A World of Geology on the Isle of Dogs: Building Stones at Canary Wharf

Ruth Siddall



Cabot Square, Canary Wharf

Canary Wharf is located on the West India Docks on the Isle of Dogs, in postcode district E14 in the London borough of Tower Hamlets. The West India Docks, originally constructed between 1800-1802 held the monopoly for ships from the West Indies importing sugar and rum from the plantations there. The original Canary Wharf was the Number 32 berth of the West Wood Quay of the Import Dock, built in 1937 for Fruit Lines Ltd., who operated the Canary Islands fruit trade (Hobhouse, 1994a). The modern development was proposed in 1985, backed by American Banks Credit Suisse First Boston and Morgan Stanley and envisioned by US architects Skidmore, Owings & Merril (SOM). However prevarications over rising costs caused these firms to pull out and the contract was then given to Canadian developers Olympia & York who continued to work with SOM. The initial building work had begun in 1987 and reached its peak in 1989, with the first phase completed in 1991. Building continues to this day. The development was extremely ambitious for its time and remains impressively modern today (having avoided too much 1980s-style post modern architecture which would now have appeared dated). On that note, architectural information quoted below is from Canary Wharf Group PLC and Cherry et al., 2005).

The stones used in the Canary Wharf development are universally 'exotic' with very few examples of British stones used here. This is probably the only guide I have written which does not use the words 'Portland Stone' and 'larvikite'; materials so typical of building in the City and Westminster. Nevertheless, if you want to study high grade metamorphic rocks on the streets of London, then you should definitely visit Canary Wharf (there are a fair few good fossil localities too). As a fairly recent development, there is a reasonably good, if not complete, record of the building stones used here. A lot of information is summarised in the Survey of London (Hobhouse, 1994b). Stone contractors Miller Druck Ltd. and Priests Stonework & Restoration have worked on the development and have listed the stones used for some of the projects listed on their website. US-based Miller Druck are responsible for the more frequent than average use of New World stones in this development. The provenance of other stones has been discovered on the websites of quarry firms *etc*., proud to have supplied the project. However, as is always the case with

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building stones, information is often either incomplete or missing. Consequently some detective work is always needed. In the mid 1990s, Eric Robinson made some effort to try to identify the stones; some were familiar to him but many were new, and sourced from non-traditional localities, especially from the New World. Without access to the internet, identifying these stones would have been a pretty daunting if not impossible task. An anonymous correspondent of Eric's writes '*there are at least 20 different stones from at least 14 different countries'*. He goes on to say that there is probably enough material here for a '*jumbo-sized book*'. The wealth of stones used here is almost overwhelming and therefore this tour is not exhaustive and lists the principal stones used on the exteriors of buildings in the main Canary Wharf development (with a few exceptions of publically accessible interiors). I have recorded around 50 stones representing about 20 countries.

Getting there …

The easiest way to get to Canary Wharf from central London is either by Docklands Light Railway (DLR) from Bank, taking a train towards Lewisham. Alternatively take the Jubilee London Underground line. The best time to visit Canary Wharf is a Sunday when the streets, squares and pavements are relatively empty. However cafés and shops are all open should you need a break from the overwhelmingly spectacular stones on show. A map of the development can be accessed at http://group.canarywharf.com/about-us/the-estate/

This walk starts West India Quay DLR Station. Leave the station and descend onto the quay of the 'Import Dock', following signs for the Museum of London Docklands. Walk along the quay, past the restaurants across cobbles of old and new granite setts and slabs of York Stone.

West India Docks

The remaining 19th Century, brick-built warehouses here, the ones that escaped the bombs of World War II, were constructed between 1800-1804 and now housing the Museum and restaurants etc., were designed by architects George Gwilt & Sons. The Museum of London Docklands is a good place to learn about the history of these docks, including the large part that they played in the Slave Trade. A stark reminder of this is the statue of Robert Milligan (1746-1809) which stands on the dockside. Milligan, the son of plantation owners, grew up in Jamaica but moved to London in 1779. He lead the consortium to establish West India Docks for the import of rum, sugar and coffee from the West Indies. The abolition of slavery, though campaigned for throughout Milligan's life, did not happen until a quarter of a century after his death at which point Milligan was the owner of 526 slaves. Milligan was never a supporter of this campaign. Nevertheless here he stands, in bronze by prominent sculptor of the day, Richard Westmacott, an a statue erected in 1813. Milligan, a Scotsman, is commemorated for the part he played in the establishment of the docks, on a plinth of **Peterhead Granite**. This is a salmon-pink granite from Peterhead, extracted from quarries at Stirlinghill, north of Aberdeen. It is a post-tectonic, Caledonian granite, intruded c. 406 Ma. Peterhead Granite is much more easily recognisable when polished, but in this case, installed before the invention of granite polishing mechanisms, the stone is honed (smoothed but not polished). Nevertheless a few of the characteristic, rounded, grey, mafic enclaves are present. Peterhead Granite had been quarried since the 18th Century, but this is a relatively early use of this stone in London.

Take the path away from the docks past the Ledger Building and then turn left onto Hertsmere Road. Follow this to the point where this descends underground. In the colonnade of the green gneiss-clad building to your left, a staircase leads up to Columbus Courtyard. The staircase is housed in 17 Columbus Court, which has its main entrance to the left of the landing.

17, Columbus Courtyard

17, Columbus Courtyard is by architects Gensler & Associates, completed in 1999 and occupied by bankers Credit Suisse. The colonnade on the podium level facing West India Dock and the façade facing Columbus Courtyard are clad in dark green **Verde Candeias** (also known as Verde Maritaca). This is one of the oldest commonly used building stones, dating to 2.75 billion years it comes from he Candeias Gneiss of the Campo Belo Metamorphic Complex in Minas Gerais state, Brazil (see Oliveira & Carneiro, 2001; Texeira et al.,

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1998). This rock has a long and complicated history; a migmatitic orthogneiss formed from 3 billion year old protoliths, it is an 'opdalite', an orthopyroxene-bearing granodiorite, which belongs to the suite of rocks known as charnockites. It is composed of quartz, plagioclase, biotite and rutile, with the green colour imparted by hypersthene (orthopyroxene), epidote and chlorite. The swirly banding is picked out primarily by biotite. Along with other spectacular gneisses quarried locally, Verde Candeias was very popular in 1980s-1990s building projects.

Turn around and walk towards the west side of Columbus Courtyard.

Bupa Dental Centre

This building and the nursery next door form the back of the crescent-shaped office and retail space which fronts on to Westferry Circus. The building is clad in the Brazilian garnet-bearing granite, **Giallo Veneziano**. This is used flame-dressed (roughened) in the walls and polished on the foundations. The stone looks much more pink in the flame-dressed surfaces (below). Giallo Veneziano is one of several granitoids and associated orthogneisses quarried in Espirito Santo and SE Minas Gerais states and described by Pedroso-Soares et al. (2011). These rocks belong to the Neoproterozoic Carlos Chagas Suite, a voluminous magmatic province associated with the Araçuai Orogen and intruded between 630-480 Ma. Many of these granitoids and orthogneiss are quarried and are very popular building stones. Indeed Espiritu Santo, one of Brazil's smallest states produces 65% of the country's dimension and decorative stones. If you encounter a yellow megacrystic granite building stone, it has almost certainly come from the Carlos Chagas Suite, and we will encounter more rocks from this district in Canary Wharf.



Five suites of intrusion are recognised in the Carlos Chagas Suite and Giallo Veneziano belongs to the second 'G2' suite described by Pedroso-Soares et al. (2011), intruded c. 576 Ma. It is composed of yellow-pink perthitic feldspar megacrysts, quartz, red garnets, biotite and white sillimanite. The yellow colouration is produced by goethite, iron oxide hydroxide, formed in the upper portions of the intrusion in the tropical weathering environment. They are quarried in the vicinity of Novo Venecia over the last 40 or so years. Columbus Courtyard itself is paved with **Giallo Veneziano**, the pink granite **Rosso Porriño** from the Spain-Portugal border and **Nero Zimbabwe,** a black dolerite from Mashonaland. The paving was supplied by Priest's for architects Koetter Kim & Associates.

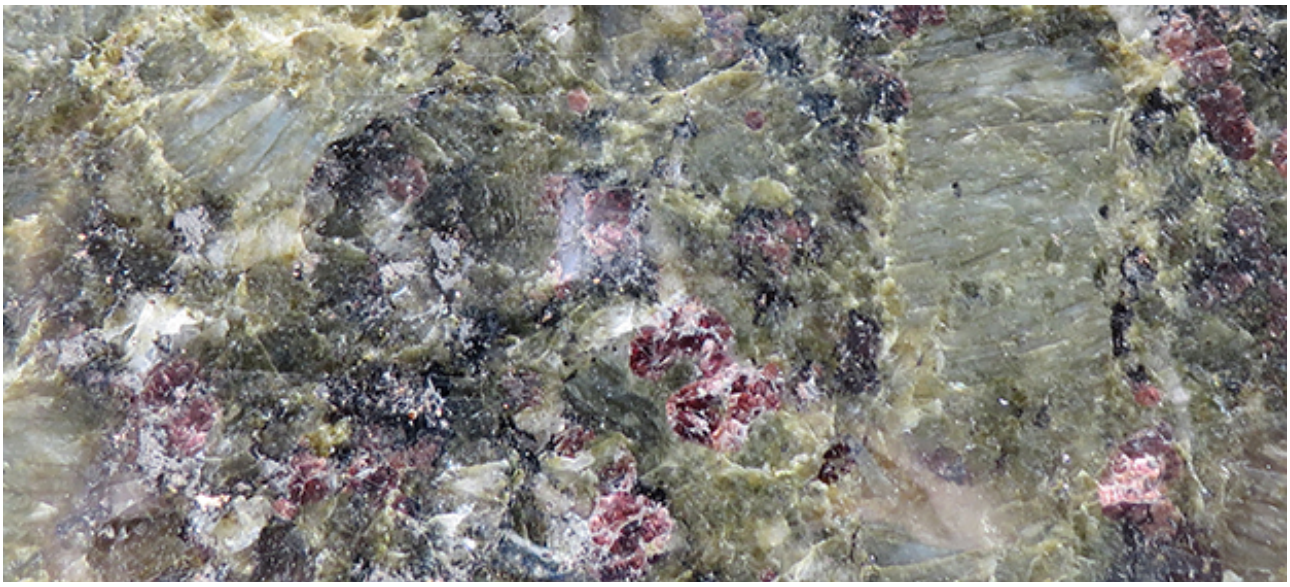
11, Westferry Circus

Leaving Columbus Courtyard, one passes 11, Westferry Circus on the right hand side. This multifunctional building houses a restaurant, office and the East London Family Court, the entrance to which is on Columbus Courtyard. The building is clad on all faces with a white flame dressed limestone with a relatively rough surface. From a distance it is white, mottled with cream and brown, but closer inspection reveals the presence of fossils, most obviously ammonites and belemnites. The latter resembling grey bullets. This fauna is typical of the so-called **Jura Marble**. This stone is derived from several quarries in the Altmühltal Naturpark, located in the hills of the Southern Frankonian Alb in central Bavaria. Geologically these sediments were deposited in a open marine environment dotted with mounds of sponge reefs. Though

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these reefs are not quarried, algal detritus is commonly seen as brownish, ring structures in the limestone. These limestones are of Kimmeridgian (Late Jurassic) age and belong to the Treuchtlingen Formation. The building was designed by architects Scott Brownrigg.

Turning right into the colonnade on the West India Avenue façade of 11, Westferry Circus, look down to the foundations which are clad in a very coarse grained, dark bronzy-green variety of **Verde Ubatuba**. This is a charnockite, a Proterozoic granitoid which contains mafic phases such as pyroxenes (and in this case garnet) in addition to the standard recipe of quartz, mica and feldspar. Look closely and the red garnets are visible. The feldspars are megacrysts, up to 10 cm across. They are a beautiful shade of blue green and are the potassic feldspar variety microcline (below). This stone was intruded at 565 Ma into the Ribeira Belt in São Paolo State, Brazil.



Turn into right into West India Avenue, and continue to Westferry Circus.

Westferry Circus Crescent

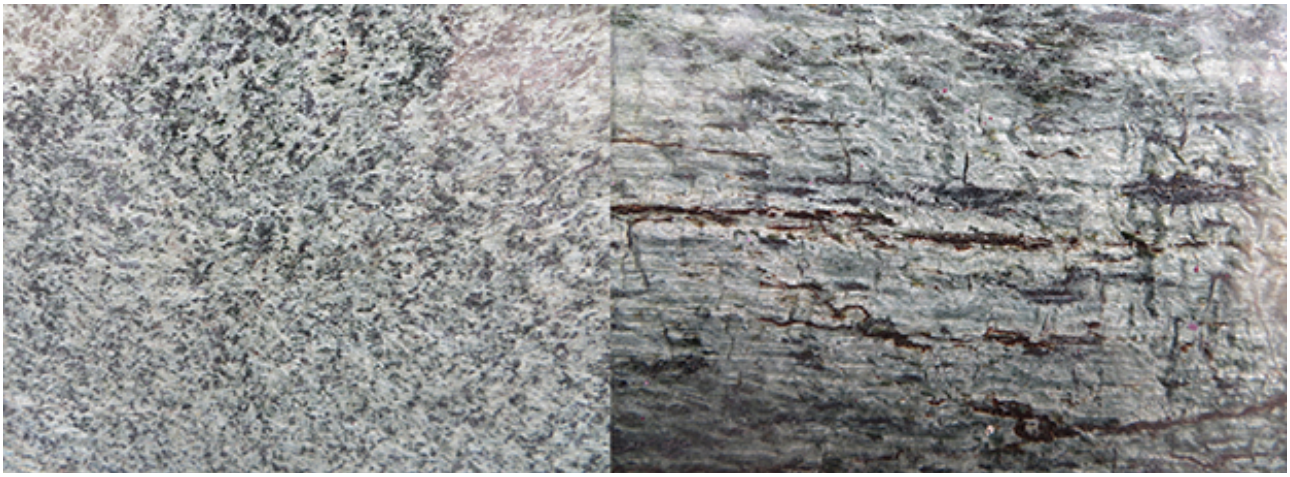
11 Westferry Circus morphs into another building at the west end of West India Avenue. The north east side of Westferry Circus is occupied by a large crescent of shops and offices designed by US Architects Skidmore, Owings & Merrill. The building comprises 1, 7 and 11, Westferry Circus. On the ground floor is a arcade, supported by square-section pillars. Of most interest is the spectacularly megacrystic **Giallo Veneziano** granite used on the Foundations of the pillars. This Brazilian stone from the Neoproterozoic Carlos Chagas Suite stone has been described for the rear of this building facing Columbus Courtyard, above. Nevertheless, the stone is polished on the sides of the pillars allowing good and photogenic surfaces, showing the feldspar megacrysts. The stone has been left rough (or quarry dressed) on the column plinths facing the Circus and these provide excellent examples to imagine how this stone would look in its natural exposure.

Thin strips of **Carrara Marble** are used to top the plinths and separate them from the upper parts of the building. This stone comes from the famous quarries in the Alpi Apuane of western Tuscany in Italy. They are Triassic-Jurassic limestones metamorphosed during the Alpine Orogeny. The stone above looks a bit grey and nondescript at first glance and could easily be passed over as concrete. However look carefully, preferably with a hand lens and it is packed with comminuted fossil fragments. Most distinctive are the net-like skeletons of bryozoa. It also contains brachiopod, crinoid fragments, forams and ooids. It is an Upper Carboniferous calcarenite from the state of Indiana in the USA and marketed as **Indiana Limestone**, this stone is as iconic to building in North America as Portland Stone is here in the UK. Extracted from the Salem Limestone Formation, a unit that strikes more or less north-south for around 100 km through Monroe and

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Lawrence Counties in southern Indiana. Many quarries are located around the towns of Bloomington and Bedford. The stone has been worked since the 1820s.

The foundations of the pillars between shop fronts are clad with a dark green stone with a beautiful silky lustre. A first glance this would appear to be a serpentinite, but mineralogically and texturally, it is not quite right. The sliky lustre is probably down to fine grained micas, phengite and the green fuchsite. The stone is also studded with tiny, bright pink garnets. The rock is strongly foliated and slabs are used here which are both parallel and perpendicular to the foliation, the latter having a blotchy appearance. The most likely candidate for the origin of this stone are the varieties from the Sesia-Lanzo Zone in the Italian Alps known as **Verde Aosta** and Verde Montey. They are from a unit called the Eclogitic Micaschist Complex and are rocks initially formed at high pressures which have undergone further metamorphism during tectonic emplacement (Sandrone et al., 2004). The image below shows this stone cut perpendicular to foliation (left) and parallel to foliation (right).



Cross over West India Avenue to 15, Westferry Circus.

15, Westferry Circus

Crossing over West India Avenue, 15, Westferry Circus stands opposite the Crescent. This building is by Terry Farrell & Partners and built between 1998 and 2001 for bankers Morgan Stanley Dean Witter. However it is now occupied by London Underground Ltd. It is clad in a spectacular coarse-grained granite with large, rose pink feldspar phenocrysts, these have irregular shapes and sometimes have a rim of white plagioclase around them. White plagioclase is also abundant in the groundmass along with grey quartz and biotite. The granite is also foliated. This stone is used on all three buildings occupied by the Morgan Stanley Group in the Canary Wharf development, as shall be seen below. The identification of this stone has been an enormous puzzle for me, but I have been recently found out that it is Finnish **Porkkala Granite**, thanks to information on stone contractors Loveld's website with reference to their work at 20 Bank Street (see below). It appears that there was a clear intention to adopt this stone as a livery for the bank's buildings.

Finland is famous for its rapakivi granites, and indeed the word 'rapakivi' means broken rock in Finnish, referring to the commonly encountered, rubbly weathered surfaces. The more famous 'Baltic' rapakivi granites come from the Finnish-Russian border and these are encountered in Cabot Square and will be described below. Porkkala comes from a small intrusion, the Obbnås Pluton, located on the Porkkala Peninsula around 30 km south-west of Helsinki on the Baltic Coast. Intruded around 1.6 Ga, the granite was deformed at the time it was intruded by movement on the Porkkala-Mäntsälä Fault, developing the foliation observed in the rocks seen here. (Heeremans & Wijbrans, 1999).

Continue back along the south side of West India Avenue to Cabot Square. The space between 15 Westferry Circus and 25 Cabot Square is currently a vacant building site.

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25, Cabot Square

25 Cabot Square constructed in 1991, is also by architects Skidmore, Owings & Merrill for Morgan Stanley, and it is also clad in **Porkkala Granite**, as described for 15 Westferry Circus above. This building has caused some controversy in the urban geology world as the Survey of London describes it as being clad 'in a mixture of natural and artificial stone and marble in brown and white' (Hobhouse, 1994b).



The pink Porkkala Granite dominates the exterior, but the interior of arcade at pavement level is clad with a white limestone. This has often been described as an artificial stone on previous stone tours of Cabot square and in fact the outside of the colonnade probably is artificial stone. Inside, the bush hammered surfaces which are mainly employed here do make it very difficult to determine the composition, but in a few corners, smooth, honed surfaces are visible. Here it can be seen to be a natural limestone. Look carefully and it is packed with large, fossil nummulites. The presence of stylolites and calcite veins also demonstrate that this is a natural material rather than a composite. Usually classed as microfossils, these nummulites, a variety of the single-celled organisms known as foraminifera are relatively huge, several centimetres in length. Their presence indicates an Eocene age for this stone, but unfortunately its provenance is unknown. Nummulitic limestones similar to this are quarried in several localities in the Mediterranean, primarily in Egypt and Turkey.

20, Cabot Square

Next door, across Cubitt Steps is 20 Cabot Square is by Kohn Pederson Fox and was completed in 1991. This building has a façade facing the Middle Dock and extends eastwards into 10, South Colonnade. The main doorway on Cabot Square is framed in a grey green granite and this is also used on the foundations of the colonnade. There are not many green granites in production and unfortunately this stone has not been named in the building descriptions. However it is texturally identical to **Silver Green Granite**, with medium-grained, green and brown feldspars, distinctive clots of biotite and relatively minor quartz. Miller Druck were the stone contractors for this building and although not identified on their website for this building, Silver Green Granite is in their portfolio of stones. It comes from a small quarry near Ranyah in Saudi Arabia, a country better known for the export of mineral wealth other than stone. It s extracted from tonalitic rocks belonging to the Kwar Barahah Pluton (see Fenton, 1983), a Proterozoic Pan-African granite.

The upper stories of this building are clad with white and grey banded marble. According to Hobhouse, 1994b, this is Vermont Marble. However the stone contractors Polycor have recently confirmed to me that they supplied the stone from their marble quarries in Georgia, USA.

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Turn back into the square, with its large, circular fountain.

Cabot Square

Part of the original designs for development by Skidmore, Owings & Merrill, the stone used in Cabot Place was supplied by Miller Druck Ltd and the square was laid out 1992. The pleasant public space that is Cabot Square has at its centre a circular fountain carved of a dark grey stone, its colour deepened by the cascading water. This is a granite called **Blaubrun**, literally 'blue-brown' referring the brown orthoclase feldspars and the distinctly blue quartz. Also present is biotite. Blaubrun is derived from several quarries in the Flivik and Hökhult Granites located on the Kalmar Coast of eastern Sweden (see Zandstra, 1988). The intrusions are named after the port village of Flivik which lies just across the fjord from the main quarries and the stone is transported by boat. The plutons belong to the suite of Småland Granitoids of the Transcandinavian Igneous Belt and were intruded 1.8 billion years ago. It is also marketed as 'Pearl Anglais'. The paving and street furniture in the square is a banded orthogneiss called **Rosa Torcicoda**. This is a salmon pink and grey, migmatite, incorporating pegmatites and the occasional large (5 cm diameter) feldspar augen. It has a granitic composition with pink and grey feldspar, quartz and biotite. This is one of several popular decorative stones quarried from the 2.7 Ga Campo Belo Metamorphic Complex. We have seen one of the gneisses from this region, Verde Maritaca in Columbus Courtyard, above. This gneiss-migmatite is from the Itapecerica Gneiss.



Indiana Limestone is used to clad the four box like buildings, two of which stand at the east end of the square and two at the west end. These house plant and stairs to the kitchens of restaurants in the case of the east side of the square. Good examples of the bryozoan-rich calcarenites are visible in these surfaces (left).

Turn now to Credit Suisse, located on the NW corner of the square.

1, Cabot Square

1 Cabot Square was opened in 1991 and at the time, with 21 stories, it was the second highest building in the Canary Wharf development. It was built for the Credit Suisse First Boston bank and designed by Pei, Cobb, Freed & Partners. It is clad with contrasting black and white stone, **Jet Mist** and **Jura Marble** (Hobhouse, 1994b). We have encountered the Kimmeridgian Jura Marble from the Frankonian Alb in Bavaria in Columbus Courtyard at number 11, Westferry Circus. The stone used here is a paler version of this stone and here it has a honed surface which shows off the fossil cephalopods very well. There are very good examples of ammonites and exceptionally well-preserved belemnites to be seen here. Look more closely, and many white flecks are just visible to the naked eye. These are the microfossils *Tubiphytes morronensis,* foraminifera with a white cyanobacteria crust (Keupp et al., 2007; Schmidt et al., 2005). Siliceous sponges are also common and indeed the Treuchtlingen Formation built up around sponge bioherms.

The black stone is called Jet Mist and is a dolerite from the USA. Quarried from the Rapidan Diabase Sheet, this is an igneous intrusion extending some 50 km between the towns of Rapidan and Culpeper in the state of Virginia. It is an orthopyroxene-rich dolerite (diabase in the USA), streaked with more felsic plagioclase-rich gabbros and anorthosites (Tollo et al., 1987). This stone is also used for paving inside the arcade and around the building.

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Above; ammonite and belemnite in Jura Marble, 1. Cabot Place.

Wren Landing

Wren Landing is situated on the north side of Cabot Square, overlooking West India Dock. Street furniture here is clad in a red rapakivi granite. Rapakivi-textured granites were largely intruded during an anorogenic setting (i.e. not associated with a mountain belt) around 1.0 – 1.8 Ga. Intrusive suites of these rocks are known from the Baltic region and in parts of North America.



Classic rapakivi granites are the variety known as wiborgites (after the Viborg Batholith on the Baltic coast at the Finnish-Russian border). They characteristically have round, K-feldspar megacrysts with a rim of plagioclase. These textures are known as 'ovoids' (above). This distinctive texture is instantly recognisable in building stones, many of which are indeed derived from the Finnish portion of the Viborg Batholith, as is the case here. This red granite is known as **Baltic Red** (or Carmen Red). The K-feldspars are red and the plagioclase rims, when present are dark green. Also present is almost black quartz (morion), hornblende and biotite (below). The Viborg batholith as intruded between 1.6-1.5 Ga. The main quarrying areas are located around Lappeenranta and Lovisa in SE Finland.

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10, Cabot Square & 5, North Colonnade

On the NE corner of Cabot Square is 10, Cabot Square which extends into 5, North Colonnade. Completed in 1991, it is also by Skidmore, Owings & Merrill. The upper stories, with decorative details are cast from reconstituted stone, essentially a concrete. The foundations are another variety of Finnish wiborgite from Lappeenranta, the more commonly encountered **Baltic Brown**. This has pale brown ovoids of K-feldspar rimmed with green plagioclase. Walking down to 5, North Colonnade, there is a slab containing a mafic enclave which also has a perfect ovoid inside it. Such textures are good evidence for demonstrating that the ovoids are not primary crystallisation textures (below).



Continue along the North Colonnade to the entrance to Cabot Place shopping mall and DLR Station.

Cabot Place Exterior

Cabot Place Mall houses shops, restaurants and the Docklands Light Railway Canary Wharf Station. The block is porous with the 1 Canada Square complex and designed by Argentinian architect, Cesar Pelli. ASFA Ltd were responsible for designing the station complex. The Survey of London has been particularly helpful in identifying the stones, stating '*The building is clad in Indian red sandstone, Briar Hill sandstone from Ohio, and greenstone from the Lake District*' (Hobhouse, 1994b). 'Greenstone' from the Lake District is a familiar stone in British Building, but Briar Hill and Agra are certainly exotic.

The entrances on the North Colonnade and their mirror images on the South Colonnade are clad with **Lake District Green Slate**. These are Ordovician volcanic sediments, ash falls and other pyroclastic deposits that have been reworked in a crater lake environment. They are from the Seathwaite Fell Formation of the Borrowdale Volcanic Group. The tuffs were transformed into slates during the Acadian phase of the Caledonian Orogeny during the Silurian. They have been worked from several quarries along outcrop, notably around Ambleside and Coniston in the southern Lake District. On the North Colonnade entrance, good examples of these slates are seen. On the right of the portico, the brass name plaque is mounted on quarry-matched slabs showing beautifully rippled and laminated bedding. On the soffits on the left hand side, facing the entrance, a slab with fine-grained rip-up clasts at the interface between fine- and coarse-grained sediments. The main building has a slightly 1930s feel about it, especially in the detailing of the upper stories. The ground floor is clad with **Briar Hill Sandstone** with contrasting stripes of **Agra Red Sandstone**. Briar Hill Stone is a so-called picture sandstone with liesegang banding forming concentrations of iron due to fluid flow through the stone. It is a quartz-rich sandstone, an arenite, with a silica and

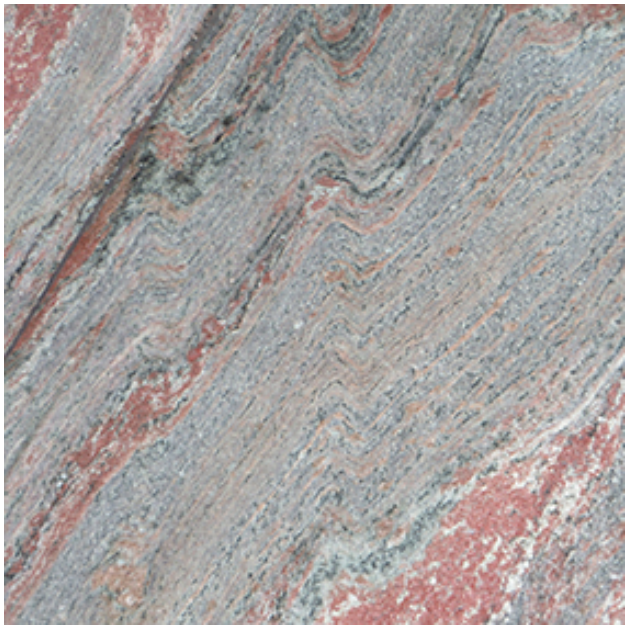
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hematite cement. It is quarried from the Upper Carboniferous Masillon Formation in Coshocton and Knox Counties in Ohio.

Agra Red Sandstone is one of the World's most famous stones, known for the Red Forts of Delhi and Jaipur, which have in turn given the name to a thousand India restaurants in the UK. Much of the stone is quarried in Rajasthan but it is also worked from Madhya Pradesh. Geologically this sandstone comes from a unit called the Upper Bhander Sandstone Formation which is of Late Precambrian age. It is composed of rounded quartz and sparse feldspar grains, coated in red iron oxides and cemented by silica and iron oxide. It is a dense and hardwearing building stone which has been quarried since at least Medieval times. There are over 14, 000 quarries for this stone within this unit which outcrops over a huge area of the Neoproterozoic Vindhyan Basin in northern India (See Banerjee & Banerjee, 2010).

On the opposite side of the road is the Financial Conduct Authority at 25 North Colonnade.

25, North Colonnade



Housing the Financial Conduct Authority (a handy cautionary establishment on this dock full of bankers), 25, North Colonnade was completed in 1998 by Troughton McAslan in collaboration with Adamson Associates. The first thing that meets our by now trained urban geologist's eye are the decorative slabs on the right hand side of the steps. This is a grey and pink banded orthogneiss which also contains pink and white, coarse-grained veins which look rather like rashers of streaky bacon. These are granitic in composition. The rock has undergone shear deformation and this has brought the banding and pegmatites roughly in line which each other and also formed the fold structures which are clear on the left side of these slabs. The origin of this rock is not known, but it is almost certainly from Brazil where the word '**Juparana'** was coined to describe such rocks. This is not a word to be found in the Oxford English Dictionary but it is applied generically to decorative stones quarried from banded orthogneiss of amphibolite facies, as seen here. The original Juparana Classico was quarried from the shores of Lake Juparana in Brazil, but the name has now been applied to similar rocks from Brazil, India and China.

The slabs are surrounded by a low wall which is composed of the same material as the steps. This is a charnockite, similar in composition to the Verde Ubatuba seen at 11, Westferry Circus above, but somewhat less coarse grained. The pale blue green blotchy crystals are the feldspar microcline, whereas the darker matrix is rich in biotite, hornblende and quartz. This is probably the South African charnockite Verde Fonteine from Bitterfontein in Namaqaland (Cairncross, 2004).

Moving up to the main building, the cladding on the porch soffits, and also used as bands around the upper stories, is a grey, uniform, medium grained granite. It is described as Canadian Granite in Hobhouse (1994b). However the uniform igneous texture, with no evidence of metamorphism suggests that this is one of the Appalachian granites from the east coast. It is in fact **Stanstead Granite**, which is only just Canadian, being quarried a kilometre or so north of the US border from the Devonian-aged Averill Pluton (see Nasseri et al., 2010).

Continue along the north side of the road to the courtyard in front of 30, North Colonnade.

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30, North Colonnade

A narrow plaza with steel sculptures resembling palm trees is sited in front of the entrance to 30, North Colonnade. It is paved with tiles and setts of a beautiful garnet orthogneiss. In addition to garnet it has yellowish to slightly pink feldspars, quartz and a foliation defined by biotite. This stone comes from the same suite of Brazilian granites as the Giallo Veneziano described in Westferry Circus and Columbus Courtyard, above. This is the Carlos Chagas Suite which underwent five phases of intrusion (Pedroso-Soares et al., 2011). This foliated variety comes from the second episode of plutonism and the granites were subsequently deformed. The garnets here are spectacular, blood red, subhedral, round porphyroblasts averaging a centimetre in diameter (below). This stone is marketed as **Giallo Santa Cecilia**.





Retrace you steps to enter Cabot Place Mall via the entrance opposite 25 North Colonnade.

Cabot Place Mall Interior

The grey and pink, variegated limestone used on the floor of the mall is an Italian limestone called **Fior de Pesco Carnico**. Cesar Pelli, the architect of 1, Canada Square and Cabot Place, has used Fior de Pesco Carnico in several of his projects. The stone is quarried and supplied by Margraf (Industria Marmi Vicenti) which was established in 1906, and the firm list its use in the Canary Wharf development on their website. The stone is extracted in the Carnic Alps, very close to the Austrian border from Pierabach Quarry in Udine. It is a Devonian brecciated limestone.

Decorative dressings are in the red marble **Aegean Bordeaux** and black limestone **Nero Marquina**. Aegean Bordeaux (also known as Rosso Laguna) is from Mugla in Turkey. The red marbles occur as lenses in the Cretaceous-Palaeogene Kizilagaç Formation (Özer et al., 2001). The strong red colouration is imparted by hematite. Nero Marquina is a Spanish limestone from the Basque region. It is of middle Cretaceous age and contains fossils of rudists which are typical of these so-called Urigonian limestones. The fossils and cross-cutting calcite veins are white, but the stone has become very popular due to the jet-black limestone matrix and the fact that it takes a very high polish (see Perrier, 1992).

Passing out of the mall on the south side, we find ourselves on the South Colonnade. Opposite is the marble-clad Thomson Reuters building.

10 & 30, South Colonnade

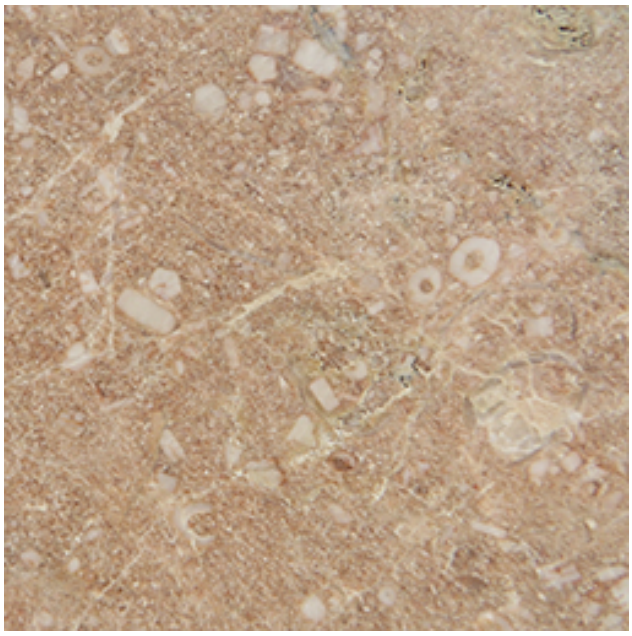
The Thomson Reuters building at 30 South Colonnade, with its curved façade and digital strip showing rolling stocks and shares news is perhaps the most iconic building on Canary Wharf after the Tower. Both this and 10, South Colonnade are clad in **Georgia Marble** as described for the adjacent 20, Cabot Square above. And like this building they are designed by Kohn Pedersen Fox.

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Continue to the plaza opposite the Canary Wharf Tower and next to 30 South Colonnade.

Reuter's Place

This plaza, leading down from 1, Canada Square towards the Jubilee Line Underground Station sits between the Thomson Reuters building and the Citigroup Tower. This is hard landscaped area which during the summer serves as outdoor seating spaces for the bars and restaurants housed in the podiums of the surrounding buildings. The stairs and confining walls for these, as well as the cladding on the front of the restaurants on the east side is of a pale brown-pink limestone. Look closely and it is packed with fossil shell fragments, predominantly crinoids, This is a calcarenite, a sandstone composed of entirely carbonate material (left). Unfortunately I have not been able to locate the provenance of this stone. A possible candidate may be the Jurassic **Crinoidal Calcarenites** worked from the Bavarian Calcareous Alps in the vicinity of Mittenwald.

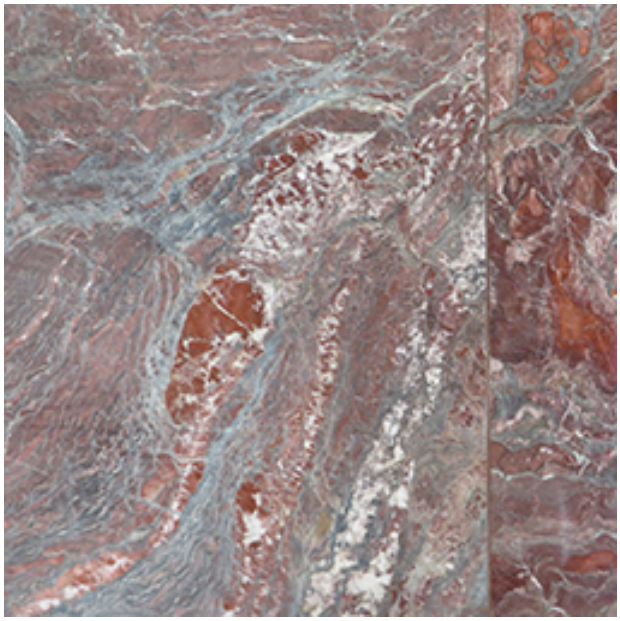


On the west side of the square, street furniture and planters are clad with **Dakota Mahogany** granite. This is probably the most exported and well-known North American stone; it has been used on a number of buildings in the City of London as well as here in Canary Wharf. This is a coarse-grained, charnockitic granite, composed of pink-brown K-feldspar perthite, bluish quartz, brown biotite and hornblende. This is an ancient stone, 2.7 Ga, quarried from inliers of the Canadian Shield exposed near the town of Milbank in the state of South Dakota.

Turn back to enter Canary Wharf Tower, 1 Canada Square at the main entrance, facing Reuter's Plaza.

1, Canada Square

Walking into the ground floor of the Canary Wharf Tower, more properly known as 1, Canada Square, is quite an experience. This most famous building in the development, which has become a recognisable addition to the London skyline was designed by Cesar Pelli & Associates. Until The Shard was built, it was the tallest building in London, with 50 stories topping out at 235 m. The exterior is clad in steel. But no expense was spared in the interior either. It is widely quoted that the 11 m high lobby is clad in marbles imported from 'Italy, Guatemala and Turkey' (Hobhouse, 1994b).



Most striking is the dark red marble cladding the central lift cores. The is **Rosso Rubino** (right) from Stazzema near Carrara in Italy. This is a banded and contorted cherty limestone which Eric Robinson most fittingly called 'sclerosis of the liver' stone.

Turning to the other walls, they are clad with several green stones. Starting first with the stair walls in three corners of the building a jade-coloured stone is used which is the serpentinite **Verde Guatemala**. If this is real Verde Guatemala then this is a truly valuable and rarely seen stone. Another stone which is almost

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identical in appearance is quarried in India and also (completely legally) marketed as Verde Guatemala. And indeed, Hobhouse states that Guatemalan stone is used in the lobby. Genuine Verde Guatemala is a serpentinite composed of almost pure antigorite and it is this mineral which gives it the blueish-green jade-like appearance. It is quarried from Upper Cretaceous ophiolites of the El Tambor Group in the Sierra de las Minas (Harlow et al., 2004). The west wall and the restaurant complex in the NW corner are clad in more normal serpentinites, this time from Italy. Two varieties are seen here: **Verde Chiesa** on the restaurant and the brecciated **Verde Issorie** on the other walls. Both of these stones are from the Val d'Aosta region of the Italian Alps. These remnants of serpentinites, once ancient ocean floor, that were uplifted and emplaced during the Cretaceous.



Verde Guatemala at 1, Canada Square

Fior de Pesco Carnico and **Nero Marquina** occur once again as paving here, following the theme used in the Cabot Place shopping mall. Nero Marquina is also used for the black bands in the Rosso Rubino walls. Similarly Rosso Rubino is used in the mall in the basement of 1, Canada Square.

Leave the tower by the main entrance on the ground floor level and turn left towards Canada Place, opposite 16-19 Canada Square.

Canada Place

Canada Place lies directly to the east of 1, Canada Square. This area was designed and landscaped by Olin & Partners in collaboration with Koetter Kim & Associates. The Big Blue, a huge sculptural bowl is by artist Ron Arad. Koetter Kim & Associates were responsible for providing the paving at the west end of the square. Here again we have a selection of decorative granites. The main area is paved with a very similar, if not identical, stone to the **Santa Cecilia** seen at 30, North Colonnade (above). It is somewhat more foliated, having a strong gneissic texture and also contains conspicuous, large, red garnets.

Also used here is a grey, slightly porphyritic granite from Sardinia called **Grigio Sardo** and the dark brown stone is **Indian Tan Brown** a Precambrian charnockite from Andhra Pradesh.

Cross the road at the east end of Canada Square to the building housing the Waitrose supermarket.

16-19 Canada Square

This building houses a branch of Waitrose and a gym. At first glance, the façade facing Canada Square is all glass and steel, but look through this and the foyer is clad and paved with decorative stones, supplied by Priest Stonework & Restoration. The building was completed in 2002 and is by architects Chapman Taylor. The walls are clad with a beautiful golden and pink sandstone. This colour pattern has given this stone the trade names of '**Golden Dawn**' and 'Golden Sunrise' (amongst many other names). It comes from just west

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of the town of Naboomspruitt (Mookgophong), in the Limpopo district of South Africa. The stone is a fine to very fine grained sandstone, varying in colour from pink through yellow to cream. A range of sedimentary structures are present including laminations, cross-bedding, trough cross-bedding, ripples, and massive units, and these are variably picked out by liesegang banding. It was deposited in an arid, desert environment, although some sections show evidence of aqueous reworking. The sandstone has been assigned to the Clarens Formation (Cairncross, 2004; Bordy & Catuneanu, 2002). This lies just below the Karoo Basalts which were erupted directly on top of the Clarens Formation dunes, metamorphosing them and injecting fluids, which are in turn probably responsible for the colouration and also the liesegang banding.

On the floor is a medium, grained, greenish-coloured, well foliated stone. This is **Pietra di Luserna**, a famous stone from the Pellice Valley in the Dora-Maira Massif of the Italian Cottian Alps (see Sandrone et al., 2004). This is a mylonitic gneiss, which was once a Permian (late Variscan) leucogranite deformed and metamorphosed during the Alpine Orogeny (Late Cretaceous). It contains K-feldspar, quartz, albite, phengite, biotite, chlorite and epidote group minerals. The green colour is imparted by the green phengite mica and chlorite. The 'micro-augen' are of K-feldspar.

Leave the building and turn right into North Colonnade and continue until you reach Churchill Place.

1, Churchill Place

The 32 storey skyscraper at 1, Churchill Place is owned by Barclay's Bank, designed by British architects Pringle Brandon and completed in 2005. The stone used on the vertical fins on either side of the huge doorway is **Nero Impala** (also know as Rustenburg Gabbro), a 2 billion year old gabbro from South Africa. It is composed of plagioclase and orthopyroxene. The plagioclase forms grey crystals around the size of grains of rice. Viewed up close, the stone has the classic gabbroic 'salt and pepper' appearance (below), but overall it appears black.



The paving in front of the building on Churchill Square is black **Nero Zimbabwe** and pink **Rosso Porriño**, supplied by Priest's. We have already seen these stones in Columbus Courtyard and they are used ubiquitously for paving and kerbs throughout the development.

5, Churchill Place

This building was completed in 2009 for US bank Bears Sterns. Designed by HOK Architects, the building was inspired by the curved forms of mid-Century Finnish designer Arvo Aalto (Marchant, 2007). The façade of the building has vertical fins clad in a pale-coloured metamorphic rock. This is a migmatite, a partially molten granitic gneiss, studded with small, red garnets. 'Schollen', blocks of more biotite-rich gneiss, float in the more leucocratic matrix. Stones of this type are marketed under the name of **Kashmir**, and the original stone to take this name comes from India, but from the state of Tamil Nadu and not Kashmir. They

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are derived from the Proterozoic Southern Granulite terrane. Similar stones are also quarried in Brazil (Kashmir Bahia and Kashmir Nuovo), but the stone used here strongly resembles the Indian variety (see Price 2007).

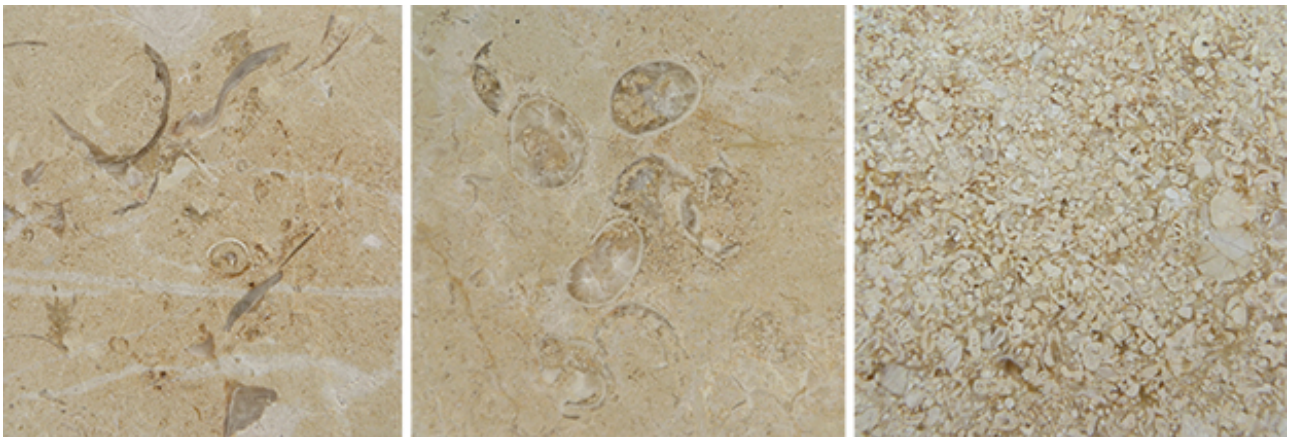
30, Churchill Place

On the south side of the square is 30, Churchill Place, by architects Kohn Pederson Fox Associates is clad in stainless steel. However the portico at podium level is supported by columns clad in a cream-coloured oolitic to peloidal limestone. This stone is also rich in fine, grey fossil fragments and shows marked cross-bedding, with variation in grain size between these. This is one of the Portuguese middle Jurassic limestones from the Lusitanian Basin. This variety is called **Moca Crème** and it is quarried from many quarries located around Santarem, around 50 km north west of Lisbon (Figueiredo et al., 2010). The Brazilian garnet-bearing granite **Giallo San Francisco** is used for paving in the portico. This is yet another variety of stone from the Carlos Chagas Suite in Espirito Santo Brazil. This is a very similar stone to Giallo Veneziano with yellow feldspar megacrysts, garnets and streaked with biotite.

2, Churchill Place

Giallo Veneziano is also used for paving and the foundations at the Rocket restaurant opposite 30, Churchill Place which occupies the southern half of a semi circular building which is number 2, Churchill Place. This building is also occupied by a branch of Barclay's Bank and Jamie's restaurant on the north side.

The building along with other structures in Churchill Place is clad with **Cenia Limestone** which comes from quarries in the vicinity of Tarragona in south east Spain. These beautiful limestones are extracted from the middle Cretaceous Benassal Formation. They were deposited in a shallow marine environment and they are packed with fossils. These include areas packed with the spiralling rudist *Toucasia* sp., nerineid gastropods, ammonites, echinoids and many other varieties of shells (below). The stone is a golden colour. The stone used here was supplied by the Spanish quarry firm Marmoles Tarragona.



Cenia Limestone. Left; Toucasia fragments. Middle; echinoids (?) & Right; peloidal matrix.

The stones used at 2, Churchill Place were identified from the documents held at the London Borough of Tower Hamlet's planning offices.

Follow the road back along South Colonade and turn left onto Upper Bank Street. Opposite is 25 Canada Square.

25, Canada Square

25 Canada Square, housing Citibank, amongst others, was constructed in 2002 and designed by architects Adamson Associates. The exterior is steel and glass, but the podium level's windows allow a good view into the interior. The walls of the foyer are coated with a Mesozoic dolomite from the Lebanon called **Monte Carlo**, whilst the impressive floor is tiled with a serpentinite from the Greek island of Tinos called **Verde Tinos** contrasted with strips of **Nero Zimbabwe**.

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Next door is Jubilee Park which houses the entrance to the underground station.

Jubilee Park
Jubilee Park (below) is a pleasant green space surrounding the main entrance to Canary Wharf underground station. It has been landscaped with lawns, walls and water features by Wirtz International N.V. in collaboration with Willerby Landscapes Ltd. The dry-stone effect walling is constructed from blocks of **Vinalmont Blue Limestone**. This is an blue-grey oolitic limestone from the Lower Carboniferous Calcaire de Meuse-Vinalmont quarried in Vinalmont Quarry near the village of Aywaille in the Liège province of Belgium. The ooids are visible to the naked eye and the stone contains white fossil fragments of brachiopods and crinoids.



Leave Jubilee Park at the southern exit onto Bank Street.

40 & 50 Bank Street
Numbers 40 and 50 Bank Street were both designed by Cesar Pelli & Associates and completed in 2002. The tower of 40 Bank Street has 32 stories, while its smaller brother next door has a mere 11. Both are clad with the same stones. The cream coloured facades are another one of the Brazilian 'giallos', garnet-bearing granitoids from the Neoproterozoic Carlos Chagas Suite of Espirito Santo state. This is a coarse grained, weakly foliated granite with large, yellowish feldspars, quartz, biotite and garnets which can be up to 1 cm in diameter. Such stones are marketed under a variety of names including **Giallo Imperiale**. The foundations of both buildings are of the green migmatite **Verde Maritaca**, quarried from the Campo Belo Metamorphic Complex in Minas Gerais, Brazil. This stone has been seen already at 17, Columbus Place, described previously.

20 Bank Street
A pink granite-clad building, with a cage-like framework stands at the end of Bank Street. We are beginning to see a pattern developing in the choice of stone used to clad buildings either currently or previously owned by Morgan Stanley's. Once again, here is the pink, coarse grained **Porkkala Granite** with pink feldspars that was used at 15, Westferry Circus and 25, Cabot Square. 20, Bank Street was designed by architects Skidmore, Owings & Merrill and completed in 2003. The stone contractors were Loveld, and I am grateful for them for naming the stone used in this construction. It is a sheared pink and white wiborgite variety of rapakivi granite.

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Porkkala Granite at 20, Bank Street.

The Mall beneath Jubilee Park and Bank Street is definitely worth a quick visit, if only to have a sit down and a cup of tea. The stones here are particularly impressive too.

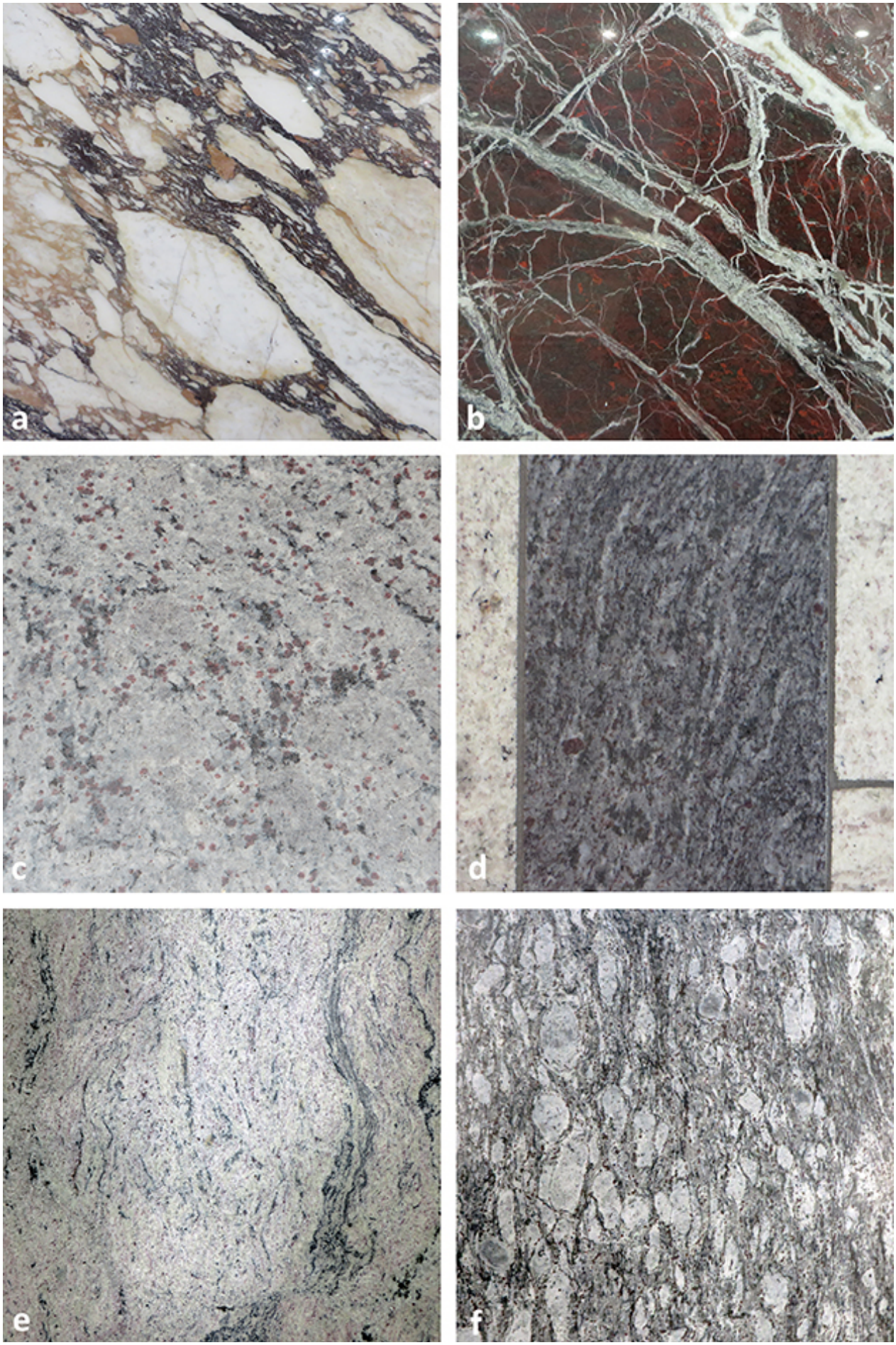
Jubilee Place Mall

Jubilee Place Mall can be entered from a number of the surrounding buildings and via Canary Wharf tube station, opposite 50 Bank Street and via Heron Quays DLR station. The walls are clad with a spectacular marble breccia, with white angular clasts in a red-brown matrix is from Carrara in Italy. It is the variety marketed as **Calacatta Viola** (amongst other names) and it is quarried from a unit known generically as the 'metabreccias' which were originally deposited in the Late Triassic. These are mainly quarried in the area around Serravezza on Mount Corchia (Carmignani et al., 2005). The Carrara marbles were metamorphosed and deformed at greenschist facies during the Alpine Orogeny in the Oligocene-Miocene. The aspect of these marbles that we see on the slabs is the most decorative. If they had been cut at right angles to these faces, one would be able to see that the clasts are extremely elongated and the stone would appear to have a texture of parallel stripes.

Dressings, lift lobbies and the entrance from Heron Quays station are clad in the red, Turkish serpentinite **Rosso Levanto Turco**. It is an Upper Cretaceous serpentinite, which was emplaced during the Alpine mountain building episode. It comes from the Maden Ophiolite Complex (see Aktas & Robertson, 1984). The red colouration indicates that this rock has been oxidised and so it must have been exposed on the seafloor before deformation. It comes from the province of Elazig and is called Elazig Cherry in Turkish.

The paving of the mall floors feature beautiful stones periodically set with lovely mosaics by Emma Biggs depicting the goods which were once imported into the docklands. The mosaics are made with tesserae of coloured stones as well as glass and ceramics. The dramatic stones used on the floor are all high-grade metamorphic rocks derived from India. The pale grey stone which is used most abundantly is the garnet-bearing migmatite **Kashmir** from the southern state of Tamil Nadu which is also used on the exterior of 5, Churchill Place. The orthogneisses used in panels around the mosaics are from stones quarried from the Eastern Ghats Supergroup in north east India, from the states of Andhra Pradesh and Orissa (Odisha). These are granulite facies metamorphic rocks, rich in garnets formed during the Archaean, part of what is now known as the East Indian Craton. They are metamorphosed granitic rocks and contain large grey-blue feldspar megacrysts. Slabs of **Orissa Blue**, quarried near Brahmapur in Orissa form the main frames of the mosaics. This stone has foliated, blotchy feldspar megacrysts in a matrix rich in garnets. The Orissa Blue frames are set with panels of a stunning **Augen Gneiss** with large, aligned, euhedral tabular feldspars around 10 cm long. Again this is a garnet bearing rock. Unfortunately I do not know the origin of this stone, but it is likely to be from a similar formation in the Indian cratons. Thin strips of a well foliated gneiss, without feldspar megacrysts is either **Vizag Blue** from Andhra Pradesh or the similar and geologically related Lavender Blue, also from Brahmapur in Orissa.

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Previous page: Stones used on the floor of Jubilee Place Mall; a. Calacatta Viola; b. Rosso Levanto Turco; c. Orissa Blue; d. Vizag Blue; e. Kashmir; f. Augen Gneiss.

This is the final stop on this walk. DLR trains can be caught from Heron Quays, which can be accessed from the west end of the shopping mall or alternatively return to Canary Wharf underground station, where this walk ends.

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Rosa Torcicoda – Cabot Square.

Rosso Levanto Turco – Jubilee Place Mall.

Rosso Porriño – paving and kerbs throughout the Canary Wharf development.

Rosso Rubino – 1, Canada Square interior.

Silver Green Granite – 20, Cabot Square.

Stanstead Granite – 25, North Colonnade.

Verde Chiesa – 1, Canada Square restaurant.

Verde Fonteine – 25, North Colonnade, steps.

Verde Guatemala – 1, Canada Square interior.

Verde Issorie – 1, Canada Square interior.

Verde Maritaca – 17, Columbus Courtyard, 40 & 50 Bank Street.

Verde Tinos – 25, Canada Square interior.

Verde Ubatuba – 11, Westferry Circus.

Vermont Marble – 20 Cabot Square, 10 & 30 South Colonnade.

Vinalmont Blue Limestone – walls and water features in Jubilee Park.

Vizag Blue – Jubilee Place Mall



Paving in Canada Place

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