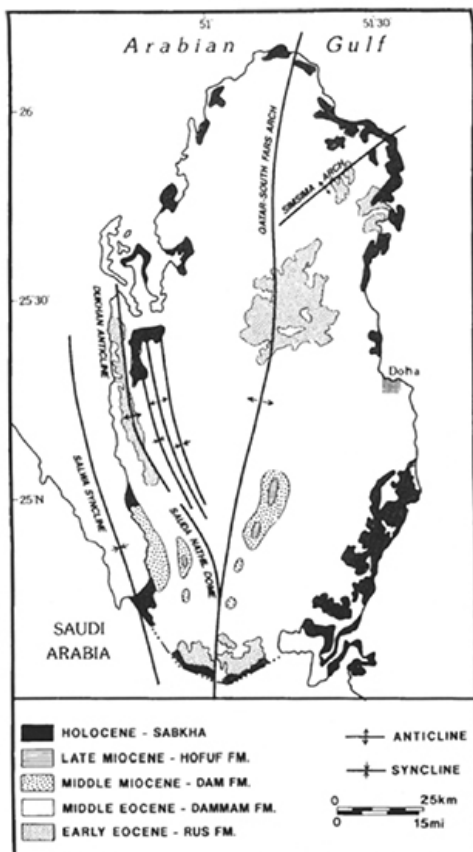


## Stone for Universities and Museums: Some aspects of Urban Geology in Doha, Qatar

Ruth Siddall

The capital of Qatar, Doha, has grown like Topsy over the last five decades, from a tiny trading post located where a creek entered a natural harbour to the huge sprawl of this modern city. Doha has all the trappings of the Gulf states of the Middle East; skyscrapers, extravagant shopping malls and even more extravagant hotels but there has also been major investment here in education and culture. This has resulted in the worlds top architects and designers being invited to design new buildings for universities and museums, with no expense spared.

Qatar's geological legacy is oil and gas and not building stones. The peninsula lies above sea-level due to the Qatar-South Fars Arch, a north-south trending, broad anticlinal structure. The hydrocarbon deposits are hosted in the subsurface Mesozoic strata, mainly within the Jurassic Arab Formation and the overlying Cretaceous Shuaiba Formation, with major oil and gas plays in Dukhan on the west of the peninsula and in offshore fields to the west. The onshore, surface geology of the peninsula is dominated by Eocene to Pliocene strata, divided into the Rus, Damman, Dam and Hofuf Formations. The Rus Formation is dominated by chalks and gypsum and the overlying Damman Formation is predominantly dolomites and marls. These two formations occupy 80% of the exposed land surface. The Dam and Hofuf Formations are exposed in structural highs in the south of the peninsula. The Dam Formation largely comprises evaporites and the Hofuf Formation are clays and sandstones (Al-Saad, 2003 and 2005).



The geological map of Qatar (left) is from Al-Saad (2015).

Holocene deposits are represented by coastal sabkhas (salt-rich coastal zones), shell coquinas ('sabban'), dune fields to the south near the border with Saudi Arabia (Mohammed & Al-Khayat, 1994; Al-Thani, 2012) and also caliches (duricrusts) cemented by groundwaters. These 'desert stones' locally called *faroosh* (Jodidio & Halbe, 2014) were used for vernacular building. Gypsum from the Rus Formation, sabban and clays have also been exploited in the past as traditional building materials. The Origins of Doha Project has studied the still remaining traditional buildings, construction techniques and materials used in Doha and is recording the few old houses and other buildings that remain<sup>1</sup>.

Stone to build modern Doha has been imported from all over the World. This short guide to the urban geology of this city just scratches the surface. There is a lot more to be seen in the high-end hotels and shopping malls of West Bay and The Pearl, and on-going construction will expand the range of materials used. Nevertheless I hope that this guide will prove to be of use to staff and students working in Education City and tourists with a one day stop-over who wish to explore Msheireb, Souk Waqif and the Museum of Islamic Art.

Unless otherwise cited, the architectural information given here is derived from Jodidio & Halbe (2014). The geological observations are largely my own and I accept all responsibility for any errors herein.

<sup>1</sup> The Origins of Doha Project blog <https://originsofdoha.wordpress.com/about/>

### **Education City**

Education City lies approximately 5 km west of central Doha along the Al Luqta Street artery. The region is occupied by a number of international campuses and the buildings of Hamid Bin Khalifa University (HBKU) as well as the Mathaf art gallery, hospitals, parks, student and staff accommodation and sporting facilities. There is also a spectacular mosque designed by Mangera Yvars Architects (2017), with sweeping minarets pointing towards Mecca.

Many of the current buildings have been designed by the Mexican-based architectural firm Legorreta + Legorreta. As a consequence, there is a strong architectural theme running through the campus buildings, both in terms of design and materials used. The Turkish firm Haz Marble have supplied much of the stone for building projects described here in Education City. However, although a number of these stones have been derived from Turkey, Haz are also suppliers of stone from around the world.

### **Georgetown University and UCL-Q**

UCL's Campus is situated in the building belonging to Georgetown University. It is one of several buildings on the campus designed by Mexican architectural firm Legorreta + Legorreta and was completed in 2010. The design team were influenced by the architecture of Mexico, similarly a hot climate, but focussed on a style that would equally feel at home in the desert environment of the Gulf. Double walls with screens protect windows and a series of courtyards and communal spaces gives an airy feel to the building.



*Georgetown University*

The sandstones cladding the exterior of the building come from India. They are derived from 4 km thick deposits of continental sediments in the Vindhyan Basin which dominates of the geology of the state of Rajasthan. Indeed, many of the great buildings of this region of India are built from these sandstones, including the Red Forts of Delhi and Agra. Both the buff-coloured and the red sandstone used here are

derived from the Upper Bhandar Sandstone Formation. These sandstones are ancient rocks, around one billion years old (1 Ga). However, due to the absence of fossils (there was no life on land at this time), they have proved very difficult to date. They are also lucky to have suffered neither deformation nor metamorphism and look almost as fresh as did on the day they were deposited by huge river systems.

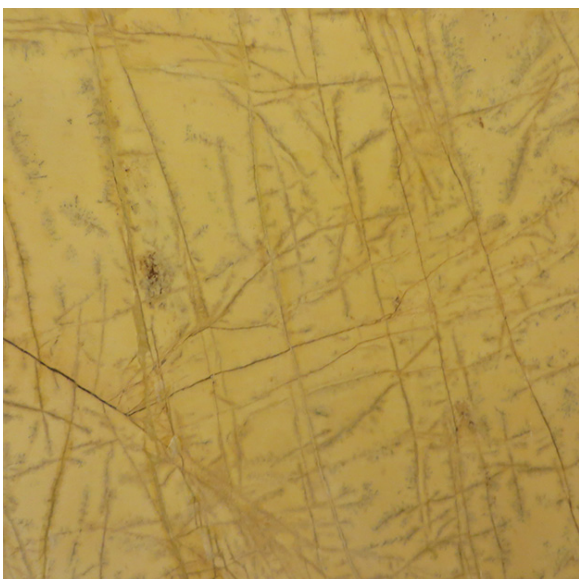
The Vindhyan sandstone deposits are vast. There are over 14,000 quarries in the Bhandar Group, and the stone is quarried over an area of 34,000 Km<sup>2</sup>. These Rajasthan sandstones have high acid and thermal resistance properties and so work well in seashore and warm climate environments such as those encountered in the Gulf.

The red sandstone is called **Agra Red**. It is an homogenous, red, medium-grained sandstone, technically an arenite-sublitharenite. Rounded quartz and minor feldspar grains are coated with a thin coating of the iron oxide, hematite and hematite and silica cement the sand grains together. A few lithoclasts (rip-up clasts) may also be present, and this indicates the fluvial origin of these stones (Banerjee & Banerjee, 2010). Looking closely, the stone is speckled with pale, grey-green reduction spots, many just a couple of millimetres diameter. Agra Red is quarried around the towns of Barauli and Karauli in East Rajasthan.

The buff-coloured sandstone is very similar to the red in terms of its composition, textures and environment of deposition, but simply contains much less iron. It is quarried at Dholpur, near Agra and is marketed as **Dholpur Beige Sandstone**.

Interesting stones are also used in the interior of the building. Look down! The floors are paved with a grey-green stone from Turkey called **Seagrass Limestone** (also marketed as Rustic Green). This stone is also used polished for furniture and counters in the refectory and communal areas of the building. It is a beautiful stone and there is much here to interest to palaeontologists; it is packed with fossils which are predominantly the remains of plankton known as foraminifera (usually shortened to 'forams'). These are the variety known as nummulites. Forams are usually regarded as microfossils, meaning they are not discernible to the naked eye, but the forams in this stone are monsters of the foram world. Here the nummulite *Assilina exponens* is up to 3 cm diameter. They are often seen in section, but these organisms had shells formed of coin-shaped discs. Kocyigit (1987) also records the species *Nummulites uroniensis* as well as *Alveolina* sp., *Orbitolites* sp., *Cuvillerina* sp. However what makes this stone special for me are the abundant (true) macrofossils. These show up white against the rest of the stone and are the remains of a number of species of echinoids – sea urchins. Sea urchins shells are pure calcite, and this enables them preserve exceptionally well as fossils. Fragments of shell or 'test' are common, showing the pores through which the creature's tube-feet protrude are common as are sections through whole shells. Less common but worth looking out for are fragments with the 'Aristotle's Lantern' preserved. This is a part of the shell housing the urchin's mouth, anus and other muscles, and appears flower-shaped in sections.

Geologically, Seagrass is a calc-turbidite, essentially a deposit left by a turbulent undersea current, perhaps triggered by a storm or an earthquake, that has swept shell debris along and redeposited it. The forams have secured a Lower Lutetian, Eocene date (around 47 Ma) for this unit of strata, which is called the Bulak Member of the Karabük Group. It is quarried in the vicinity of Safranbolu in north-central Turkey.



Even the toilets are worth a geological excursion. I cannot speak for the Gents, but the Ladies are clad with and basins made from a beautiful yellow limestone called **Amarillo Triana** (left, field of view 10 cm). This is from Andalucia in Spain and geologically comes from a Triassic-aged unit called the Macael Marble. It is a fine-grained, bright yellow dolomite, with a network of fine fractures developing delicate, black manganese oxide dendrites. These features are often mistaken for fossils, but they are in fact tree-like crystals formed of the



mineral romanechite (Potter & Rossman, 1979). The yellow colour of the limestone is imparted by the iron oxide hydroxide mineral goethite.



*Eocene echinoderm and Nummulite fossils in the interior paving of Georgetown University and UCL Qatar. Clockwise from top left; a circular section through a sea-urchin shell (field of view is 15 cm). Partial section through a sea-urchin shell with preservation of the Aristotle's Lantern. Another example of preservation of an Aristotle's Lantern (field of view is 10 cm). A fragment of the shell showing a double row of pores.*

### **Northwestern University, College of Media and Communication (CMC)**

Next door to Georgetown University is the building housing Northwestern's College of Media and Communications, designed by Antoine Predock and completed in 2014.

This building is clad in individually-sized blocks of travertine. Travertines are strong and lightweight stones which are commonly used as decorative cladding, and are often cut at right angles to the bedding and polished to reveal their laminated structure. Here the stones are used creatively with a rough-hewn surface

to the blocks. Supplied by Haz Marble, **Yellow Travertine** is sourced from Turkey, but the precise origin is unknown; similar stones are available from several locations. The main areas in Turkey which have economically viable deposits of yellow (and other colour) travertines are Bitlis, in the east near Lake Van, Denizli in the west and Sivas in north central Turkey (Erdogan, 2011). All of these rocks have been deposited over the last million or so years and some are only a few tens of thousands of years old.



The deposition of travertines requires a source of limestone and a source of geothermally heated water to dissolve said limestones. Whereas limestones are common rocks in the Mediterranean region and Middle East, hot ground waters only occur where there is volcanic activity or deep seated faults (or both). Limestone is composed of calcium carbonate and this is dissolved by the hot waters at depth and then carried in solution until the water escapes to the Earth's surface along fissures and cools. At this stage the calcium carbonate precipitates out of the water as travertines.

*Left: Northwestern University clad in yellow travertine.*

### HBKU Student Centre

Forming the social hub of the Education City campus, and another building designed by Legorreta + Legorreta, the student centre houses support services, sports and social space. The building is arranged around a beautiful courtyard, with a garden and fountains, designed by Mexican-based artist Jan Hendrix; the white, laser-cut aluminium decorative screen is an installation called *Helix*. The building was completed in 2010.

Indian **Dholpur Beige Sandstone**, as used at Georgetown University is used again here to clad the exterior of the building, but it is worth going inside the building not only to see the beautiful garden courtyard but also the central atrium contains an urban geological gem.

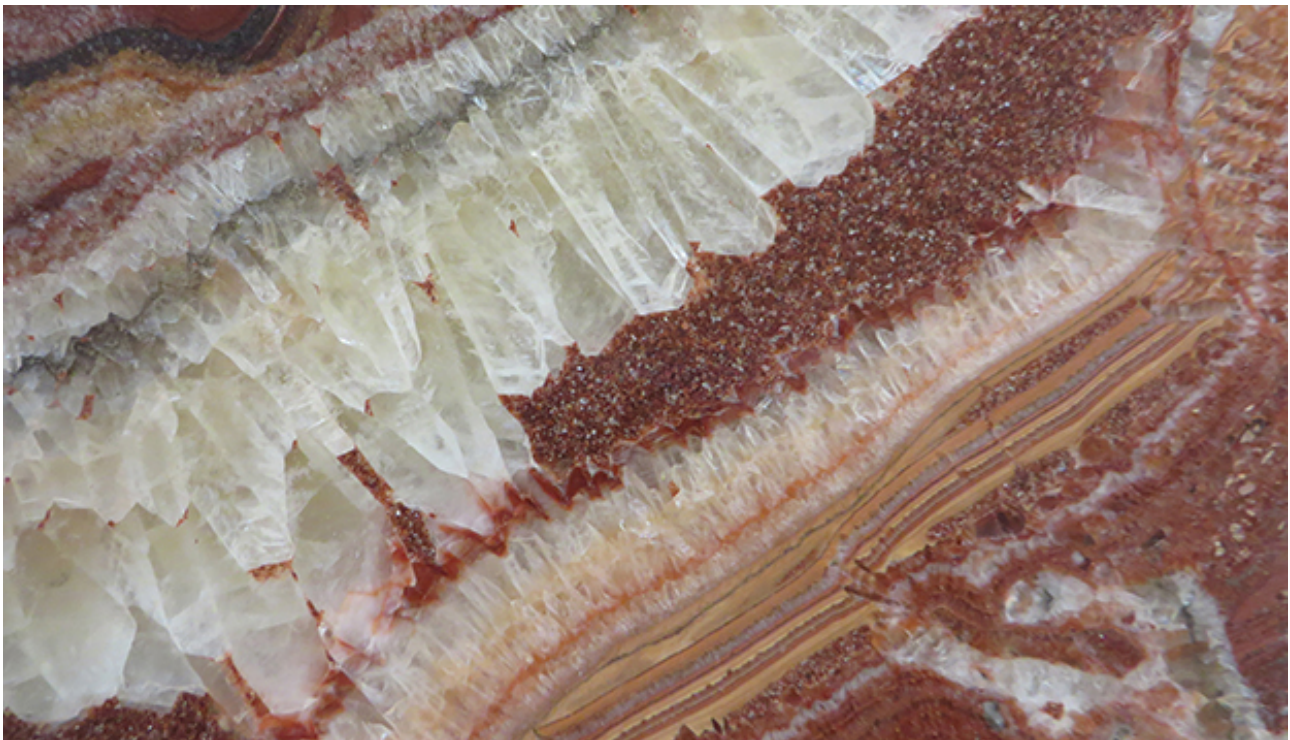
Yellowish **Rust Granite** is used for paving throughout the building and also for seating in the courtyard. Like many granites used for this purpose today, this comes from China. Chinese stones are marketed under an alphanumeric system which records the rock variety (in this case G for granite) and a number denoting the province of origin and the quarry. This stone is labelled G682, which shows that it comes from Shijing in Fujian Province, a state with a huge amount of granite and granite quarries. The stone is yellow, sometimes with a slightly pink shade and composed of quartz, feldspar and biotite mica. Rust spots have developed around the iron-rich micas and the overall yellow stain is down to the iron oxide hydroxide mineral goethite. Such staining in granites is often the effect of tropical weathering.

Another Chinese stone, **Chengde Green Granite**, is used for furniture and also for paving (especially in the food court area). As the name suggests, this is quarried near the town of Chengde which is located in Hebei Province, in the mountains north of Beijing. This is a coarse grained rock, composed of large (1.5 cm), grey-green sodic plagioclase feldspars and quartz. Perhaps, unexpectedly for a granite, the mafic mineral is orthopyroxene. Some feldspars are zoned and may be rimmed by biotite and opaque oxides. Texturally and compositionally, this rock is very much a charnockite, a rock of granitic composition but with pyroxene as a major rock-forming mineral. The origin of charnockites is poorly understood and there is evidence of both metamorphic and igneous petrogenesis. Most charnockites are ancient and these charnockites from the North China craton are 2.5 billion years old.

In the central area of the student centre is a spectacular use of decorative stone. This space, with social seating, is also the main point for ascending to the upper floors, but the staircases are cleverly hidden by large panels of book-matched red **travertine**, to form a repeating pattern. These slabs would have been carefully cut from a single block of travertine, with slabs then opened like a book to give a symmetric



design. Stone like this is very much a one-off find. Travertines like this, with large, calcite crystals, form in cavities, fissures and caves in rocks. The combs of well-shaped (euhedral) calcite crystals, 5-10 cm long have grown into an open space where their growth has not been hindered by the presence of other solids. This rock would have been full of holes in its natural state, but the voids have been filled by a resin with a filler of crushed stone and a dye to match the colour of the natural stone. The red colours we see in the natural stone are imparted by the iron oxide mineral hematite. The origin of these stones is unknown, but Turkey is certainly a likely place of provenance, where such travertines can form in the cavities developed along fault planes.



*Book-matched travertine panels in the HBKU Student Centre. Below: large calcite crystals and resin-filled cavities.*

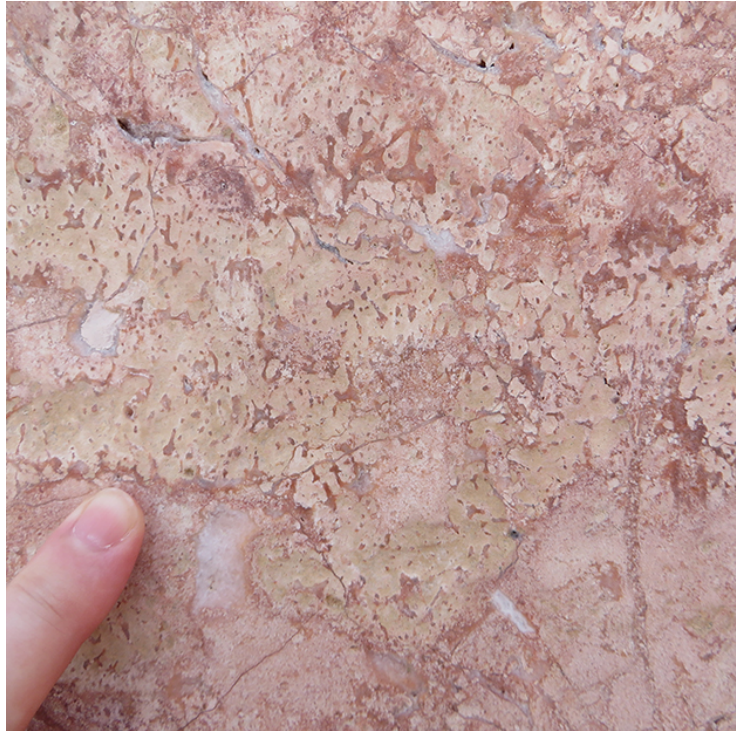
### **Texas A & M and Carnegie Mellon Universities in Qatar**

Buildings for these two American Universities are situated next to each other, opposite the Student Centre and they too were designed by Legorreta + Legorreta and were the first buildings by this architectural firm



to be completed at Education City in 2008. Continuity in the style and theme of the buildings again continues with the use of **Dholpur Beige Sandstone** as the main material used for cladding the exterior.

A rose-pink stone is used to clad the steps, tower, pyramids, water feature and walls around the Texas and Cornell buildings, forming a contrast to the Dholpur Sandstone. Also supplied by Haz Marble from quarries in Turkey, this red travertine is most probably from Altintas near Kutahya which is famous for red (and white) deposits, known not unsurprisingly as **Kutahya Red** (right). These are Pliocene-Quaternary age travertines which are associated with geothermal waters associated with volcanic activity, and the travertines overly lavas. The volcanic rocks are the source of iron oxide which has turned the travertines red and alarmingly they are also rather enriched in arsenic ... (see Dogan & Dogan, 2007), but this should not pose any risk from stones used on the exterior of the building. The travertine used on Texas A & M and Cornell has been fleuri-cut, meaning that it has been cut parallel to the lamination in the travertines. This gives a pleasing, blotchy, mottled appearance to the stone.



### **Museums**

Qatar has some fabulous museums, both architecturally and in terms of their collections. They also have some amazing urban geology.

### **Mathaf**



The Museum of modern Arab art is located close to Education City in what was once a school and has now been remodelled to house the museum by Jean-François Bodin (2010). *Mathaf* means 'museum' in Arabic and this gallery houses a permanent collection and exhibitions showcasing the contemporary art of the Arab region. The building itself is white and functional. It is all about the art. The main geological interest here are the large sculptures installed outside the museum, created by sculptors Adam Henein and Ismail Fattah who have both chosen Aswan Granite as their medium.

Adam Henein's sculpture *Ship* (2008-2010; detail, left) stands outside the museum. Henein is very much influenced by ancient Egyptian sculpture and uses the same materials used by ancient Egyptians, namely the granites quarried at Aswan. The pink granite, with large rose-pink crystals of potassic feldspar is **Aswan Monumental Granite**, also known as *Granito Rosso Antico*. It also contains yellow sodic feldspars, quartz, biotite and hornblende. The black

stone used is **Aswan Tonalite** which has phenocrysts of white and pink potassic feldspars, in a dark groundmass of hornblende, feldspar, biotite and minor quartz.

Ismail Fatteh's *The Guardian of the Fertile Crescent* (2001-2010) is also carved from Aswan Monumental Granite. The Monumental Granite is the earliest intrusion of the Aswan granite suite, intruded into c. 620 Ma gneissic basement. The Aswan Tonalite is co-eval with or slightly younger than the Monumental Granite. Geochemically, they are A-type, shoshonitic granitoids, formed during the late orogenic extensional phase of the collision of the Arabian Nubian Shield and the Saharan Metacraton during the Pan-African Orogeny (see Finger et al., 2008). The Aswan quarries have been in operation since the third millennium BC (Klemm & Klemm, 2008).



*The Ship, Adam Henein (2008-10).*

### **Museum of Islamic Art (MIA)**

The jewel in Qatar's substantial cultural crown is the Museum of Islamic Art (MIA) designed by Chinese-American architect I. M. Pei and completed in 2008. Pei of course looked to the traditions of Islamic architecture for his inspiration and designed a building based on a small ablutions fountain, a *sabil*, in the Mosque of Ibn Tulun in Cairo. An octagonal base rise up in steps to geometric squares. This height is seen within the atrium of the museum where there is a central court with a fountain and huge multi-storey windows looking out towards Richard Serra's monumental steel sculpture 'Seven'. The structure of the MIA is simple and austere but it is also one of the world's most beautiful museums.

The museum is predominantly clad with an ivory-coloured French limestone, the **Oolithe Blanche**. It is also used for paving and furniture in the atrium of the building. This stone is quarried from several quarries in the Côte d'Or region of Burgundy and specific varieties are named after these quarries. The stone used here is extracted from the same strata which outcrops in both the quarries at Magny-Lambert and Chamesson, which are around 7 km apart. This stone is a calcarenite – a limestone that has formed from the accumulation of particles, shell fragments and spherical ooids. Evidence of the currents that deposited these sediments in the shallow, warm seas of the Burgundian Platform can be seen in the cross-bedding which is well developed in most of the stones used in this building. The Oolithe Blanche is of Bathonian, Jurassic age.

The black stone used for paving both inside and out of the MIA and for the bands and dressing on the exterior is a dolerite (or diabase if you're from USA) called **Jet Mist**. This is a medium grained, orthopyroxene-rich dolerite, which was interlayered at the time of intrusion with a plagioclase-rich anorthosite ('leucocratic diabase'). This accounts for the streaks of grey 'mist' which cross-cut the rock. This stone is from Rapidan, Virginia in the USA and has been quarried from dolerite sheets (with associated

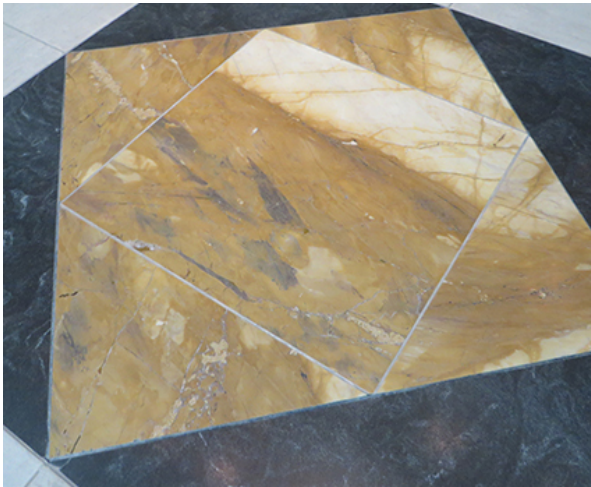


basalt flows) which were intruded into Upper Triassic - Lower Jurassic sediments of the Culpeper Basin during the middle Jurassic, 198 years ago (Tollo et al., 1987).

Floor paving, wall cladding and display furniture in the galleries use a speckled chocolate brown stone, either honed with a moderate polish or textured by a grooved surface cut. This is a volcanic rock from Argentine Patagonia called **Porfido Puerto Madryn**. This is not a commonly used decorative stone but its rich yet subdued colours and textures are perfect for this environment. Rightly so, the lighting in the galleries is focused on the objects in the museum rather than the stonework and this means the stone is difficult to see. However once one gets one's eye in, the streaky, granular texture of the stone is clear. Predominantly composed of Quartz, feldspar and volcanic glass, streaky blebs are *fiammé*, an Italian word meaning 'flame', referring to their shape. This texture is typical of hot, ash-flow tuffs, a variety of violent pyroclastic flows known as an ignimbrite. These eruptive products are derived from a phase of large-scale caldera volcanism associated with the break-up of Gondwana in the Mid-Jurassic. They belong to the Marifil Formation of the Chubut Group, which now form the Sierra Chata of Chubut Province in Patagonia. The quarries are located in the hinterland of the town of Puerto Madryn.



(Previous Page) Stones in the MIA: Clockwise from top left; The MIA as seen from the Dhow Harbour. Oolithe Blanche with cross-bedding and shell debris. Porfido Puerto Madryn with the streaky texture typical of ignimbrites (field of view 10 cm). Jet Mist dolerite.



In the central atrium and staircases, the yellow stone (left) used as decorative inlay in the interior floors along with Jet Mist and Oolithe Blanche is **Siena Marble** from Tuscany in Italy. This is a distinctive stone, a calcite marble coloured by the iron oxide hydroxide mineral goethite. It often has dark purple streaks too and the variety used here also has numerous white patches. It is a Jurassic calcite marble that underwent metamorphism during Alpine tectonism in the Eocene.

Siena Marble has been mainly worked in the 19<sup>th</sup> and 20<sup>th</sup> Centuries from quarries, owned by the local convent, located on Monte Arrenti in the hinterland of the city of Siena in Tuscany, Italy.

### MIA Park

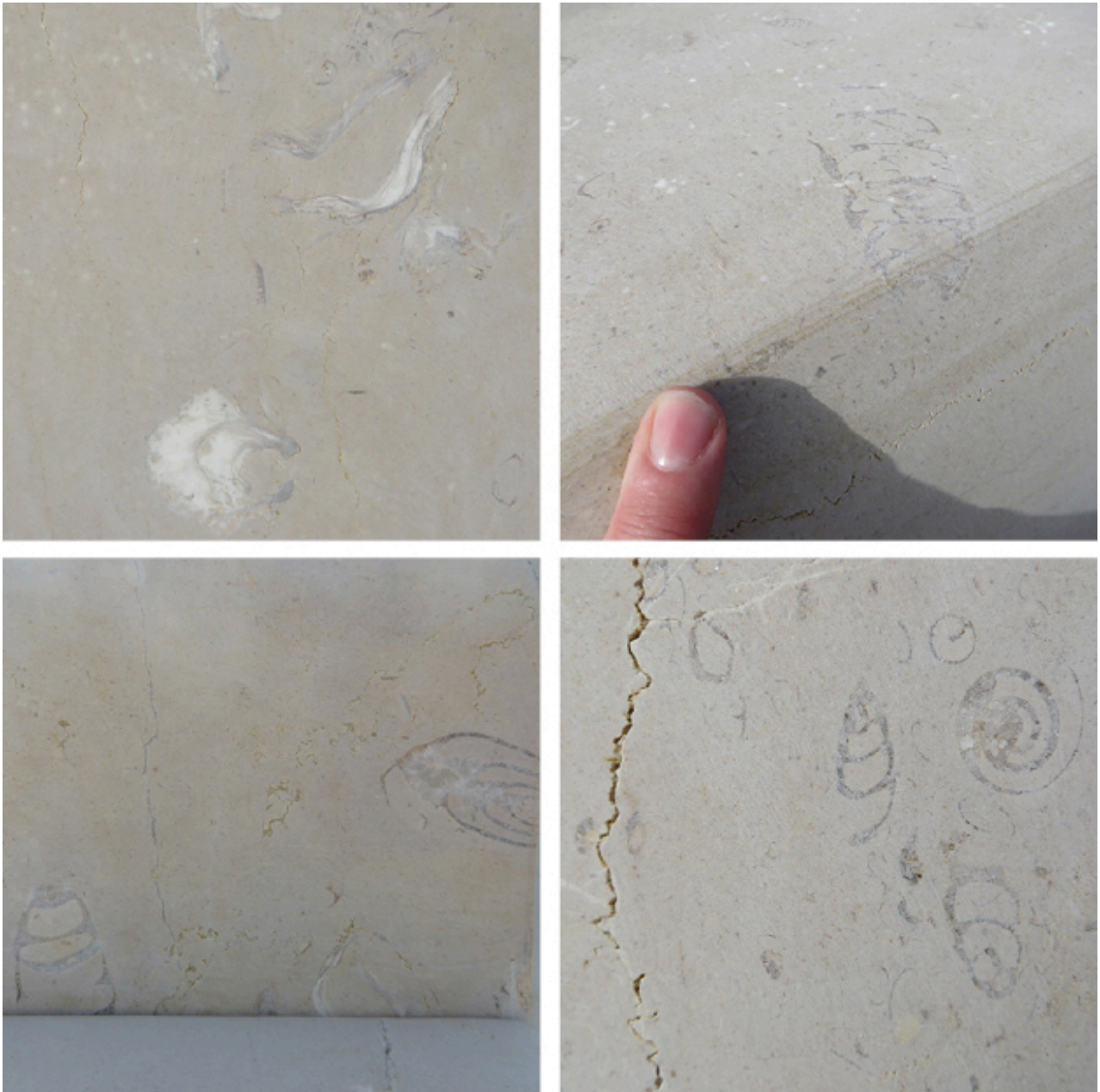
MIA Park is part of I. M. Pei's masterplan for the landscape and setting of the Museum and was designed along with it, including the artificial bay curving away around the Corniche. The landscape architect was Michel Desvigne Paysagiste. A beautifully sculptural white limestone bench is situated in MIA Park, a few meters along the Corniche from the Museum (below). Entitled simply 'Bench', this functional sculpture is by Lebanese artist Saloua Raouda Choucair (1916-2017) and was created in 1971. It belongs to Mathaf's collection. This is a great place for a sit down to take in the view across the bay to Richard Serra's 'Seven'. However it is also easy to look down and to be distracted by the fossils and other textures of this stone. The bench is made up of 17 blocks of shaped, honed, fine grained limestone, locked together like jigsaw pieces.

The stone used is a fine-grained, micritic limestone with stylolites. Fossils are concentrated in layers clearly parallel to bedding. These include fragments of rudist bivalves, small gastropods around 1 cm in length and larger (5-8 cm), well-preserved *Nerinea* sp. gastropods and *Trochactaeon* sp., an Acteonelloid gastropod (Kollmann, 2014).



I have not been able to identify the provenance of this limestone, but from the fossils, present it is of Upper Jurassic or Cretaceous age. A possible match is the Jurassic, white limestone quarried at Trani in Puglia, Italy.





*Fossils in the bench in MIA Park. Clockwise from top left; Rudist bivalves (field of view 25 cm). A Nerineoid gastropod. Nereneoid and Acteonelloid gastropods (field of view 10 cm). Gastropods and stylolite (field of view 5 cm).*

### **Msheireb Downtown Complex**

This region of Doha, just inland from the Corniche and west of Souk Waqif is a major redevelopment project in Doha which is regenerating a former residential and commercial district. The plan is to create a space where the feel of old Doha still exists, with architecture influenced by traditions and the preservation of older buildings. Importantly, Msheireb is a place for pedestrians, intended as an ‘urban neighbourhood’ with schools, residential areas, office space and cultural organisations. The area is being developed during five phases of construction, to an overall architectural plan by John McAslan + Partners. Phase 1 is largely complete and includes the Jumaa Mosque, the building housing Qatar’s National Archives and the restored houses that comprise the Msheireb Museum. These buildings have been clad in Oryx Limestone. This is a Jurassic limestone, provenanced from Ibri in northern Oman. It is a calcarenite, with reworked clasts of corals and other reefal material including shell debris. Overall, this is pure white, with the superficial appearance of a ‘true’ marble, but look more closely and its is packed with detrital fossil material. Oryx is one of the few Arabian stones used for construction in Doha. Geologically Oman is famous for the Semail

ophiolite complex, a slice of Cretaceous sea-floor obducted onto continental crust during the Alpine-Arabian mountain-building phase. The Ibri limestones belong to the Hawasina Nappe, an allochthonous section of the Arabian Carbonate Platform, tectonically underlying the Semail Nappes (see Bechennec *et al.*, 1990).



The Juma Mosque, Msheireb, clad with Oryx Limestone.

### Msheireb Museum

The Msheireb Museum is a neighborhood of four, separate houses which have been restored and remodeled as exhibition spaces. Of these the Radwani House (see below) has been restored with sympathy to traditional Qatari architecture. The Mohammed Bin Jassim House – built by the son of the founder of the modern state of Qatar - currently has a display relating to the architecture and materials used in the Msheireb Downtown Complex development. All the houses feature beautiful, serene designs and are worth visiting for their architectural beauty as well as the exhibitions concerning the social history of Doha. The geological aspects of the Bin Jelmoed and Radwani Houses are described below.

### Bin Jelmoed House

The Bin Jelmoed House has a permanent exhibition on the history of slavery in the Arab and wider world. The galleries are located around a central courtyard in the form of a traditional Qatari house, however the architecture is entirely modern. The courtyard is accessible and contains a reflecting pool and a seating area with striped paving of purple stone. This is a volcanic rock, **Trentino Porphyry** from the Trento-Bolzano region of northern Italy. Here a 2 km thick volcanic pile was erupted from subaerial fissures during the Permian. The resulting lavas are rhyolites, with quartz and feldspar phenocrysts. This has become a widely exported stone, used especially for outdoor paving and cobbles and there are over 80 quarries in operation (Perrier, 1998). Trentino Porphyry is used in in contrasting stripes with a shell gravel.

'**Sabban**' is a local name for an accumulation of shells, a coquina. Al Thani (2012) in his description of the geography and landscape of Qatar notes that such deposits can be found some distance from the present shoreline. Several varieties of shells are present but tiny gastropods are the most abundant, *Clypeomorus*



*bifasciatus* and other Cerith shells, as described by Mohammed et al. (1994). Sabban is used as 'gravel' in the courtyard of the Bin Jelmoood House. However the shell deposits were also mixed with cement and cast to form a light-weight breezeblock which was used for building in the mid 20<sup>th</sup> Century. Indeed blocks of this material were found during the restoration of the Msheireb Museum houses and an example is on display in the Mohammed Bin Jassim House, along with materials used in the construction of the current development of this quarter. Sabban was traditionally used in courtyards as it reduced dust.



*Sabban and Trento Porphyry in the Courtyard of the Bin Jelmoood House.*

The wall and patio surrounding the reflecting pool are clad in a yellow, fossiliferous limestone. The main evidence for life here are the abundant burrows – bioturbation – representing trackways left by worms and other burrowing sea creatures. Shell fossils are also present, including bivalves and gastropods. A few excellent examples of Nerineoid gastropods are present, up to 10 cm in length. The main feature of the Nerineoidea gastropods are their complex internal cavities. These are known as 'plaits' (Kollmann, 2014) and these are particularly intricate in the Ptygmatididae family of Nerineodia, where they are thin, folded and bifurcate, producing a delicate appearance in section. '*Ptygma*' means folded in Greek. Several species are present in this stone.



*A section through a Nerineoid gastropod, 10 cm long, showing the complex 'plaits' of the internal cavities.*

Unfortunately the origin of this stone is unknown. From the fossils, it is probably Cretaceous in age. It could have been derived from a number of locations in the Mediterranean region, from Spain to Israel.

### **Radwani House**

The Radwani House is a recreation of a traditional Qatari family home as it would have appeared in the late 1960s. Various rooms of different function are accessed from a cloistered central courtyard. Rooms on the northern side of the courtyard have been excavated by UCL Qatar students under the Origins of Doha

Project in 2012-2013 and have revealed an older domestic complex with a bath house. These were the first archaeological excavations to have taken place in Doha. The Radwani House itself dates from the 1920s and has a courtyard with sabban gravel. The communal room, the *majlis*, has traditional ventilation grills made from intricately carved gypsum, each one of a different design. **Gypsum**, quarried locally from the Early Eocene Rus Formation was used to make the decorative grills used to ventilate the houses, situated over lintels and around the eaves of houses. This use of gypsum is very much part of Doha's vernacular architecture and its carving was a local craft specialisation (see Morgan, 2014).



*The Radwani House with traditional gypsum grills above the windows.*

### **National Museum of Qatar**

The new National Museum of Qatar is still under construction at the time of writing in Spring 2017. However the external structure is beginning to take shape and I am reliably informed that the collections, representing the archaeology, culture, history and natural history of Qatar are also being put together. The building is clad with reconstituted stone slabs, but it is not the geology of the materials used which is of interest here, geology has inspired the entire building. Designed by French architect Jean Nouvel, the structure of the museum is based on that of gypsum desert roses.

Desert roses form in arid environments in ephemeral lakes (playas) and sabkhas by the crystallisation of platy crystals of gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) in the subsurface environment, where the water table intersects the sediment. Masses of these rose-like crystal growth-forms can occur in such environments and they are common deposits along the coastal regions of the Gulf. (see Al-Hussaini et al., 2015).





*Above: The National Museum of Qatar slowly crystallises. Below: Gypsum desert roses.*

### **Souk Waqif**

A souk (marketplace) has stood on this site for several centuries; Lockerbie, in his blog posts dating from 2005-2017, reproduce some of the earliest photographs of the Doha settlement, located on the shores of a wide bay ('doha' means bay in Arabic) where the creek of Wadi Msheireb enters the sea. The souk naturally grew around the port as the point of sale for goods traded. Today's Souk Waqif has largely been rebuilt, but in the style of the vernacular architecture. The project was overseen by the Private Engineering Office (PEO) operating under the auspices of the Emiri Diwan and was completed in 2008. The overall design was created by Qatari artist Mohamed Ali Abdulla, who's father had owned a shop in the old souk and who had therefore grown up there. The overall aim was not to produce a theme park, but to recreate a working market place, and this has been achieved. Souk Waqif is the only open air shopping space in Doha and has been designed for locals, tourists, merchants and residents alike.

The construction and reconstruction of Souk Waqif has used traditional techniques and materials. No steel and only minimal concrete has been used in the reconstruction of the Souk (see Eddisford 2015). Mangrove wood (danshal) beams are been used to support ceilings and lintels, the superstructure is built largely of sun-baked clay bricks and walls are coated with a mud or gypsum plaster (Radoine, 2010). Traditionally, a form of beach rock, known locally as *faroosh* was the main building stone, used as rubble masonry. This was an abundant material along the shores of Qatar and forms in warm and tropical waters by the cementation of littoral sediments by calcium carbonate. It is a relatively fast-forming and surprisingly hard and durable rock. By the 21<sup>st</sup> Century, local *faroosh* was no longer available, but a similar material was sourced for the project (Jodidio & Halbe, 2014).



*The Bird Market in Souk Waqif. Rubble masonry construction, with wooden poles supporting the ceilings.*

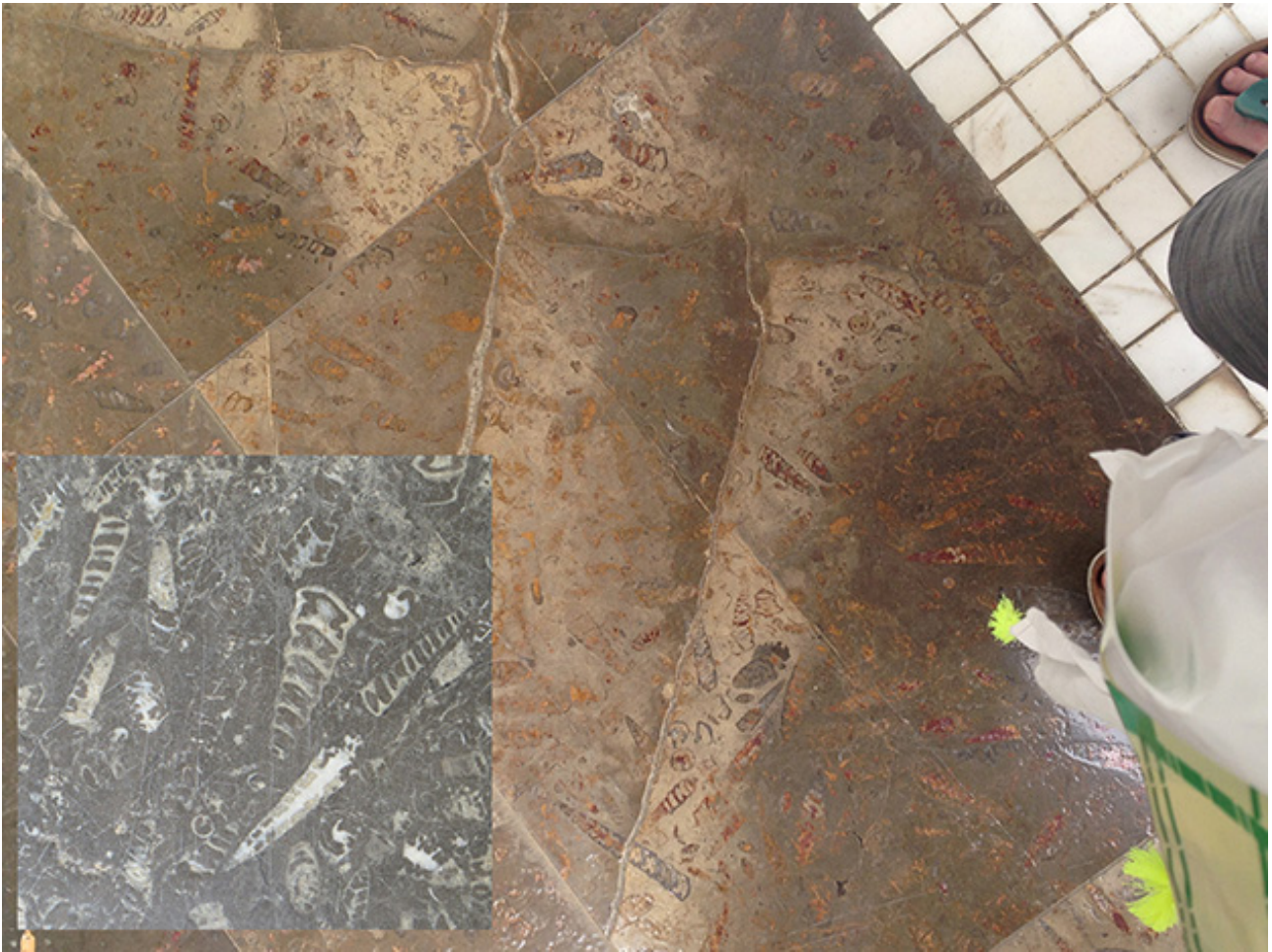
The reconstruction of the Souk has not been without controversy as this has been reconstruction rather than conservation of an historic site (see Radoine, 2010).

*There is little geology on show in the Souk, however the amazing fossils in the stone cladding of Al Jasra Hotel on Al Jasra Street, near to the falcon souk is well worth a look.*

### **Al Jasra Hotel**

The paving outside the hotel and cladding in the porch area is a spectacular, fossiliferous stone, **Nerinea Marble**. We have encountered Nerineoidea gastropods previously in MIA Park and at the Bin Jelmoed House and other buildings of the Msheireb Museum. However in both of these localities, we are rewarded with only a few examples of this fossil after searching over the stone. The gastropods here cannot be missed, the stone is packed with them. They have large S- and Z-shaped plaits and are in a matrix which varies with colour from dark grey to shades of brown. The colour variation is down to variable iron content and oxidation conditions. The fossils too have been affected by this, with some stained bright red or orange. The original sedimentary rock was black with white shells (*see inset in the photograph below*). Fossils are 10-15 cm in length. This stone is derived from SE Spain, from the mountains inland of Valencia (Anon, 2013). It is Jurassic in age and represents a low-energy, shallow marine environment which has accumulated these shells in a layer, but has not caused them to be broken up. They are probably the species *Nerinea bononiensis*. This stone has recently become available on the market and the suppliers are keen to associate it with high-end projects.





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**Amarillo Triana** – Restrooms in Georgetown University and UCL Qatar.

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**Chengde Green Granite** – HBKU Student Centre

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**Sabban** – Msheireb Museum

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*The National Archives in the Msheireb Downtown Complex, clad in Oryx Limestone from Oman.*

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