

Stones used in the National Memorial Arboretum at Alrewas, Staffordshire

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The Armed Forces Memorial; Portland Stone

The National Memorial Arboretum at Alrewas has become established as a garden of National Remembrance, with almost 400 memorials and thousands of commemorative trees (with new ones added every year) which commemorate Her Majesty's Armed Forces who have served in military campaigns since the start of the 20th Century. Civilian organisations are also represented. These include the Emergency Services and other civilian services, organisations, charities and groups who have served the nation from the UK or the Commonwealth. Other memorials commemorate individuals or groups who have achieved recognition for their service or sacrifice.

The site was conceived in the mid 1990s by Royal Navy Commander David Childs CBE and Group Captain Leonard Cheshire who were partly inspired the Arlington National Cemetery in the USA, believing that the UK lacked a single place for national remembrance (Bowdler, 2021; Williams 2014, Gough, 2009). However, unlike Arlington, this is not a cemetery, it is a 'cenotaphic memorial landscape' and one not just dedicated to the remembrance of troops and civilians lost in wars (Williams, 2014). The only burials here date to the Bronze Age; several barrows are located on the site (NMA, 2017, Williams, 2014). Land was donated by Lafarge Tarmac Aggregates Ltd., much of the 150 acre site was formally a gravel pit working the glacial river gravels of the Rivers Trent and Tame (the Arboretum is still surrounded by gravel pits today). The area was landscaped and the first trees were planted in 1997. Trees, as the name suggests are an important part of the Arboretum, and many of these exist as memorials in their own right or are used for special planting as memorial woodland or in outdoor 'chapels' associated with the memorials. British and overseas trees can be found here, many indigenous to countries or landscapes associated with specific theatres of war or with the nationalities of troops or services being commemorated. The site has been managed by the Royal British Legion since 2003.

The National Memorial Arboretum is, as others have remarked (see Bowdler, 2021; Gough, 2009), a somewhat bewildering collection of memorials commemorating everything from 50th Wedding Anniversaries to the D-Day invasions, which seek somehow to evoke a collective national memory.

However as Moshenska (2010) reminds us with respect to modern conflicts as in everything else, memory, *remembrance*, is always personal rather than collective. I also found it interesting to discover that this site is on the 'Dark Tourism' list of places to visit in the UK. Nevertheless, it was very clear from observing groups of veterans on the day of my visit, that the National Memorial Arboretum is as much about the happy reuniting of old friends, colleagues and comrades as it is about mourning the fallen.

The memorials in the National Arboretum take all forms. Some are simple inscribed plaques, set on simple brick or stone plinths. Others are engraved memorial stones or groups of stones and a few are elaborate, large-scale monumental structures. Most are constructed with stone elements, if not entirely from stone, but a significant number are also constructed from wood, brick and metal. Williams (2014) provides an account of some of the monuments which incorporate trench art and materials, such as sections of the Burma Railway, which have been brought from places of conflict to stand as memorials in the Arboretum. This article will focus on the stone used in the monuments, although the large number of monuments means that this list is far from exhaustive. The memorials I will discuss below are the ones I was able to record on my visit to the Arboretum in August 2021. I would welcome any further contributions of knowledge of specific stones used for memorials which are not on the list produced here and indeed for any further information on the stone used in the memorials that I specifically discuss or include on my list.

However, I must inject a note of caution at this stage. Stone knowledge is often poor (through no fault of many masons, architects and observers) and there are often grave errors in the literature describing the stone used for memorials. For example, The **Royal Marines Memorial** is recorded as being constructed of Dartmoor Granite in NMA (2017) and the Imperial War Museums War Memorials Register describes it as Portland Stone. Two more distinctively different stones could barely be imagined. The memorial is in fact made of sandstone, very probably derived from the Upper Carboniferous Millstone Grit Group and probably one of the varieties quarried in Derbyshire from the Ashover Grit Member of the Marsden Formation.

The choice of materials used for memorials is largely related to their cost although in some cases and discussed below, there is occasionally a great sense of meaning or symbolism to the choice of stone (or other materials used). Some of the memorials here at the National Arboretum represent large organisations with considerable resources and financial clout, such as the Royal Navy or the UK Police and they have employed high quality materials and established artists and architects in the design and construction of monuments. However the vast majority of the memorials here were conceived and planned by individuals, veterans' associations and charities who have had to work extremely hard to fund raise for their monument to be constructed and installed in the Arboretum.

This guide to the stones is best used together with the National Memorial Arboretum's map and/or Guidebook (NMA, 2017) which also provides further information about the organisations involved with the installation of monuments, and in some cases the stories behind their conception, construction and dedication. This guide is written for people who have an interest in building stones and particularly in the significance (or not, as the case may be) of stone chosen for the purpose of commemoration.

The National Memorial Arboretum is entered via its main building, the Remembrance Centre. Although wood features prominently in its design, this structure is clad on both the interior and parts of the exterior with Moleanos Limestone, a shelly, Jurassic limestone from the Lusitanian Basin of Portugal. Designed by Glen Howells Architects, the Remembrance Centre won a RIBA Award in 2017. The building houses reception, resting and catering areas, lecture theatres and teaching space as well as a chapel. The National Memorial Arboretum is free to visit, and open from 10.00 am to 5.00 pm every day except Christmas Day.

Generic Stones

Many of the smaller memorials in the National Arboretum have been made by monumental masons and therefore it is not surprising to discover that there is great overlap between the stones used as grave

markers and the stones used here for memorials. For such enterprises, few stones are sourced direct from quarries; a monumental mason's 'stock' stones are generally supplied by stone contractors, i.e. middlemen acting between the quarries and the masons. In fact a number of stone contractors may exist within this *chaîne opératoire*. It is very easy to lose track of the provenance of stones as they pass along the chain. Trade names are not necessarily helpful either as there is no such thing as *appellation d'origine contrôlée* for the vast majority of stones and different stone masons may use their own trade name for a particular stone. A stone contractor in China can choose to call a stone 'Aberdeen Granite', say, and by the time it reaches a monumental mason's yard in the UK, there may be very little record of whether it comes from China or Aberdeen. This makes many of these generic stones very difficult to provenance. Identifying the rock is the easy bit (for geologists at least), identify stone can be hard!

For obvious reasons, black stones are popular for both grave markers and memorials and dolerites (generically known in the stone trade as 'black granites') have been popular choices as hardwearing stones capable of taking a good polish. In the late 19th Century, dolerites from Sweden and Finland supplied these markets, and although some of these stones are still worked, they are expensive. Until relatively recently, the go-to stone for black memorial stones and plaques has been Nero Zimbabwe, derived from a series of dolerites quarried from the 1.87 Ga Mashonaland Sill Complex in Zimbabwe. Also of Proterozoic age, a dolerite called 'Black Emperor' is quarried in Shaanxi Province in China and this stone has become popular in the last decade, largely because of its affordability. Dolerites are also quarried in Andhra Pradesh, India. Unfortunately, these stones have little to distinguish them in hand specimen and are impossible to differentiate. One may make a guess at the origin of the stone, based on the age of the memorial. There are a huge number of memorials at the National Arboretum which use dolerites as commemorative plaques. Notable examples are the **Argyll and Sutherland Highlanders Memorial, Hong Kong Police Memorial, Queen's Regiment Memorial, Russian Convoy Veterans (Arctic Convoys) Memorial, RAF Regiment Memorial** and the **South Atlantic Medal Association Memorial** as well as many plaques inserted into other stone or brick memorials. The **Royal Green Jackets Memorial** is specifically named in NMA (2017) and other sources as being constructed from a slab of Indian Black Granite. These dolerites are quarried from sills outcropping in the vicinity of Chittoor in Andhra Pradesh (Reddy et al., 2013)

Dark grey slate from Blaenau Ffestiniog has a strong track record of use as grave stones and it has been used for a number of memorials at the National Arboretum, including the **Cavalry Grove Memorials** (9/12 Lancers, The Queen's Royal Hussars, The Royal Dragoon Guards and The Light Dragoons memorials), **Intelligence Corps Memorial, RAF Medical Services Memorial** and the **Search & Rescue Memorial**, as well as being the first choice of stone for representing memorials commemorating Welsh regiments and services (see below).

Granite is also a popular choice for monumental masons and this rock is defined as being composed of quartz, mica and feldspar. However granites come in a whole range of 'flavours' with a wide variation in colours, grain size and igneous textures. A great number of memorials in the National Arboretum are built from granite, from the large Polish War Memorial (see below) to small plaques holding inscriptions.

Granite can be an expensive stone. Affordable varieties have been sourced from China since the 1970s and are predominantly derived from the SE China Cretaceous magmatic arc in Fujian and Guangdong Provinces. Shandong and Sichuan are also important granite producing provinces. In China, quarried granites and related rocks are given a 'G-number', that is a four digit number prefixed by the letter G. The number relates to the province of origin (first two numbers) and the quarry (last two numbers). G35 granites, for example, are from Fujian Province. Locating stone to quarries can be a difficult task for any stone, but for the Chinese granites this is further complicated by the language barrier. Nevertheless there is a wealth of academic literature on the geology of China which can help to narrow down sources. Unfortunately some stone contractors do not use the G-numbers and simply make up names for the Chinese stone they provide, destroying that link between stone and quarry (except for very distinctive and recognisable varieties). This is the case for the **Irish Infantry Grove** memorial, where the paving depicts a map of Ireland

picked out in green and grey Chinese granites, named 'Kobra' and 'Pheno' respectively by the stone contractor. Both stones are reportedly derived from Fujian Province but little more can be said about them.

The 'interior' of the **Masonic Memorial** is also constructed from un-named and un-numbered Chinese granites. Similarly, grey Chinese granites are used in the **Jewish Ex-Servicemen & Women's Memorial** (Laizhou Granite) and the **Normandy Veterans Memorial** (Stone Specialist, 2015). Yellow-stained granite, with liesegang bands picked out in iron oxides is used for the large **Malaya & Borneo Veterans Association Memorial** (Stone Specialist, 2013). These textures and colours are typical of granites that have undergone tropical weathering on their surfaces and this distinctive stone can be identified, it is G3582 (Padang Yellow Granite) from Shijing in Fujian.

The recently installed **Canadian Royal Air Force Memorial** is made of red and white granites symbolising the Canadian Flag. It is surmounted by a granite maple leaf and sits on maple leaf-shaped paving. It is recorded that the granite used for the paving was donated by Lafarge, an international quarry firm that has stakes in the sands and gravel pits adjacent to the National Memorial Arboretum as well as operations in Canada. The stone is a brown porphyritic granite, with a strong lineation defined by phenocrysts of pale brown feldspar. This is Canadian Sage Granite quarried in Ontario. The pink and red granite varieties used for the monument are unknown.

A striking red granite called Balmoral and originating from Finland is used for **The King's Royal Hussars Memorial** (Fig. 1a). This is an ancient granite, 1.5 billion years old, with brick red feldspars quarried from the Vehmaa Batholith in SW Finland. The **Royal Air Force Halton Apprentices Memorial** includes a large rough-hewn block of red granite which appears to be Mountsorrel Granodiorite from Leicestershire.

Another red granite was used to construct the **Basra Memorial Wall** which was originally erected in Iraq by soldiers stationed there to commemorate their fallen comrades. The monument was dismantled in 2009 and brought to the National Memorial Arboretum where it was re-assembled and rededicated on 11th March 2010. The granite used is not recorded but it is very probably Indian New Imperial Red which is readily available throughout the Middle East. This is a coarse grained, dark red granite quarried in the Bagalkot District of Karnataka. Another ancient rock, this is 2.5 billion years old.

The **HMS Argonaut Memorial**, **Royal Navy Patrol Services Memorial** (capped by a bronze mine; Fig. 1b), **SS Aguila Memorial** and **The Reconciliation Stone** in the Japanese garden are all made from un-named granites of various colours and textures.

Granodiorites and diorites are intrusive igneous rocks which contain small amounts of or indeed, no free quartz. However like granites they contain feldspar, predominantly plagioclase, biotite mica. They commonly contain the dark green or brown mineral hornblende in addition. These rocks are usually grey in colour and in the stone trade they are usually considered to be 'granites'. Examples of monuments utilising dioritic rocks are the **Adjutant General's Corps Memorial**, the **RAF Benevolent Fund (RAFBF) Memorial** and the sculpted aircraft carrier on the **Fleet Air Arm Memorial**. The RAFBF memorial (Fig. 1c) is a beautifully smooth monolith of diorite with the organisation's logo, the familiar RAF red, white and blue roundel, but with the central red circle replaced by a heart. Larvikite (see below), a white granite (leucogranite) and a red granite (probably New Imperial Red from India) are used to make these details.

Charnockites are not particularly well-studied by geologists but are beautiful rocks and incredibly common as building stones. In terms of global outcrop, they are restricted to the Archaean and Proterozoic cratons and are broadly granitic in composition in that they contain potassic feldspars (often microcline) and free quartz. However their chemistry is confused by the additional occurrence of mafic minerals including pyroxenes, amphiboles and garnets which are not normally encountered in granites (in the geological sense of this word). The jury is somewhat out on whether these ancient rocks are igneous or metamorphic. They were first recognised by Thomas Holland of the Geological Survey of India who actually first discovered these unusual lithologies in a building stone context rather than in outcrop. Indian charnockite was used as

a construction stone in Job Charnock's (d. 1692) mausoleum in Calcutta. On visiting the tomb, Holland remarked that the dedicatory inscription is carved upon slabs of a 'handsome' rock 'hitherto undescribed'. He later was able to describe these rocks in the field and noted "As this is a new type of rock ... I would suggest for it the name Charnockite in honour of the founder of Calcutta, who was the unconscious means of bringing, perhaps, the first specimen of this interesting rock to our capital" (Holland, 1893). Charnockites and related lithologies are quarried today in India, Brazil, Southern Africa and Australia and being certainly handsome stones, many varieties find their place in the stockyards of memorial masons. The **Ex-National Servicemen's Memorial**, **King's Shropshire Light Infantry Memorial** and the **WRAC Memorial** are all constructed from rock which is arguably 'charnockitic'. The former two monuments have a clearly metamorphic texture. The WRAC Memorial is made from a typical, coarse grained 'igneous' charnockite.

Not a granite in the geological sense but a monzonite¹, Larvikite is a spectacular rock sourced, as the name suggests, from Larvik in southern Norway. This region in the Vestfold, west of the Oslo Graben is the only supplier of this stone which is famous for its 'schillerescent' feldspars which reflect blue light at certain angles. This feature has made it a very popular building stone and it has been commercially quarried since the 1880s. A number of memorials in the National Arboretum are made from Larvikite including parts of the **Gibraltar Memorial** and the **RAF Benevolent Fund Memorial** and it is the main stone used for **Queen Alexandra's Royal Naval Nursing Memorial** and the **Oddfellows Memorial**.

Limestone may be initially disregarded as good stone for monuments in the English climate because of its softness and solubility. Whilst true that it does not have the resistance to weathering of a granite, many limestones do make good quality building stones and therefore it is in fact widely used. Lower Carboniferous Kilkenny Limestone, a well-known sculptural stone, is used in several monuments. This is a blue-grey limestone with scattered fossil crinoids quarried from the Lower Carboniferous Ballydams Limestone Formation in County Kilkenny. This stone has been used to great effect in the **Bevin Boys Memorial** and for the figure in the **Naval Services Memorial**, both the work of sculptor Graeme Mitcheson. Look at the crown of the hat of the figure in the Naval Services Memorial where fossil crinoids are easily seen (Fig. 2a). Kilkenny Limestone is also used as the plinth for the **Royal Leicestershire Regiment Memorial**.

English Jurassic oolitic limestones, including Cotswold Stone, Portland Stone and the various Lincolnshire Limestones are also widely used for the construction of memorials at the National Arboretum. Portland Stone (Fig 2b) arguably has a place as England's most important stone used for commemorative structure will be discussed in more detail in a later section the stone used for the huge **Armed Forces Memorial**. Other monuments made from Portland Stone are the **Stillbirth and Neonatal Death Memorial**, **The Military Police Memorial**, both of which utilise the fossil oyster shell-crowded Fancy Beach Whitbed variety. Portland Whitbed and Basebed are used for many memorials including those of the **10th and 11th Hussars Memorials**, **The Fleet Air Arm Memorial**, **The Light Infantry Memorial**, the plinth of the impressive bronze of Bellerophon riding Pegasus for **The Parachute Regiment Memorial** as well as the obelisk in **The Royal Engineers Memorial** and the stone in the **WRNS Memorial Garden**. **The Essex Regiment Memorial** is largely built of Portland Stone but also includes local stone elements (see below).

The golden yellow, shelly Cotswold Stone calcarenites are used in a number of memorials featuring walling, including the **South Atlantic Medal Association Memorial** wall, the **Brigade of Gurkhas Memorial**, the **British South African Police Memorial** and the **Rhodesian African Rifles Regiment Memorial** and the **British Nuclear Test Veterans Memorial**. The **RAF Technical Communications Wing Memorial** has a plinth of Great Tew Ironstone supporting a York Stone plaque (Fig. 1d). Lincolnshire limestones are used for the **Royal Air Force Boy Entrant's Association Memorial** (Ancaster Stone) and the **Quaker Services Memorial** (Clipsham Stone). Ketton Stone is used for elements of the **Royal Leicestershire Regiment Memorial** (despite it being quarried in Rutland).

¹ An intrusive igneous rock containing no free quartz, but equal amount of plagioclase and potassic feldspar.

The **Masonic Memorial** is an impressive structure, and not surprisingly, full of symbolism and constructed of a number of different stones, chosen primarily for their colour. The entrance to the garden is formed by two pillars, capped by globes, constructed of yellow Great Tew Ironstone. This is a distinctive calcarenite composed of ooids and detrital sands and very rich in iron minerals and particularly berthierine (a blue grey, iron-rich serpentine group clay mineral) which rapidly alters to siderite and bright yellow goethite. The stone is quarried at Great Tew near Chipping Norton in the Oxfordshire Cotswolds and is from the Lower Jurassic Marlstone Rock Formation. The sandstone wall flanking the entrance is carved with the square and compass, the Mason's symbol. The origin of this sandstone is not secured but it is almost certainly of Lower Carboniferous age and perhaps derived from NE England. Darney Sandstone is a good candidate. British Stones were supplied to this project by Meister Masonry. Through the archway, a chequered floor, representing dark and light is set with two ashlar, one rough and one smooth. According to the brochure produced to accompany the dedication of the memorial in 2017, these structures are constructed from Chinese granites. Further information on the symbolism of the garden can also be found in this brochure (Masonic Memorial, 2017).

Several monuments are made from sandstone although not a huge amount considering the fact that several high quality sandstones are quarried locally in Staffordshire. Local troops are commemorated in the **Mercian Volunteers' Memorial**. This rough-hewn boulder might be a local sandstone, such as Arden Sandstone (Permian) or that quarried at Grinshill (Lower Triassic), but its source is not recorded. The same is true for the **Civil Defence Memorial**. Several memorials use what appears to be Millstone Grit. Various sandstones can be extracted from this thick succession of Upper Carboniferous fluvial sandstones which outcrop in the adjacent county of Derbyshire and the broader South Pennines area. High quality dimension sandstones are quarried from the Ashover Grit Member of the Marsden Formation at various quarries including at Birchover and Darley Dale. The **Royal Marines Memorial** and the **Royal Navy Artificers Memorial** are both assumed to be sandstones from this geological unit. The **RNLI Memorial** has a large and impressive sculpture of a lifeboatman carved by Andrew Fitchett standing in a garden designed by Chris Beardshaw. This sculpture is also assumed to have been cut from a coarser grained variety of Millstone Grit sandstone.

York Stone is arguably Britain's national paving stone. It does not come from York however, it is sourced from fine sandstone beds derived from either the Pennine Lower Coal Measures Group or the Millstone Grit Group, both of Lower Carboniferous age. The quarries are all located in the South Pennines. The engraved slabs in **Heroes Square** are cut from Scoutmoor York Stone supplied by Marshall's and quarried near Rossendale from the Millstone Grit. York Stone is also used for the flagstones commemorating recipients of the Victoria Cross which are located alongside the path leading to the Armed Forces Memorial.

Finally, the **Government Communications Headquarters (GCHQ) Memorial** is an enigmatic sandstone sphere², but I'm afraid it's so secret I can't tell you anything more about it.

Significant Stones

It is acknowledged and understood that often the choice of a stone for a memorial is simply functional; a hard-wearing medium capable of taking and preserving an inscription and chosen mainly on the grounds of availability, colour or cost. Using natural stone can be an expensive choice. However, when it comes to war memorials in particular, a sense of 'place' can be of huge importance. Personally, I have long held an interest in the choice of stone used for war memorials and the association made for stone to represent a particular landscape, be that a theatre of war or 'home' (see Siddall, 2014). How many veterans have

² There appears to be very little information available about this monument. The sculptor is Nick Jones. The stone ball is described as granite by NMA (2017), but it is clearly a 'picture sandstone' with liesegang banding picked out by rims of iron oxide minerals. A likely candidate is Indian Teakwood sandstone, but similar varieties are also available from China and many other parts of the world.

brought back a souvenir of the land on which they fought? A pebble from a beach where they were landed or a jam jar or boot polish tin full of sand or soil from a theatre in which they fought. I remember this as a child in the 1970s, a jar full of sand on the mantelpiece of an elderly friend of my dad's, sitting incongruously amongst china ornaments. This habit is echoed in war memorials too; indeed the **1940 Dunkirk Veterans Association Memorial** is surrounded by sand brought from the beach at Dunkirk. A deeper discussion of the significance of objects brought from theatres of war to form memorials at the Arboretum is provided by Williams (2014). A number of stones used in the memorials at the National Arboretum have a deep personal or collective symbolism to the organisations being commemorated and the theatre in which they fought. There is a clear intention in their use, adding a layer of authenticity to the monument.

For some, the selection of stone is intrinsic to the monument and strongly representative of a place and a time. A clear example here at the National Memorial Arboretum is the **Cyprus Emergency Memorial** (Fig. 1e) which features a 'rock' specifically brought from the island. A veteran of the 1955-1959 campaign, David Littlemore of Porthmadog, fundraised to have a rock, 'a piece of the island' shipped from Cyprus to construct the memorial (Mears, 2016). Losers in campaigns (Cyprus attained independence from Britain in 1959) are often poorly remembered despite their heroism and sacrifice, and for Mr Littlemore and his fellow veterans this monument was of huge personal importance. The 'rock' appears to be a basalt (Fig. 1e). I have not been able to locate where it came from but it is likely to be either from the Kyrenia Range of Northern Cyprus or from Troodos in Southern Cyprus.

The **Camp Bastion Memorial** is a replica of the *ad hoc* memorial created by troops at Camp Bastion in Afghanistan's Helmand Province (MOD, 2015). This memorial started with a pyramidal cairn made of pebbles set in concrete and then enlarged with three blast wall panels to memorialise fallen troops. The Camp Bastion Memorial at the National Arboretum is constructed to the same design except it is made from Rosa Monção Granite (Stone Specialist, 2015; Fig. 2c) from the Porriño Massif situated on the Spanish-Portuguese border. This is a coarse-grained, post-tectonic Variscan granite with distinctive pale pink potassic feldspars (Fig. 2c). This stone has no connection to Afghanistan or to British Troops fighting there, it was simply available, affordable and attractive. But walk around to the back of the wall where there is a map of Afghanistan cut from black dolerite. Look closely and the named locations on the map are marked with tiny pebbles picked up by soldiers in Afghanistan near the locations that they now represent.

The **Phantom Memorial** is a block of coarse-grained granite surmounted by a Cross of Lorraine. This monument commemorates F Squadron Phantom, a Wireless Communications Unit who provided communications for SAS troops parachuted behind enemy lines in the Vosges Mountains of eastern France in 1944. Based in and around the village of Moussey, close to the Rhine and the border with Germany, F Squadron Phantom also worked with the local resistance. One of their members Sergeant Gerald Donovan Davies was betrayed and shot by the Gestapo. Signalmen George Gourlay Johnston and Peter Bannerman also lost their lives in the region. The granite used in the monument is from the Late Variscan Senones Massif and is labelled as Coral Red (*Rouge Coraile*). Two types of granite are worked in the quarry at La Forain near Moussey, and this specimen more resembles the variety with violet-coloured potassic feldspar, known cheerfully in French as *Feuille Morte* (dead leaf) rather than Coral Red with its brick-red feldspars. Nevertheless, this stone was chosen specifically to symbolise the place where F Squadron Phantom, the members of the SAS Regiment and the men and women of the local resistance who lived, fought and died together in this region of the Vosges.

A chunk of limestone brought from the Rock of Gibraltar was carved by sculptor Anselmo Torres into a relief model of The Rock to be placed on top of the **Gibraltar Memorial**. The Lower Jurassic Gibraltar Limestone Formation consists of carbonate rocks deposited in a shallow water, tidal environment (Rose, 2016), and evidence for this is visible in the block of stone used on the plinth. This is a pale grey, laminated limestone, both micrites and sparites are present along with abundant layers of peloids and fossil debris. The limestone 'Rock' stands on a base of Blue Pearl Larvikite which itself stands on a plinth of Carrara Sicilian Marble.

Stone has been specially transported from the Falkland Islands for use in both the **Royal Engineers Memorial** and the **South Atlantic Medal Association Memorial**. In both cases, the stone is quartzite, which is also the predominant lithology outcropping on the islands (Stone, 2016 and Fig. 3). Devonian white quartzites outcrop around the islands' capital, Port Stanley and these lithologies are a good match for the stones used in these memorials. Both monuments use rough-hewn boulders. Imaginatively, the huge blocks of stone in the Royal Engineers Memorial are raised up, to recognise the sappers' ingenuity and ability to reshape the land and overcome what may seem like impossible tasks. In the South Atlantic Medal Association Memorial, boulders of Falklands Quartzite form the gateway to the memorial garden (Fig. 2d). A boulder of grey sandstone commemorates Doreen Bonner, Mary Goodwin and Susan Whitley, the Falkland Islanders who lost their lives in the liberation of Port Stanley in 1982. I have not been able to locate further information about this stone, but it is reasonable to believe that this too was brought from the islands to form part of this memorial.

The stones used in the **British German Friendship Garden** are of particular significance, but their story is somewhat different from other chosen stones discussed above. The Frauenkirche (Church of Our Lady) in Dresden was built between 1720 and 1743 and destroyed by Allied firebombing during raids taking place from 13th to 15th February 1945. 650,000 incendiary bombs were dropped on the city by the RAF's Bomber Command; temperatures inside the church reportedly reached 1000°C and the sandstone glowed bright red, with stones literally exploding. The building lay in ruins for 50 years but was reconstructed following the reunification of Germany in 1994. The church has subsequently become a symbol of reconciliation between Britain and Germany and this relationship has been formalised by The Dresden Trust, a charity founded in 1993 to support reconciliation and the rebuilding of the ruined city. The new church has been constructed from Postaer (Posta) Sandstone from Mühlleite Quarry (Heinz & Siedel, 2009), although remarkably, around one third of the original stone was salvaged and reused. Postaer Sandstone is one of the Elbe Sandstones, an Upper Cretaceous sequence of quartz-rich, marine and fluvial, buff-coloured sandstones, many facies of which have been widely used as building stones in Germany and across Northern Europe (Ehling, 2018). These strata outcrop in Saxony in the vicinity of Dresden, and if the original Frauenkirche was not constructed for Postaer Sandstone, it was certainly built from one of the related Elbe Sandstones. Fifteen stones were salvaged from the rubble of the Dresden Frauenkirche and were brought to Staffordshire to construct the stone circle in the British German Friendship Garden.

A nice story is related in NMA (2017) concerning the **Auxillary Territorial Service (ATS) Memorial**. The *force majeure* behind this garden and its monuments was Mrs Vee Robinson. Looking for just the right shape of stone to recall the angle of the searchlights used by the ATS spotters, she regularly visited a quarry until she found the perfect stone that fitted the idea in her mind of the memorial. Unfortunately for us the quarry is not named but the memorial is constructed of rough-hewn blocks of a red sandstone, almost certainly one of the Triassic sandstones quarried in the West Midlands or Cheshire Basin.

Stone to Represent a Nation

Portland Stone has been traditionally used in the UK to construct war memorials both in the home nations and abroad and partly because of this it has achieved UNESCO designation as a Global Heritage Stone Resource (GHSR) and if England were to have a National Stone, it would surely be Portland Stone. It is a material widely used in civic architecture and for monuments representing national mourning such as the Cenotaph on the Mall in London (see Siddall, 2014) as well as many grave markers and memorials maintained by the Commonwealth War Graves Commission and for hundreds of local war memorials in towns and villages across the British Isles. The varieties of Portland Stone, Basebed, Whitbed and Roach, come from a sequence of late Jurassic oolitic limestones outcropping on the Isle of Portland, Dorset. The **Armed Forces Memorial** is the centrepiece of the National Memorial Arboretum Gardens, designed by Liam O'Conner Architects and built in 2007 from Portland Stone. The inscribed memorial wall is constructed from Bower's Basebed supplied by Albion Stone, the finest quality of Portland Stone available. The rest of the structure, including the obelisk are built from Coombefield Whitbed supplied by Portland Stone Firms.

The **Household Division Memorial** has an altar-shaped plinth made from Portland Stone upon which stand a bronze replica of the railings from outside the old Chelsea Barracks. The Household Cavalry consists of the Grenadier Guards, Scots Guards, Welsh Guards, Irish Guards and Coldstream Guards, representing between them the four nations of the United Kingdom. This has been reflected in the design of the memorial, as the paving on which the Portland Stone altar sits is created from stones reflecting the four nations; they are Cornish Granite representing England, Blaenau Ffestiniog Slate representing Wales, green Connemara Marble (Irish Green) representing Ireland (though actually derived from the Republic rather than Northern Ireland) and red Balmoral Granite representing Scotland. Here and somewhat regrettably, we see played out the problems with linking stone names to provenance. Balmoral Granite is from Finland despite its Scottish-sounding name. Scottish architecture and culture was fashionable in late 19th Century Fenno-Scandia and hence this stone quarried near Turku adopted a regal sounding Scottish name.

The **Royal Scots Dragoon Guards Memorial** is made from a Scottish Stone, though not one that is typically used as a building material beyond its use in dry stone walls and some buildings local to outcrop. This is the oldest rock in the British Isles, the 2.7 billion year old Lewisian Grey Gneiss which is found on the north west coast of the mainland and on the Outer Hebrides. It gets its name from the Isle of Lewis.

Both the **Royal Welsh Regiment Memorial** and the **Queen's Dragoon Guards** (Welsh Cavalry Regiment) are made from monolithic slabs of dark grey slate from Blaenau Ffestiniog (Stone Specialist, 2011). This stone has been used for numerous memorials in the Arboretum but here it was specifically chosen to represent Welsh Regiments.

Another large and impressive structure is the **Polish War Memorial**. The memorial comprises an 18 metre diameter circular wall enclosing a courtyard in which the centrepiece is a bronze sculpture by Robert Sobocinski. The grey granite walls are inscribed with plaques, commemorating the Polish military and underground organisations who fought in World War II. Unfortunately, I have not been able to find any information concerning the origin of the granite used for this memorial. I would like to think that it is from Poland and although it very much resembles Strzelin Granite from Silesia (a late Variscan, medium to coarse grained, biotite granite) I have no evidence to prove that this is actually the case.

Local Stone

A few regimental memorials intentionally use stone that intrinsically links them to the British county from which they are named and from where the troops were traditionally recruited. The local **Staffordshire Regiment's Memorial** is constructed from local stone in the form of Hollington Sandstone, quarried at Hollington & Wootton Wood. This is a distinctive, Lower Triassic, red and buff-mottled sandstone which was also used for building Lichfield Cathedral nearby.

The **Duke of Lancaster's Regiment's** most distinctive feature is its large bronze *lion rampant* modelled by sculptor Georgie Welch. This beast stands on a plinth of a pale, buff-coloured sandstone with orange iron staining in the form of liesegang bands, described in NMA (2017) as 'Cumbrian Sandstone'. This name probably relates to the quarry owners (Cumbrian Stone) rather than the actual stone. This is surely Longridge Sandstone worked from Leeming Quarry near Preston in Lancashire, an Upper Carboniferous sandstone of the Pendle Grit Formation.

Kentish Ragstone is used to construct the **Royal Kent Regiment Memorial**. Most often seen rough and used as a dimension stone, this monument uses polished Kentish Rag which really brings out this stone's beauty. This is a well-cemented calcareous sandstone, one of the Cretaceous Lower Greensands, rich in the mineral glauconite which is responsible for imparting the stone's grey-green colouration. The polished surfaces also show the fossilised traces made by marine creatures burrowing through this sand when it formed on a Cretaceous seabed. Look carefully and there are a few, small, brown fossil belemnites in this memorial's fabric. This stone is quarried at numerous sites along the east-west strike of the Ragstone outcrop

throughout the county of Kent. It has been used since at least the Roman period and is still actively quarried today.

The **Essex Regiment Memorial** is mainly constructed from Portland Stone, but panels around the base of the plinth are set with knapped flints. Essex is not a county rich in dimension stone, but flints are readily available, derived from the Cretaceous Chalk and they have been used as cladding on buildings since the Roman Period. This is a nice touch which relates this otherwise generic stone memorial to the people who served in the regiment.

Bold Boulders

Natural boulders are a good choice for a memorial, they often have pleasing, ready-made, shapes and they don't need quarrying. It is straightforward to polish a face to add an inscription or to insert a plaque. Such boulders are entirely natural and are found either on the surface or as otherwise useless and unwieldy blocks in Quaternary fluvial-glacial sand and gravel deposits. Alternatively, rough-hewn blocks of stone can be acquired from quarries. Again these are attractive, and besides transportation, require little work to transform into a striking memorial.

Glacial boulders are also used for the **Glider Pilot Regiment Memorial**, the **Parachute Squadron Memorial** and the **Home Front Memorial**. The Glider Regiment memorial was brought from Gelderland in the Netherlands, where gliders were used to transport troops and supplies for the doomed Operation Market Garden (17th-25th September 1944). The region is highly glaciated and such erratic boulders are a common occurrence. The stone used is a medium-grained granite, stained with red hematite and probably ultimately derived from Scandinavia. The provenance of the Parachute Squadron boulder is not recorded. However, this is a spectacular rock, also a glacial erratic and also ultimately derived from Scandinavia (Fig. 2e). It is a coarse-grained, quartzo-feldspathic augen gneiss, a metamorphic rock formed in a high-strain tectonic environment. The Home Front memorial is a block of white vein quartz of unknown provenance, but also most probably transported by glaciers.

Rounded boulders of clearly glacial origin are used for several memorials in the Arboretum. The **Boy's Brigade Memorial** garden includes two stone components. The first is a rough-hewn block of purple Welsh Slate from the Cambrian slate belt which is quarried today at Penrhyn near Bethesda. The second is a large stone boulder, probably glacially weathered but unmistakably made from the riebeckite-bearing granite which forms the islands of Ailsa Craig, located in the outer firth of Clyde (Fig. 2f). Riebeckite is a blue-coloured sodic amphibole and it can be seen on the polished surface of the boulder forming dark blue clots in the grey and white quartz and feldspar matrix. The Ailsa Craig Microgranite is part of the suite of Tertiary (c. 60 Ma) intrusions of western Scotland.

A number of boulders and rough-hewn blocks of limestone have been supplied to the National Memorial Arboretum from Longcliffe Quarry near Brassington, Derbyshire. These pits are situated in Bee Low Limestone (Visean, Lower Carboniferous), which is partly dolomitised. Both the dolomitised and non-dolomitised varieties of limestone are quarried predominantly for aggregate and the latter as a high purity lime. A small amount of building stone is also produced. The curving wall of the **Women's Institute Memorial Wall** is built of Longcliffe Limestone by dry stonewaller Sally Hodgson. The **Household Cavalry Regiments Memorials** are two boulders, representing the Blues and Royals and the Life Guards which were donated by the High Sheriff of Derbyshire. Both are of Longcliffe Limestone.

Similarly, the boulders used for the **British Korean Veterans Memorial** are from the Milldale Limestone Formation, also of Lower Carboniferous age and come from Waterhouses Quarry in Derbyshire. Five blocks are arranged in an arc. Four of these are crinoidal limestones some with karstic weathering on surfaces, typical of Milldale Stone. The central stone in this arc is not a limestone though, it is an igneous rock, a porphyry crammed with white feldspar crystals (phenocrysts). The precise origin of this stone is unknown though volcanic clastic breccias (Tissington Hyaloclastic Formation) outcrop a kilometre or so east of

Waterhouses. This stone may be derived from these units, or it could be a glacial erratic from much further away. Now, it is important to know that quarries often act as warehouses to store stone from other operations, and so there is no guarantee that boulders supplied from Longcliffe or Waterhouses were actually extracted from those quarries.

The **Army Dog Unit (Northern Ireland)**, commemorates both humans and dogs who lost their lives serving in Northern Ireland. Fittingly, they are remembered with a rough block of Antrim Basalt set with a dolerite plaque featuring the 'red paw' logo of the unit.

Two spectacular chunks of rock are the Merchant Navy Association Memorial and the Fauld Explosion Memorial. Both are constructed of rough-hewn stone blocks. According to NMA, (2017), the stone used for the **Merchant Navy Memorial** came from a Cornish granite quarry. Given the caveat made about stones and quarries above, this may be the case but this is certainly not a granite. This stone appears to be a compact, hard, iron stained grey limestone, with some calcite veining. As such it is more likely to have been derived from Devon and probably the Plymouth area, rather than Cornwall.

During WWII, explosives and ammunitions were stored in an abandoned gypsum mine at Fauld, Staffordshire. An accidental detonation on 27th November 1944 caused 4,000 tones of munitions to explode, killing 70 people and leaving behind a crater 300 m wide and 30 metres deep. The **Fauld Explosion Memorial** (Fig. 1f) commemorates these men, which included army personnel and Italian Prisoners of War. The stone is a block of gypsum from the Fauld Mines, which lies only 15 km north of the National Memorial Arboretum. This is an important British decorative stone from the Triassic Tutbury Gypsum Beds which has been quarried since the 11th Century. During the Medieval period, this stone was exported across the British Isles and northern Europe for the construction of church monuments and other trappings and its use continued in this manner until the early 20th Century. Some very fine examples of so-called 'English Alabaster' monuments can be seen locally in Lichfield Cathedral.

A List of Memorials and their Stones at The National Memorial Arboretum

Please note that this list is not exhaustive and does not include all the stone monuments at the National Memorial Arboretum. It lists stone monuments that the author has visited and/or for which information about stones used is available. Named stones are in bold. Generic rock types, where the origin is unknown are in italics. Dates in square brackets are the year the monument was dedicated (where known). Not all the memorials listed here are described in the text above, and new information will be added as it becomes available.

National Memorial Arboretum reception centre – **Moleanos Limestone**

10th Royal Hussar's Memorial – **Portland Stone**

11th Hussar's (The Cherry Pickers) Memorial – **Portland Stone**

1940 Dunkirk Veterans Association Memorial [1999] – **Dunkirk Beach Sand**

Adjutant General's Corps Memorial – *diorite*

Argyll and Sutherland Highlanders Memorial - *dolerite*

Armed Forces Memorial – **Portland Stone**

Army Dog Unit (Northern Ireland) [2009] – **Antrim Basalt**

Auxillary Territorial Service/ACK ACK Memorial – **Hollington Stone**

Basra Memorial Wall [2010] – **New Imperial Red Granite (?)**

Bevin Boys Memorial [2013] – **Kilkenny Limestone**

Boy's Brigade Memorial (Boulder) [2009] – **Ailsa Craig Granite**

Boy's Brigade Memorial (Plinth) [2009] – **Cambrian Welsh Slate**

Brigade of Gurkhas Memorial – **Cotswold Stone**

British German Friendship Garden [2006] – **Elbe Sandstone**

British Korean Veterans Memorial – **Milldale Limestone**

British Korean Veterans Memorial – *porphyry*
British Nuclear Test Veterans Memorial – **Cotswold Stone**
British South African Police Memorial [2010] – **Cotswold Stone**
Brotherhood of Greek Veterans Memorial – *red sandstone*
Camp Bastion (Afghanistan) Memorial – **Rosa Monção Granite**
Camp Bastion (Afghanistan) Memorial (paving) – **Alpendurada Granite**
Canadian Royal Air Force Memorial – *pink granite, white granite*
Canadian Royal Air Force Memorial (paving) – **Canadian Sage Granite**
Cavalry Grove Memorials – **Blaenau Ffestiniog Slate**
Civil Defence Memorial [2007] – *sandstone*
Cyprus Emergency (1955-1959) Memorial – *basalt*
Duke of Lancaster's Regiment Memorial [2016] – **Longridge Sandstone**
Essex Regiment Memorial [2014] – **Portland Stone, Flint**
Ex-National Servicemen's Memorial [2003] – *charnockite gneiss*
Fauld Explosion Memorial – **Fauld Gypsum (English Alabaster)**
Fire & Rescue Service Memorial [2008] – **Corrennie Granite**
Fleet Air Arm Memorial (plinth) [2009] – **Portland Stone**
Fleet Air Arm Memorial (ship) [2009] – *granodiorite*
GCHQ Memorial [2012] – *picture sandstone*
Gibraltar Memorial (base) [2015] – **Larvikite**
Gibraltar Memorial (plinth) [2015] – **Carrara Marble**
Gibraltar Memorial (Rock of Gibraltar) [2015] – **Gibraltar Limestone**
Glider Pilot Regiment Memorial – *glacial erratic (sourced from Gelderland, Netherlands)*
Heroes' Square Memorial Paving Stones – **Scoutmoor York Stone**
HMS Argonaut Memorial – *grey granite*
Home Front Memorial [2006] – *erratic boulder (quartz)*
Hong Kong Police Memorial – *dolerite*
Household Cavalry Regiments Memorials [2016] – **Longcliffe Limestone**
Household Division Memorial (paving) [2009] – **Cornish Granite, Balmoral Granite, Connemara Marble, Blaenau Ffestiniog Slate.**
Household Division Memorial (plinth) – **Portland Stone**
Intelligence Corps Memorial – **Blaenau Ffestiniog Slate**
Irish Infantry Grove – *Chinese granites*
Jewish Ex-Servicemen & Women's Memorial [2006] – **Laizhou Granite**
King's Royal Hussar's Memorial – **Balmoral Granite**
King's Shropshire Light Infantry Memorial – *charnockite gneiss*
Light Infantry Memorial – **Portland Stone**
Malaya & Borneo Veterans Association Memorial – **G3582 (Padang Yellow)**
Masonic Memorial Garden [2017] – **Great Tew Ironstone, sandstone, Chinese granite**
Master Mariners Sundial [2015] – **Dunhouse Sandstone & Elterwater Slate**
Merchant Navy Association Memorial [2003] – **Devon Limestone**
Mercian Volunteers' Memorial [2004] – *sandstone*
Military Police Memorial – **Portland Stone (Fancy Beach Whitbed)**
Naval Service Memorial [2014] – **Kilkenny Limestone**
Normandy Veterans Memorial [2014] – *Chinese granite*
Oman Armed Forces Memorial – *gneiss*
Parachute Regiment Memorial [2012] – **Portland Stone**
Parachute Squadron Memorial [2017] – *glacial erratic (augen gneiss)*
Phantom Memorial – **Vosges Rouge Corail Granite**
Polish War Memorial [2009] – *granite*
Quaker Services Memorial – **Clipsham Stone**
Queen Alexandra's Royal Naval Nursing Memorial – **Larvikite**
Queen's Dragoon Guards Memorial – **Blaenau Ffestiniog Slate**

Queen's Regiment Memorial [2016] – *dolerite*
Rhodesian African Rifles Regiment Memorial – **Cotswold Stone**
RoadPeace Memorial [2021] – **Honister Cumbrian Green Slate**
Royal Air Force Benevolent Fund Memorial (RAFBF) – **Larvikite, New Imperial Red Granite, granite, diorite.**
Royal Air Force Boy Entrant's Association Memorial – **Ancaster Oolite**
Royal Air Force Halton Apprentices Memorial – **Mountsorrel Granodiorite**
Royal Air Force Medical Services Memorial – **Blaenau Ffestiniog Slate**
Royal Air Force Regiment Memorial [2001] – *dolerite*
Royal Air Force Technical Communications Wing Memorial – **Great Tew Ironstone, York Stone**
Royal Engineers Memorial (obelisk) [2007] – **Portland Stone**
Royal Engineers Memorial (stones) [2007] – **Falklands Quartzite**
Royal Green Jackets Memorial – **Indian Black Granite**
Royal Kent Regiment Memorial – **Kentish Ragstone**
Royal Leicestershire Regiment Memorial (base to sculpture) – **Ketton Stone**
Royal Leicestershire Regiment Memorial (plinth) – **Kilkenny Limestone**
Royal Marines Memorial – **Millstone Grit**
Royal National Lifeboat Institute Memorial – **Millstone Grit**
Royal Navy Artificers Memorial – **Ashover Grit**
Royal Navy Patrol Services Memorial – *grey granite*
Royal Scots Dragoon Guards Memorial – **Lewisian Gneiss**
Royal Welsh Regiment Memorial [2006] – **Blaenau Ffestiniog Slate**
Russian Convoy Veterans (Arctic Convoys) Memorial [2012] – *dolerite*
Search & Rescue Memorial – **Blaenau Ffestiniog Slate**
South Atlantic Medal Association Memorial (Boulder) [2012] – *sandstone*
South Atlantic Medal Association Memorial (Standing Stones) [2012] – **Falklands Quartzite**
South Atlantic Medal Association Memorial (Wall) [2012] – **Cotswold Stone**
SS Aguila Memorial – *grey granite*
Staffordshire Regiment Memorial [2015] – **Hollington Stone**
Stillbirth & Neonatal Death Memorial – **Portland Stone**
The Guinea Pig Club Memorial [2016] – **Cumbrian Green Slate**
The Oddfellows Memorial – **Larvikite**
The Reconciliation Stone – *red granite*
Ulster Ash Grove Memorial Stone [2003] – **Mourne Granite**
Victoria Cross Commemorative Paving Stones [2015] – **York Stone**
Women's Institute Memorial Wall [2009] – **Longcliffe Limestone**
WRAC Memorial – *charnockite*
WRNS Memorial Garden (stone) – **Portland Stone, Blaenau Ffestiniog Slate**

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Useful websites for further reading

Albion Stone Projects: <https://www.albionstone.com/portland-stone-projects/national-memorial-arboretum>

Dark Tourism: <https://www.dark-tourism.com/index.php/great-britain>

Geology of the Falklands Islands: Wikimedia Commons: https://commons.wikimedia.org/wiki/File:Geology_of_the_Falkland_Islands.svg

Graeme Mitcheson: Artist & Sculptor: <http://www.chisel-it.co.uk/sculptures-settling-national-memorial-arboretum/>

Hardscape: Irish Infantry Grove: <https://hardscape.co.uk/irish-infantry-grove-stafford/>

Imperial War Museum War Memorials Register: <https://www.iwm.org.uk/memorials>

Marshall's. National Memorial Arboretum: <https://www.marshalls.co.uk/commercial/case-studies/national-memorial-arboretum>

Meister Masonry: <https://meister.co.uk>

Portland Stone Firms: <https://www.stonefirms.com/portland-stone-projects/armed-forces-memorial/>

RoadPeace: <https://www.roadpeace.org/2021/08/12/roadpeace-memorial-stone/>

Royal Air Forces Association TCW & 90SU Memorial: <https://branch.rafa.org.uk/tcw-90su/who-we-are/nma-memorial>

Royal Naval Association: <https://royal-naval-association.co.uk/news/the-naval-service-memorial>

The Dresden Trust: <https://dresdentrust.org/2020/10/01/the-british-german-friendship-garden/>

The Household Division: <https://www.householddivision.org.uk/hq-memorials>

The National Memorial Arboretum: <https://thenma.org.uk>

Young Johnson Monumental Masons: <https://www.youngjohnson.com/services/national-memorial-arboretum/>

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<http://ruthsiddall.co.uk/Walks/NationalMemorialArboretum.pdf>



Figure 1.

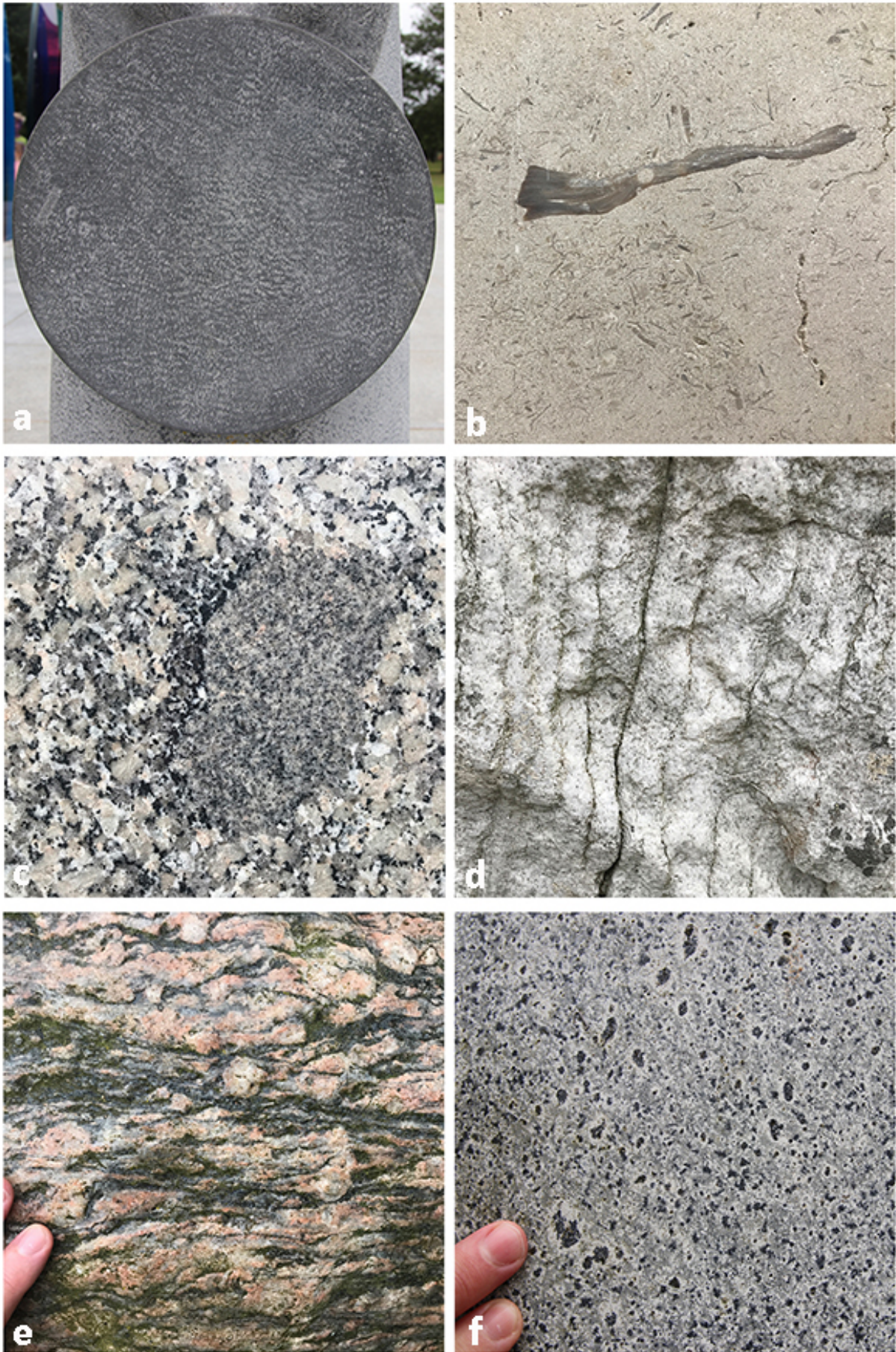


Figure 2.

Figure 1. Memorials at the National Arboretum; a). The King’s Royal Hussars Memorial, Balmoral Granite; b). The Royal Navy Patrol Services Memorial in grey granite; c). The RAF Benevolent Fund Memorial in grey diorite, with the roundel constructed from larvikite, white granite and red granite; d). The Royal Air Force Technical Communications Wing Memorial constructed from Great Tew Ironstone with a York Stone plaque; e). The Fauld Explosion memorial made from Fauld Gypsum.

Figure 2. Stone textures in the National Memorial Arboretum; a). Kilkenny Limestone with fossil crinoids, Naval Services Memorial; b). A fossil oyster shell in Portland Stone, Armed Forces Memorial; c). Enclaves in Rosa Monçao Granite, Camp Bastion Memorial; d). Falklands Quartzite, South Atlantic Medal Association Memorial; e). Augen gneiss, Parachute Squadron Memorial; f). Ailsa Craig riebeckite granite, Boys Brigade Memorial.

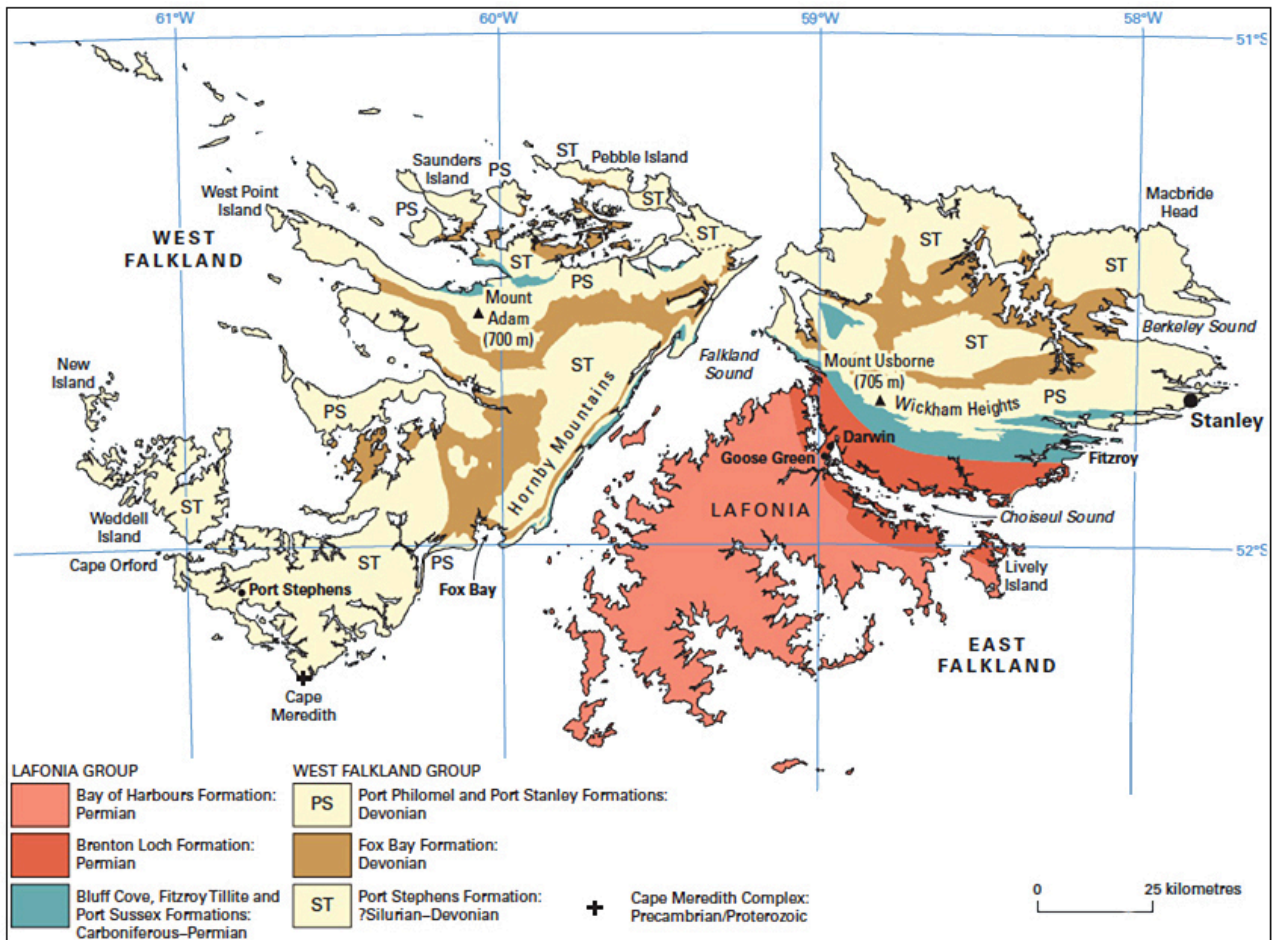


Fig. 3. The Geology of the Falklands Islands showing the distribution of the Port Stanley and Port Stephens Quartzite Formations (adapted from Stone, 2016).