the Dicq granite which gave a date of 570 Ma (recalculated from 580 Ma), comparable with that of granitic rocks in Guernsey.

The Longueville granite extends inland from Dicq Rock [659 477] to Longueville, and is generally similar to the Dicq granite but lacks the potassic feldspar megacrysts. It has a characteristic yellowish weathering and is composed of a coarse-grained aggregate of plagioclase, potassic feldspar, quartz, hornblende and mica. The content of quartz varies from place to place, so that parts of the mass are syenitic. The granite typically contains many basic inclusions of gabbroic or dioritic origin. No intrusive contact between the Dicq and Longueville granites is exposed, and the granites probably grade into one another by variation in the proportion of potassic feldspar megacrysts.

The La Rocque granite occupies a large area extending from Grouville Arsenal to Gorey, La Rocque and the intertidal reefs in St Clement's Bay. In Petit Portelet bay it is assumed to be faulted against volcanic rocks. On the foreshore near the slipway [7107 5019] west of Gorey Harbour and in a small quarry [7114 5030] in the Gorey area the granite has intruded the Jersey Shale Formation. Most of the mass is pink-weathering granite composed of potassic feldspar, usually perthitic, with plagioclase and abundant quartz, and with biotite and hornblende as the most common ferromagnesian silicates. Zircon, apatite and allanite are accessories. The mass is not of uniform texture, however; the grain-size increases eastwards from Le Hocq [685 467], and around La Rocque the granite contains large, squat, tabular crystals of orthoclase perthite, some of which have a thin mantle of plagioclase. The granite at Mont Orgueil Castle [716 503] has a more brownish tinge than elsewhere, and quartz is locally less abundant here than is normal. Furthermore, the granite contains a few inclusions of rhyolite, which refute Plymen's (1921) contention that a flow-banded dyke of rhyolite indicated that rhyolite had flowed over the exposed surface of the granite and into fissures within it. Aplite and pegmatite are present as patches throughout the mass, and pegmatites closely associated with aplites are exposed on the reefs near La Rocque [707 463].

The Fort Regent/Elizabeth Castle granophyre is a compact rock that weathers to a yellowish pink colour. It has intruded diorite at Elizabeth Castle, with the production of sharply bounded angular inclusions of diorite in granophyre. Near the Hermitage [6392 4732], however, granophyre has penetrated the diorites as subhorizontal sheets which have crenulated margins that cannot be the result of simple dilation intrusion. There is also abundant evidence of reaction between host diorite and intruding granophyre, with the production of grey rocks intermediate in character between the two. These dioritic rocks extend eastwards of the Castle to the reefs at La Collette.

The granophyre is composed of tabular plagioclase, usually partially altered to sericite, and mantled by potassic feldspar which is graphically intergrown with quartz. Ferro-magnesian minerals are rare and are mainly chlorite after biotite. The micrographic texture is well developed, with feathery branching intergrowths extending outwards from a common plane in the orthoclase that is coincident with a crystal face.

Unlike the other igneous complexes, there is clear field evidence in the south-east complex for two pulses of granite emplacement. The older comprises the Dicq porphyritic granite and the Longueville granite. The diorite/Dicq granite complex has been intruded by basic dykes with an ENE–WSW trend and about 1 to 2 m wide. In several places at La Grève d'Azette [eg. [663 467]] the diorite/Dicq granite/basic dyke complex has been further intruded by veins of a later, pink, even-grained granite, which is similar to the main mass of the La Rocque granite; these veins cut across some of the early basic dykes in the diorite/Dicq granite complex. Reaction has occurred between the diorite and the newer granite, but reaction between the basic dykes and the granite was minimal. Around Green Island and Le Nez Point it is difficult to separate the effects of the Dicq and La Rocque granites so far as the diorites are concerned. The late pegmatites, and the reaction that accompanied veining by recognisable La Rocque granite, are ascribed to the second pulse of granite emplacement, but much of the reaction could belong to either intrusive event.

A further phase of dyke intrusion followed the emplacement of the La Rocque granite and these later dykes have the same general trend as those truncated by this granite.

The concept that the south-east complex was composed of granites of different ages goes back to Plymen (1921) and Groves (1927; 1930); it derived from the observations that three granite 'masses' (the Elizabeth Castle/Fort Regent, Longueville and Gorey granites) were aligned, that they were more syenitic than the younger granites, and that they contained different suites of heavy minerals. Detailed mapping has cast doubt on the idea of linearity and, although it is true that the Longueville and Gorey granites are locally deficient in quartz, isotopic dating indicates that they are of different, not similar, age; moreover, experience has shown that heavy minerals are unreliable indicators of age.

The relationship of the granophyre to the granites is far from clear. Aplitic granite, but not granophyre, occurs close to the Dicq granite at and south of Havre des Pas bathing pool, but sharp contacts between the two are wanting. Adams's Rb:Sr whole-rock isochron for the south-east granite (509 ± 4 Ma, recalculated from 520 ± 4 Ma) included the Elizabeth Castle granophyre, and geologically it is grouped with the La Rocque granite rather than with the older Dicq granite. Henson (1956) compared the Elizabeth Castle granophyre mass with the Beau Port aplogranite, and superficially they have much in common, but pink aplogranite is associated with all the Jersey granites.

There remains an unresolved problem resulting from isotopic age determinations. Field evidence indicates that the St Saviour's Andesite Formation followed the Jersey Shale Formation and was succeeded by the outpouring of acid volcanic material. All were deformed together during the Cadomian orogeny. The Jersey Shale Formation is older than 553 Ma, and it was intruded by the Dicq/Longueville granite also, though actual exposures of the contact are not available in the alluvium- and loess-covered inland areas. If the age of about 570 Ma for the Dicq/Longueville granite is accepted, and on geological grounds it must be older than 509 Ma, then the emplacement of gabbro and diorite must predate this, and isotopic determinations in both Jersey and Guernsey suggest a date of about 580 Ma for this event. The simplest interpretation for the poorly exposed diorite at Les Augres is that it is an intrusive mass which is younger than the andesites into which it was emplaced; the andesites, therefore, are presumably older than about 580 Ma. Duff (1978), however, obtained a Rb:Sr whole-rock isochron age of 522 ± 6 Ma (recalculated from 533 ± 6 Ma) for the andesites from West Mount [646 493], and this was interpreted as the age of extrusion. If this is so, then it is possible to reconcile this age with Adams's isotopic dates only if the 570 Ma age of the Dicq granite is discarded or if it is assumed that the andesite has been incorrectly correlated; further, it would be necessary to interpret the Les Augres diorite as a mass of older diorite faulted against younger andesite. Bishop and Mourant (1979) have suggested a reconciliation by questioning the assumption that Duff's date represented the time of outpouring of the andesite, because the andesites at West Mount Quarry contain feldspathic patches and the quarry is only 100 m or so from the Elizabeth Castle granophyre which has given a 509 Ma age (recalculated from 520 Ma). It could be that Duff's isochron represents an event later than the solidification age of the andesites. $Ar^{40}Ar$:^{39}Ar date of 477 ± 6 Ma (formerly 470 ± 6 Ma) has been obtained for toumaline separated from andesitic tuff at Maison de Haut [6760 4925] (Allen, 1972).

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References

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