MUSEO GIARDINO GEOLOGICO

Sandra Forni

ERRANDOM

A brief tour of Bologna's urban geology

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A brief tour of Bologna's urban geology

... bella giornata è questa qua
l'aria più fresca ti esalta già
il momento migliore per cominciare
un'altra vita un altro stile
profondo o leggero
quando c'è gusto è bello
usa le gambe
utilizza il cervello
con l'entusiasmo
o con l'istinto
fai un passo
fuori del tuo recinto ...

Lucio Battisti – E già, 1982 | Scrivi il tuo nome

... What a beautiful day this is
the cooler air excites you already
it's the best time to begin
another life, another style
profound or light
it's great to take pleasure in things
use your legs
use your brain
with enthusiasm
or instinctively
take a step
outside your enclosure...

RegioneEmilia-Romagna

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Sommario

Presentation

The Geological, Seismic and Soil Survey (SGSS) began to take a close interest in the city of Bologna and its geology many years ago, with studies examining the complex relationships between the city centre, the subsoil and the original morphology of the territory. Subsequently, a meeting with Professor Marco Del Monte of Bologna University prompted the Survey to share the scholar's work documenting the lithology of the buildings and monuments of the historical centre. It is a project which Del Monte worked on throughout his professional life and which so captured our own interest, we translated it into a map, "The stones of Bologna. Lithology of a city" published in 2005 under the patronage of the Municipality of Bologna. The paper discusses in detail the different types of lithologies found in the historical centre, describing the type and materials utilised for the construction of various monuments dotted around the old town which can be considered, to all intents and purposes, an open air museum and the key to understanding this permanent exhibition.

The analysis of the historical centre was recently expanded to encompass the subsoil, with the 2013 publication of the geo-archaeological map of Bologna which summarizes and shares with the public knowled-

ge acquired by SGSS, the Superintendence for Archaeological Heritage of Emilia-Romagna and Bologna University's Department of Biological, Geological and Environmental Sciences. The subsoil, unfortunately inaccessible to visitors, is actually where important examples of the different developmental stages in the history of the city appear stratified, layer upon layer. The "Sandra Forni" Geological Garden Museum (MuGG) was inaugurated by SGSS in 2010 with the aim of raising awareness of geology among the population and at institutional level. The Museum is located in the Fair District, which is also home to Emilia-Romagna regional government. Here you can touch lithotypes that compose the Apennines and take a look at the SGSS collection of minerals, fossils, rocks and soils, samples collected over a thirty year period from all over Emilia Romagna region and the wider world. In 2003 the SGSS published a small book titled "MemoRandom, for those who are curious by nature", an introduction to Earth Sciences and the exhibits of the museum and to the garden through the eyes of an individual who is "curious by nature," and who thus ponders the less obvious meanings of nature.

In October 2014, Bologna municipal council and Bologna Welcome teamed up to propose the itinerary "Geology in Bologna", a new tourist offering, and I am now pleased to present "Errandom - a brief tour of Bologna's urban geology ", a short guide to the historical centre through the eyes of an inquiring geologist.

Happy reading and enjoy your walk!

Gabriele Bartolini
Chief of Geological, Seismic and Soil Survey of Emilia-Romagna

Prologue

We've all at some point found ourselves waiting for someone in a city centre street and, in an effort to while away the time, looked a little more closely at the buildings around us, our gaze lingering on a particular view, a detail or a stone. Then the person we've been waiting for arrives, an affectionate kiss or greetings are exchanged and suddenly the preceding interminable moments of waiting vanish, including the memory of what we had been observing.

Errandom is written precisely for those moments when you feel the need to make meaningful use of time spent waiting, to make the most of passing time and the emptiness that surrounds us.

In those moments of limbo, memories of the past and of life lived seem almost to emerge from the buildings, from the street, and they are memories that somehow belong to us.

Errandom offers an introduction to a tour of the historical centre of Bologna seen from the rather askant perspective of a geologist, but it also encourages the ideal spirit and frame of mind in order to gain a better insight during your visit. It is important to remember that the future thrives on the past and that the present is only the thin line that divides the two. *Carpe Diem*.

The language of stone

Each field of knowledge has its own language: words, lines, colours, spatial dimensions, sounds and so on, and every language is both abstract and concrete. Abstract if broken down into its individual elements, as it is reduced to a simple meaningless convention, but concrete when considered globally as it asserts a certain authenticity, an articulate and vital moment in an individual life and in time. We must abandon the notion that there is a single, preferred descriptive method for the study of historical city centres; only then can we acknowledge the multiplicity of cultural forms of expressions to be found throughout the territory. We can convey the same idea in countless different ways, in each case making it unique and recognizable. Paying attention to the lithology of a historical centre is a creative act that can conjure echoes of a past that belongs to us and increase our sensitivity to the artistic message.

When you visit a city

When tourists visit a city, generally speaking they take in the various artistic monuments, exhibitions and then, if they have a little time left, they they head for the busiest streets for a quick tour of the shops and market stalls. In many cases, they leave with just a few memories of the cities they have visited, having a general impression and only a vague idea of what permeates those places. In some cities, even an extended stay doesn't allow the visitor to fully appreciate the significance of certain historical centres. Urban structures define a way of thinking, living, adapting, a culture, and monuments illustrate all this. To fully understand a city, we must first of all be able to open our minds to cultures that differ from our own and acquire the ability to observe. A cultural visit cannot focus exclusively on monuments and art; details, views, colours, the faces of people are equally important and relevant. What a strange feeling to see in the face of a passer-by the same identical features you just observed in a 2500-year-old statue in the local museum! How curious it is to find out that a tradition, a symbol, a name, contains references lost in the mists of time. But the most difficult tourist itinerary of all is in that of our own city. The fact that we have plenty of time to visit it makes us lazy and reluctant. We put the tour off to some future date, never to be established, and in any case we feel justified doing so. Yet visiting our own city is important because it allows us to reflect, to create a logical bridge with our everyday lives, to consolidate our knowledge with certain references and gain a reliable touchstone.

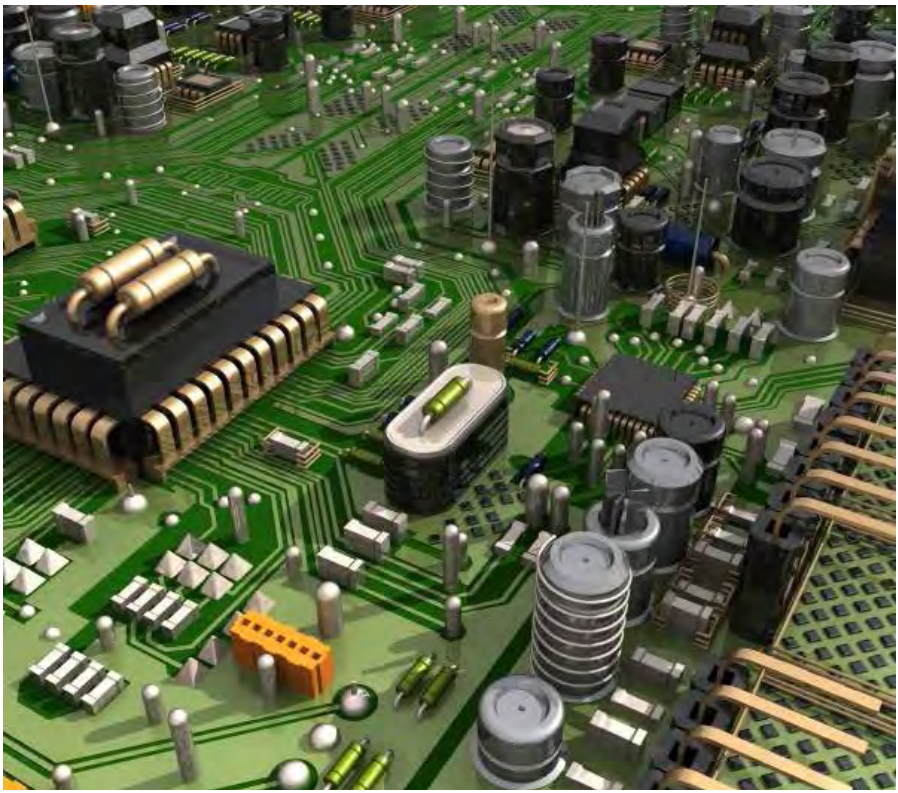
The meaning of stones

In semantic terms, stone has always been associated with the definitive, the permanent. In Italian the idiomatic expression "let bygones be bygones" is translated with "let's put a stone on the past". But stone also embodies the idea of a beginning (as the ancient Romans said, "incipit"): we lay the foundation stone of a building, or from Holy Scriptures "he that is without sin among you, let him cast the first stone" (John 8:7), and sometimes it also signifies arrival (e. g. in Tuscan dialect, the expression "we arrived at the door with stones" which refers to arriving at the gates of the city walls, thus indicating the end of a path). Stones can cause us to stumble, hence the Italian expression "the stone of scandal" where scandal derives from the Greek *skandalon* which means obstacle, stumbling. Stone also provides a testimony, both in a verbal sense and in everyday life: because it is heavy and bulky, transporting it around requires considerable physical effort. And like all testimony, down through the years it occasionally gets buried and forgotten, at other times it is reused, other times still it is carried to distant shores. Stone is a symbol of wealth (precious stones), luxury (marble floors), power (obelisks and statues) and wellbeing. To stone we entrust abiding messages and our fondest memories. Technology and progress have partly overshadowed this value, encroaching in the last 150 years, but in historical city centres, in small towns, in the subsoil of all that has been built from stone, the message it actually passes down to us continues to be heard loud and clear, if we stop and listen.

The meaning of paths

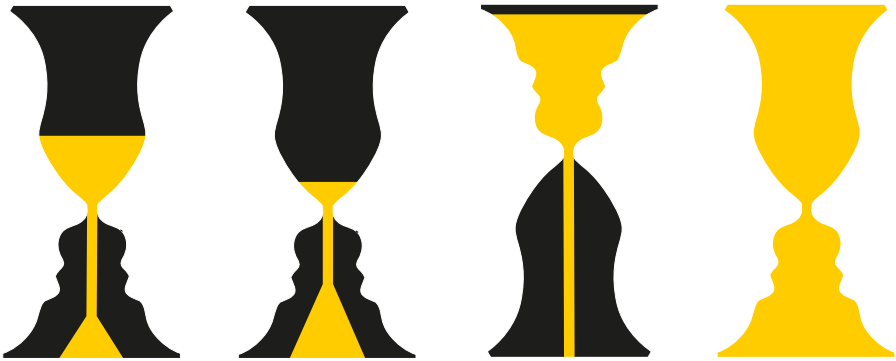
Stone delimits physical volumes, circumscribing spaces and defining areas. Buildings perform the opposite function compared to streets, roads and alleyways, all of which regulate transit, flow, pauses, quiet places within a city. When working on a park, many urban planners choose to let people circulate freely before drawing any pathways. That way, they can observe the pattern of trampling of the grass, noting how certain directions are preferred to others, how paths often disregard linear routes, and how the limitations are not defined by physical obstacles. Additionally, if green is restored again across the entire park, covering the pathways, the latter typically return in the same places as before, favouring the same routes. The same thing happens outside cities: over the centuries, historical communication routes have remained virtually unchanged: the Bologna-Florence motorway, albeit with a few modern changes, follows the route of the Flaminia military road built by the Consul Gaius Flaminius in the second century B.C. to connect Bologna and Fiesole. This road, in turn, was the same that connected the Etruscan settlements of

Kainua (Marzabotto) and Aritimi (Artimino, Prato) which, again, was the same route used in prehistoric times.
Piacenza, Parma, Modena, Reggio, Bologna, Forli and Rimini were all founded by the Romans and the via Emilia road links them all. This road, too, has more ancient origins and was conditioned by the presence of hills on one side and swampy land on the other.
In a city centre, the streets and alleyways represent the urban planning framework: orthogonal and formal in Roman times, rounded and sinuous in the Middle Ages, geometric again during the Renaissance, then grand and imposing in the nineteenth century. The road network is the backbone of the city, it is the urban skeleton. This skeleton with its particular conformation is the framework of the body while the road system, complete with all the unbuilt space, is the backbone of the city. So it is the empty, unbuilt space, in this case, that lets the urban fabric breathe.



Signs of passing

Every city nonetheless retains traces of the past, whether we consider the temporal or spatial dimension. The passage of time is marked in folklore, legends, popular sayings, words which reveal specific etymologies. In physical spaces it is documented in stones and ruins. It is interesting to see how the use and reuse of stone materials involves the enhancement, at different moments in time, of the same materials, often reworked to incorporate a new style, and how many urban areas of old towns are frequently used, in subsequent periods, for similar purposes. This cannot be explained away as a result of apathy and tradition alone: the use of a given asset or building is the result of a previous urban organization which served a specific purpose. Sacred, consecrated ground is frequently the site of successive places of worship, as churches are rebuilt on the same site as previous churches, often reutilising stone and other materials from the earlier building, even when the new church preaches a different faith. Thus, in order to better understand and characterize a historical centre, it is useful to identify the oldest urban areas. City walls and the location of the train station are especially important. The station, in particular, given that the construction of the railway network came shortly after the unification of Italy, provides a given for establishing where the suburbs began at that time: in that period, the railway line encircled the city just like medieval walls.






True and false

Over the centuries all historical city centres have undergone changes and alterations. In recent times, the most striking examples are the changes that impacted urban planning at the end of 1800 and those following the damage caused by war. In many cases, remedial action was taken to preserve or correct the architectural style of a location, creating modern urban elements that nonetheless exuded an appearance of great age. These attempts at embellishment often now confuse visitors, leading them to mistake relatively modern constructions for ancient, and vice-versa to ignore ancient buildings and old monuments, which they erroneously judge to be marginal or even imitation. Obviously there are tools which can provide a proper overview, first and foremost a guide to the artistic attractions of the city. But since guidebooks largely focus on the most famous monuments and the most renowned views, only careful observation can allows us to understand the true nature of the buildings before us. Stones and how they have been used are very useful, revealing inconsistencies and contradictions.

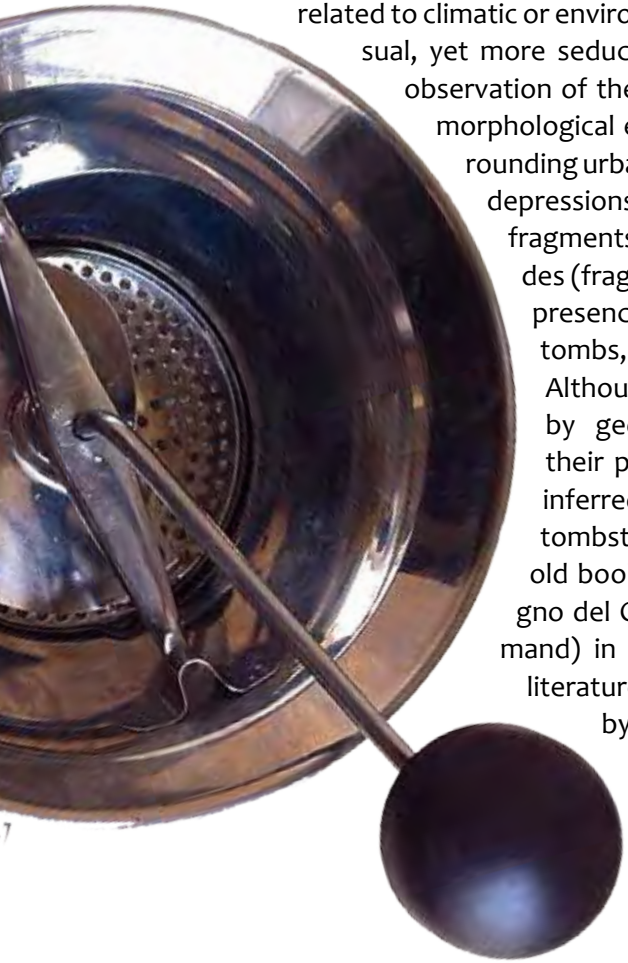
Stone as a guide to the city

In any historical city centre, local stone is naturally used for the majority of buildings. In ancient times the transportation of materials was problematic and expensive, while labour, on the other hand, was cheap. This situation persisted until the second half of the nineteenth century. Then the railways, industrialization and, subsequently, social evolution inverted the situation: an ever greater abundance of cheap materials, but in contrast ever more expensive labour costs. In Republican and Imperial Rome, roads were regularly paved and this was possible thanks to the ready availability of slaves, a source of free labour, apart from costs associated with food. The Romans, around 2000 years ago, favoured limestone thanks to its abundance and ease of quarrying but both prior to and after the fall of the Roman empire, the road system throughout the peninsula was very rough and uncertain. The paving of city centre streets with blocks of granite, porphyry or basalt is a relatively recent construction technique, certainly later than 1850. Asphalt or tarmac, which is now everywhere, began to be used widely only in the 1950s. So the presence of stone materials unrelated to the local area should make us stop and think. By local stone, we mean both bricks and locally quarried stone. Bricks can come in different shapes and thicknesses but their specific characteristics, such as the presence of impurities or type of kiln firing, can provide valuable information on the origin of the raw material, the clay, the firing technologies, and on the purity of the material. As regards local stone, we have to distinguish between autochthon and proximal stone. Typically, proximal stone is

that located within a 20 kilometre radius of the construction site. From a construction or ornamental point of view, this stone is generally of superior quality compared to autochthon stones, but, of course, it is more expensive because of supply and transportation costs. The abundance of local stone in monuments is an indication of considerable economic hardship. In addition to the two types of lithology just described, we must also consider stones of remote or even exotic provenance. During the classical age and especially during the Roman Empire, polychrome marble, jasper, basalt, granite, granodiorite and syenite were the prime materials of choice. The close relationship between the economy and monuments during the historical development of the city is clear to see: prosperity coincides with the use of highly prized stone; on the contrary, reuse and poor quality materials are evident signs of economic crisis or post-war periods. In addition, the artistic style of the period also provides clues as to the historical context and local socio-economic conditions. The distribution of monuments and buildings sharing the same lithology allows us to evaluate the spread of the town and consequently the size of population in a certain historical period. Finally, place names in conjunction with stones can provide clues about customs, work activities and roads.

Stone and past environments

A perhaps surprising yet nonetheless relevant aspect of lithology is that it can also be used to describe climate, environmental and social changes in urban settings. Apart from the effects of pollution, involving rapid and widespread deterioration of stone materials, other phenomena can be detected by observing the surface of monuments. Degradation caused by precipitation may be indicative of the quality of the materials used, symptomatic of the age of the monument; the presence of rough and spongy surfaces can be an indication of plant forms or lichen related to climatic or environmental changes. Equally unusual, yet more seductive, is the geomorphological observation of the city centre. The existence of morphological elements unrelated to the surrounding urban landscape, such as bumps or depressions, often associated with stone fragments inserted in monument facades (fragments) can lead us to infer the presence of artefacts, vestiges, ruins, tombs, landfills, wells buried in situ. Although this can only be confirmed by geo-archaeological excavations, their presence in the subsoil can be inferred from clues, inscriptions and tombstones. All this brings to mind an old book by Giuseppe D'Agata: "Il Segno del Comando" (The token of command) in which a professor of English literature, inspired by a diary penned by Lord Byron in 1817, enjoys a magical adventure in Rome in 1971 looking for a mysterious piazza mentioned by the poet in his diary.











The colours of Bologna

Having defined an interpretative model that can be applied to virtually any historical city centre, we can now examine the lithology of the city of Bologna. The variety of stones here offers a chromatic reflection of the personality of the city. Warm vivid colors are the hallmark of the lithology of the city. The red hue of terracotta and brick is all around, with sanguine shades found in the more sumptuous palaces where terracotta is often used as an artistic element in the shape of tiles and decorations. Simple brick, meanwhile, appears in lighter shades in the oldest and sturdiest walls, and is frequently used in social housing. Brick is often combined with selenite and sandstone. Selenite is a translucent rock composed essentially of chalk. Sandstone is also partly autochthon and comes in various different colours from straw yellow to dark ochre and grey. Monuments are commonly built from stone brought to the city from afar. This stone is mainly ammonitic red marble quarried principally in Verona and white Istrian stone transported from the homonymous peninsula. These vibrantly coloured stones harmoniously enrich the chromatic palette of the old town. Other lithologies are also present but to a far lesser extent and generally confined to certain areas. It is interesting to note the harmonious combination of plaster and lithoid materials in the city's old buildings.

Selenite

Gypsum is important in Bologna and has been used down through the centuries for different purposes. A prime example are the city's selenite walls, the first line of defence built to protect Bologna, which are believed to date back to the eighth century B.C.. Bologna was Etruscan (*Velzna* then latinized to *Felsina*), although the area was already inhabited in prehistoric times and later in the Villanovan age. The arrival of the Boii Gauls (latin plural, singular *Boius*; greek *Boîoi*, Bogos meaning destroy) from France in the fourth century B.C. ended the Etruscan presence. The Gauls settled and the city took the name *Bononia*, derived from the Celtic (Bona), meaning fortified place (a precise reference to the walls of selenite). The suffix Bona is also common to other cities, mostly French: Boulogne-sur-Mer in the region of Calais and Boulogne-sur-Seine near Paris. Under the Gauls, Bologna was neglected and fell into a state of disrepair, then the Roman conquest in 189 B.C. saw the city rise from the ashes again. The walls of selenite were restored and defended the city throughout the imperial rule.

Selenite is a particular variety of translucent gypsum whose colour and transparency are reminiscent of moonlight (from greek *selene*, meaning moon). This rock is found all over the Emilia Romagna region and around Bologna. Numerous quarries supplied the city in the past. The importance of selenite is especially linked to the health and wellbeing of the city. Natural gypsum is a calcium sulphate hydrate. The fact that the rock is hydrate means that it does not allow rising damp because, as it is already saturated in water, it acts like a buffer. It is important to remember that until the last century, Bologna was traversed by numerous waterways, evidence of which can still be detected today in place names. The frequent use of selenite in building foundations represented a source of health and prosperity of the city. Selenite also contains sulphur, therefore it also constituted a natural disinfectant against fungi and rot.

It is an easy material to work so was used in numerous monuments of the city centre for architraves, capitals and columns, often adorned with decorative reliefs. In the nineteenth century the use of gypsum in construction stopped as a result of a flourishing new industry producing dehydrated gypsum marketed as plaster and other derivatives such as stucco for decorations.

Selenite is the name given locally to a rock consisting predominantly of gypsum crystals. It is an evaporitic rock formed by the precipitation of a salt, gypsum (calcium sulphate dihydrate - $CaSO_4*2H_2O$) as a result of sea water evaporation . The deposition of Bologna gypsum dates back to the Messinian "salinity crisis" (about 6 million years ago) when the Mediterranean Sea was isolated from the Atlantic Ocean and intense evaporation turned it into a series of saline pools.

In these conditions, sea salt precipitated and crystallized, giving rise to evaporitic rocks, including selenite.

It was in the shallow waters of the basins bordering the Apennines that Bologna's selenite deposited. This gypsum belongs to the larger Emilia-Romagna Gypsum-Sulphur Formation outcropping along the "Gypsum Vein", which extends all the way to Sicily, with different names in various areas. Gypsum is a mineral which is highly soluble in water and it outcrops where the landscape is marked by karst features such as sinkholes and caves; the Farneto and Spipola caves near Bologna are particularly famous.

The brick

Although this is an artificial stone, obtained by firing clay in a kiln, it is used in abundance in the city since clay is commonly found in the plains and hills close to Bologna. Specific mineralogical considerations aside, it is important to note that, as this is compact sediment, it also allows easy transportation of large quantities in close proximity to the city. The firing process causes dehydration resulting in compactness, leading to the final product which, depending on the techniques used, can be used for the production of bricks, pottery or ceramics. The thermal process is irreversible inasmuch as if the brick is subsequently ground down, the resulting dust cannot be used to produce a new brick. This process is well known in geology because it occurs naturally in the same way in certain tropical areas (a process known as soil lateralization). In the city the use of brick is widespread. All the medieval towers (the city centre originally boasted over eighty in all, of which only around twenty remain standing today) including the Garisenda and Asinelli towers, the symbols of the city, were built of brick with a selenite base. The use of brick for buildings has ancient origins, as already documented by the remains of buildings from the Etruscan-Roman period, featuring highly sophisticated designs and styles. From "tiles" made for heating systems, specific kinds of bricks for coverings, up to reuse for filling masonry walls together with lime, rough stones and gravel (*opus cementicium).* We can note how brick and cement are two anthropogenic lithological expressions: in order to construct buildings, man actually produces artificial rocks that could be compared to sedimentary rocks: a concrete casting can be considered similar to a limestone; a brick to shale or sandstone; concrete and stones in fact constitute a breach limestone while morphologically speaking, concrete and brick together resemble stratified rock. We build our a cities by stratifying, eroding, transporting and dismantling rocks and materials, mimicking the actions of the natural elements.

In Bologna, the use of bricks reached its peak in the seventeenth century when, following numerous fires, the local administration ordered that wooden elements of buildings and porticos be replaced with mason-

ry structures. In particular, with reference to porticoes, we can still admire today some small portions which retain the original wooden structure (some are reconstructions). Note that the base is always made of selenite. Bricks allow us to date buildings relatively easily, generally using mensiochronological analysis. Systematic measurement of the dimensional variations of bricks, in addition to the chemistry and the presence of specific nannofossils similar to the bricks of analogous buildings in the same geographical area, allow us to date the buildings and even identify the quarry that provided the materials. This type of study has been used not only in Bologna, but in many cities including Siena, Pisa, Lucca and Genoa, especially to identify buildings constructed in the Middle Ages.

Clay is extremely abundant around Bologna. It is carried by rivers across the plain while in the hills it outcrops in large areas, often in the form of striking badlands. Clays localized in the hills were deposited during the Pliocene (5.3 million years ago to 2.5 million years ago), on the seabed of a marine gulf that extended over the area corresponding to the present-day Po plain.

Sandstone

This rock is present in Bologna in two different forms: one is yellowish, poorly cemented and quite fragile (with obvious signs of degradation), while the other, also known as *pietra serena* stone, is much harder and grey - light blue in colour.

Sandstone is a compact sedimentary rock composed largely of cemented limestone or limestone-clay and it is a highly workable material. With its neutral, elegant appearance, which is both solemn and concrete, sandstone is still widely used in construction.

The granules can have differing mineralogical compositions depending on paleogeographic origin and may even include fossils on occasion.

The term fossil (from the Latin *fodere*, to dig) was coined by Georgius Agricola in the sixteenth century to denote all that was extracted from the ground digging, and so initially the term also applied to minerals. Neutral and elegant, simple and solid in appearance, this stone is still widely used in construction.

There are many different types of sandstone: that of local origin, light in colour and not particularly substantial, that from areas in close proximity to the Apennines which is generally more compact and durable and dark ochre in colour, and finally the most compact sandstone of all, superior in quality to all others, called *pietra serena*, a name derived from its sky blue colour. The quarries of this lithological type are located in areas close to the border with Tuscany. In old buildings, this type of sandstone is commonly grey in colour. Widely used during the Etruscan age (the archaeological museum of Bologna houses many examples, especially stems), sandstone fell out of favour during the Roman period. In the Middle Ages it enjoyed a resurgence and was widely used for masonry, decorative elements, columns, cornices and ribs. Extremely attractive from an architectural point of view, nonetheless it is highly vulnerable to atmospheric agents, especially where water stagnation occurs. Degradation manifests itself in the formation of surface peeling followed by cracking and detachment.

Poorly cemented **sandstones** come from the formation named **Yellow sands**, a Pleistocene formation located along the Pede-Apennine margin. These sands were deposited about 1 million years ago in shallow waters along the coastal shores of the Po Gulf, an area that now corresponds to the Po Plain. **Pietra serena or Macigno**, instead, is a sandstone that formed in a period between the Oligocene and Miocene (from 34 to 5 million years ago), following the deposition of sediments transported by giant underwater landslides. The Macigno formation dominates the landscape of the Apennines.

Ammonitic red marble

The transportation of materials and stone depends on road and infrastructure systems and certainly in Bologna, in the past, waterways were the cheapest and quickest way of moving goods. For this reason, from medieval times on, valuable stone materials were quarried in the Verona area in the Southern Alps. Historically the district of Verona, rich in ammonitic red marble, together with Carrara with its classic marble, were the main Italian mining areas for ornamental stone. Ammonitic red marble was used for all of the city's major monuments. From the Cathedral of St. Peter's and the Basilica of San Petronio, to the Pavaglione portico and the Church of Santa Maria dei Servi, not to mention many grand palaces, ammonitic red marble is used exquisitely and in abundance. Many polychrome lithological combinations employ Verona red marble to emphasise architectural perspectives and angles. Ammonitic red marble is widely utilized in Gothic and Renaissance architecture in many cities across northern Italy.

Ammonitic red marble is a poorly stratified limestone with a nodular structure, its name derives from the presence of ammonite fossils and the red hue (in various shades ranging from pale pink to purple and even light green) given by the presence of iron oxides.

Ammonites are cephalopod molluscs: their shells are generally spiral shaped, vaguely resembling a curled horn, like that of a ram. In his encyclopaedia Naturalis Historia, written around 2000 years ago, Pliny the Elder mentioned this kind of fossil, calling them ammonis cornua (horns of Ammon) referring, thus, to the Egyptian god Amun, depicted as a man with ram's horns.

Ammonitic red marble was formed as a result of sediment deposition in a deep sea basin during the period of time stretching from the Middle Triassic (235 million years) to the Upper Jurassic (150 million years). This geological formation is present in the Southern Alps, the Umbria-Marche Apennines and in the southern Apennines.

Istrian Limestone

Istrian limestone is a very compact microcrystalline rock, milky white in colour with conchoidal fractures, which is quarried in the Istrian peninsula. Highly resistant to atmospheric agents, to erosion by wind and salty sea air, it has a characteristic trait, namely in particular light conditions, for example during storms or at sunset, it reveals a unique luminescence. In Adriatic regions it has been used since Roman times for the construction of the finest buildings: the Mausoleum of Theodoric in Ravenna, Tiberius Bridge in Rimini and numerous patrician houses, banks, bridges, churches and monuments in the city of Venice, were all built using Istrian stone. In Bologna too this lithological type is largely used often in combination with red Veronese limestone. Similarly to selenite, limestone - and especially Istrian stone - does not permit the capillary action of water, thus it acts as a buffer against rising, penetrating damp. Proof of this can be found in the fact that the submerged portion of Venetian palaces, up to the high water line, was built in Istrian limestone. Brick was used only above the water line because the highly porous nature of bricks would result in crumbling and pulverization. It is reasonable to assume that both red ammonitic and Istrian limestones arrived in Bologna as semi-finished products, if not actually finished: generally the costs and risks associated with transportation prompted clients to choose stone materials that were basically ready to use.

Like red ammonitic limestone, **Istrian stone** contains fossils, although they are difficult to detect. The fossils in question are rudists, asymmetrical bivalve shells with a thick, conical right valve and a lid-like left valve. These bivalves lived in shallow waters between the Late Jurassic (150 million years ago) and the Upper Cretaceous (70 million years ago). Calcareous rock rarely has impurities consisting of pyrite, chlorite and clay layers.

Fragments and minor stones

We have briefly looked at the most common lithological types, deliberately ignoring everything that may have made an appearance in the city after 1850, such as porphyry and granite paving for roads, paving stones of piazzas of uncertain origin, slabs of modern buildings in the historical centre, asphalt, steps and typically modern artefacts. If we intentionally exclude all these lithologies, considering them irrelevant and indeed misleading for the purpose of accurate historical interpretation, we are left with only fragments, namely bits and pieces of rock included in walls or a few examples here and there of various types of exotic stone. As these are present in limited quantities and in only a handful of sites, for the purpose of a quick , effective overview, we will take one of the most famous monuments in the city as an example: the Basilica of Santo Stefano. This religious complex is also known locally as "Sette Chiese", (Seven Churches), and from a lithological point of view represents a splendid historical training ground. The succession here of destruction, rebuilding and restoration resulting from complex historical and political events over a period of time ranging from the Roman Empire until 1900 makes it particularly representative. The fragments I wish to focus on are few in number but highly significant. The wall of the Church of the Holy Sepulchre, on the "courtyard of Pilate" side, features a mosaic made with tesserae of ancient red porphyry, ancient green porphyry and other minor lithologies. These stones unquestionably come from larger blocks and appear clearly to have belonged to the monuments of Imperial Rome. Neither green nor red porphyry were ever used in Bologna at any other period if not during Roman times. The ancient red porphyry comes from Egypt from a mountain range now called Gebel Dokhan located west of Hurghada in the Eastern Desert. It is an igneous rock characterized by large effusive plagioclase crystals immersed in a vitreous red paste. The Romans called it lapis porphyrites after its characteristic purple colour. Long used by the Egyptians for statues, after Augustus' conquest of Egypt it was also used by the Romans. Because of the purple hue and the difficulties of working with it, this stone was reserved exclusively for works for

the imperial family. In Italy there are only a few monuments that use this material: for example, the sarcophagus of Saint Helena in the Vatican museum, the sculpture of the four tetrarchs on the corner of the facade of Saint Mark's church in Venice. Ancient green porphyry, which Pliny the Elder called *lacedaemonius lapis* (Spartan stone) is an effusive igneous rock in which large crystals of plagioclase are immersed in a green matrix. This stone comes from the Peloponnese and the quarries were described as long as 2000 years ago by Pausanias. What is striking is that given the difficulty of obtaining these materials, it become relatively easy to identify their provenance and the historical period that first witnessed their arrival here. Continuing our visit, if we pause for a moment, for example, in the courtyard of the cloisters, we can observe that high up on the wall of the gallery surrounding the well, in addition to the monstrous capitals (the very ones, legend has it, that inspired the young Dante Alighieri to devise the pains of purgatory) are marble slabs and torsos, probably made of Carrara marble during the late Roman Empire. In such a small space, so much history in such plain sight as to pass virtually unnoticed. Knowledge gained becomes an investigative method each time we encounter a new monument: experience aids investigation and discovery.

Conclusions

Stones yield so much history: this is what emerges in the end from our short itinerary. Stone, like oral tradition, remains and does not allow the story of events to fade over time. The use of certain materials is related to economic conditions, to knowledge and to needs. However, some incongruities deserve our consideration. Ammonitic red marble juxtaposed with Selenite. Selenite next to brick. Each material with its own age, and geological ages so far apart, yet united together by a single building. So many different buildings and monuments, each with their own identity and a story to tell. A choir of stones, countless realities and tales that flow into the river of history. To observe is to know how to listen to what our culture tells us. In a figurative sense, a tombstone is the clearest expression of how we bend humbly towards the ground to read about our past.

ANGOLO BAR A BOLOGNA

OVE VIVEVO
ERANO USI SUONARE
É LAVORO E ORO VALE
ALLA BISOGNA TANGO SI BALLA
E LA SETE SALE
AFONA VOCE ECO VANO FA
ILLUSA FINGO SOGNI FASULLI
È RARO VALER E LAVORARE

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An italian palindrome tribute to Bologna

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