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TOURinSTONES: a Free Mobile Application for Promoting Geological Heritage in the City of Torino (NW Italy)

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Geoheritage

TourinStone: a free mobile application for promoting geological heritage in the city of Torino (NW Italy)

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Abstract:	The Piemonte mountains surrounding the city of Torino comprise a wide variety of rocks, characterized by a multitude of minerals, structures and colors. The Alps, for their long and complex history, offer a wide variety of ornamental stone used in the town, over the centuries, for both aesthetic and structural reasons. TourinStone is an application for the mobile phone that allows geotourists to walk in the center of Torino, where the visitor can be find Alpine rocks used in palaces and historical monuments as witness and tangible symbols of the city. The application consists of twenty-six historical sites of interest in each of which ornamental stones of historical and scientific interest can be observed in detail. The sites are grouped in four thematic itineraries through which the user can discover the city from the cultural and architectural point of view. By a numbered list of the stones used in all described monuments the user can access specific data on each rock including quarry location, petrographic description and utilization in Torino. The mobile application can be downloaded free from the App Store or Google Play respectively for Apple and Android devices.
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TourInStone: a free mobile application for promoting geological heritage in the city of Torino (NW Italy)

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ABSTRACT

The Piemonte mountains surrounding the city of Torino comprise a wide variety of rocks, characterized by a multitude of minerals, structures and colors. The Alps, for their long and complex history, offer a wide variety of ornamental stone used in the town, over the centuries, for both aesthetic and structural reasons. TourInStone is an application for the mobile phone that allows geotourists to walk in the center of Torino, where the visitor can be find Alpine rocks used in palaces and historical monuments as witness and tangible symbols of the city. The application consists of twenty-six historical sites of interest in each of which ornamental stones of historical and scientific interest can be observed in detail. The sites are grouped in four thematic itineraries through which the user can discover the city from the cultural and architectural point of view. By a numbered list of the stones used in all described monuments the user can access specific data on each rock including quarry location, petrographic description and utilization in Torino. The mobile application can be downloaded free from the App Store or Google Play respectively for Apple and Android devices.

KEY WORDS: applied petrography, multimedia application, ornamental stones, cultural heritage, Torino

INTRODUCTION

Dimension stone has long been recognized as one of the most important natural resources for construction. In particular they have been used as raw materials for sculptural masterpieces and architectural elements and thus are representative of worldwide cultural heritage. Therefore, the knowledge of stone resources (the minero-petrographic features, their use and exploitation techniques from ancient times to the present) can provide a broad overview of the historical and cultural significance of such materials, highlighting the relevance of an economic activity so

important for the history and traditions of the different cultures developed through the centuries all over the Mediterranean area (Cooper 2015).

The abundance of stone materials coming from different areas in the Piemonte region and employed over the centuries to realize paving, monuments and public buildings, to embellish churches, storefronts and commercial shops, shows the close link between the city of Torino and the surrounding territory, emphasizing the role that stone has played on the culture and economic wealth of Torino during the centuries: first as capital city of the Savoy kingdom, then as the Italian capital, and finally as a major center of domestic industry. In recent decades, Torino has been the venue of the XX Winter Olympic Games in 2006 and has undergone a major transformation that has led it to become a tourist town full of cultural attractions. Its monuments and stone palaces built over the centuries now represent a major city attraction. In this framework, the knowledge and enhancement of historic ornamental stones from Torino can lead to a new geotouristic approach for the development of urban geological heritage. Over the last century, the petrographic description of Torino ornamental stones has been the subject of numerous papers (e.g., Sacco 1907; Peretti 1937; Rodolico 1953; Chiari *et al*. 1992; Fiora *et al*. 2002; Borghi *et al.* 2014, 2015; Poretti *et al.*, 2015). Recently, a multimedia CD petrographic guide of the city was produced by Fiora *et al.* (2007). However, a tour guide, easy to use and which allows appreciation of the geodiversity offered by the historical buildings of the city, is not yet available.

This paper reports about an app recently created which describe some itineraries in Torino that provide to visitors the opportunity to learn, not only the historical and architectural aspects of the buildings, but also their geological character. In tourist and popular publications, in fact, this issue is rarely addressed and many tour guides are not prepared to consider it or to answer questions on the stone materials that are encountered with field examination. Proper geological review should be interesting from many viewpoints. The various ornamental stones used in architecture play a structural function and provide an important colour component. Moreover it can also be viewed in a broader perspective, as a transformation element of the region, through quarrying activity, the unique geological characteristics of the stone materials and the characteristics of the site of origin.

TourInStone is an application for smartphones and tablets in which twenty-six selected sites are considered. These provide an overview of the main ornamental stones used in historical buildings, churches and streets of the city centre, thus offering an open-air collection of stone types. The development of itineraries and the simplified texts for non-experts can bridge a gap between the geology of the Alps and the city, its citizens, its students and its tourists.

GEOLOGICAL SETTING

The great variety of ornamental and building stones used in Torino for architectonic elements is due to the highly varied geology of the region. In Piemonte, very different geological units occur: the western portion of the metamorphic Alpine Chain and the sedimentary Tertiary Piemonte Basin. The large variety of rocks outcropping in the Alpine system is grouped into four main units separated by tectonic contacts and characterized by similar paleogeographic origin and geological history. These units are named (outwards along the chain): Southalpine, Austroalpine, Penninic and Helvetic–Dauphinois Units. In the Alpine region quarrying districts of particular importance exist for the natural stone sector, some of which were employed in the Torino architecture (Fig. 1 and Tab. 1). In the Southalpine Unit the Verbano district is characterized by the exploitation of some magmatic rocks as Alzo, Baveno and Montorfano granites as well as the Anzola "black granite" (actually a gabbro- norite). From the Austroalpine domain the Balma Syenite and Vico Diorite are sourced. The quarrying district of Cusio-Ossola is rich in amphibolites facies orthogneiss such as Serizzo. In the Penninic domain, the most important quarrying district is represented by the Dora Maira (DM) Massif, from where many different stones originate (Cumiana, Luserna, Malanaggio, San Basilio and Vaie), as well as the Barge Quartzite. From the oceanic crust unit (Piemontese Zone) the prasinite and the Verde Alpi ophicarbonate are quarried. In the past, other parts of the Piemonte region were the subject of intense production of stone materials: an example is the quarrying district of the Briançonnais Zone, where most Piemontese colored marbles, such as Bigio di Moncervetto and Ormea black marble, were sourced. Finally, many Piemontese white marbles were exploited, generally, from small lenses of different Alpine geological units, such as the Brossasco, Chianocco, Foresto and Prali Marbles (from Dora -Maira Massif), the Pont Canavese Marble (from Sesia Lanzo Zone), the Ornavasso Marble (from the quarrying district of the Ossola Valley; Borghi *et al.* 2009). Only one sedimentary rock (Verde Roja) was exploited from the Alpine chain,specifically from the Dauphinois Unit. More abundant were the sedimentary ornamental stones originating from the Tertiary Piemonte Basin (TPB) developed in the internal part of the Western Alps from Eocene to Miocene. Among them limestones such as the Gassino Stone and the Finale Stone were utilised.

A small amount of ornamental stones from other Italian regions, in particular sedimentary rocks, were also employed in Torino monuments and buildings (Fig. 2 and Tab. 1). The leading position of Italy in the natural stone field is a result of its extremely composite geological nature. Italian geology is characterized by the presence of several mountain chains and their associated sedimentary basins. From North to South the orogenic belts are: the Alps (Northern Italy), the

Apennines (central Italy), the Calabrian – Peloritan Arc (Southern Italy) and, finally, a portion of Maghrebid belt (Sicily). In these orogenic chains are exposed igneous and metamorphic rocks (in the Alps and Calabrian-Peloritan Arc), or sedimentary successions (Alps, Appennines and Maghrebid belts). The associated sedimentary basins are made up of sedimentary rocks of Paleogene to Recent age. The geologic framework of Italy is completed by the Sardinian-Corsican block that represents a segment of the Paleozoic belt preceding the formation of the Alpine chain. The great variety of natural stones quarried in Italy therefore includes rocks of very different kinds, coming from various geological units. Between the ornamental stone employed in Torino, many additional carbonate sedimentary rocks such as Botticino, Macchia Vecchia Svizzera, Vicenza Stone, Rosso Verona and Istria Stone came from the Mesozoic to Paleogene successions of the Southern Alps (Southalpine Domain). Other carbonate sedimentary rocks noticeable at Torino are Trani Stone and Roman Travertine (Southern and central Italy, respectively). Among the magmatic stones employed in Torino there are the Sardinian Granite, coming from Sardinia, the Peperino from Apennines, the Trentino Porphyry and the Euganean Trachyte from Southern Alps. Finally the metamorphic rocks used in Torino are the Valmalenco Serpentinite (from Southern Alps), the Rosso Levanto, the Giallo Siena and the Carrara Marble, sourced from the Apennines.

THE STRUCTURE OF THE APPLICATION

TourInStone is an innovative instrument to promote, increase and enhance understanding of the urban geological heritage of Torino, thanks to which the visitor at the same time can enjoy both the cultural and scientific aspects of the city. The development of a multimedia application, indeed, provides access to some basic qualities of the web: effectiveness, accessibility, user attention, responsiveness, information management and content.

TourInStone is an application in which the selected sites are part of four thematic itineraries through which the user can discover the city from the cultural and architectural point of view, and at the same time learn about the stone materials used in buildings and monuments.

The strategy of the app is to propose some geotouristic walks in the historic center of Torino that relate some important moments in the history of the city, as described by its main buildings and monuments, but also the natural history that during tens and hundreds million years saw the formation of the Alps.

Opening the app, an introductory page can be displayed in which the TourInStone project is briefly described. From here you can access an index that contains the following items: 1) Buildings and Monuments, 2) Rocks, 3) Itineraries, 4) Geological setting, 5) Glossary, 6) Bibliography (Fig. 3).

1) **Buildings and Monuments**. The use of various types of stone in architecture is never neutral or random. It, in fact, results from the expressive choice of the artist (including architects), or from the economic or social importance of the artifact. A remarkable variety of relationships among materials, processing techniques, types of artifacts and formal results follows.

Thanks to this, the Torino architectural landscape allows the potential geotourist to range from monuments consisting of a single stone, such as the monument to Emanuele Filiberto in *Balma Syenite* placed in front of the Teatro Regio in Piazza Castello, to architectural works where the materials used are disparate such as the arcades of Via Roma in the block of Sant'Emanuele, where as many as nine different ornamental stones were employed.

Taking into account the requirements of both artistic and scientific representativeness, 26 peculiar sites of Torino architectural history were selected and listed in alphabetical order in the application (Table 2 and Fig. 4). The numbering allows to find sites on the city map; clicking on them the respective card can be opened. The selected sites are also linked to some information such as the time of construction, the former quarries of stone materials and other historical and architectural aspects useful to place them in the urban context of Torino. The card of each monument is organized according to the following fields: name, photos of the site of interest, address, itinerary in which it is included, artistic and historical description. At the bottom of the form there is a list of ornamental stones used at the specific site, from which their descriptions can be accessed (Fig. 5). The execution of photographs of monuments and buildings was performed in correspondence with particular architectural elements in which it is possible to highlight the use of quality stone materials.

2) **Rocks**. All the rocks used as stone materials, in addition to being appreciated from an aesthetic and architectural point of view, can tell us important "stories", both about their genesis and geological evolution in the millions of years, both on the subsequent historical periods during which the different rocks were distinguished on the basis of the methods of cultivation, transport and use as an ornamental stone. By a numbered list of the stones used in all described monuments the specific data of each rock can be accessed (Table 1). The list of selected rocks shows that it includes only Piemontese or Italian rocks. This deliberate choice was made on the one hand for restricting the set of selected rocks, on the other hand it is the result of choices made by past architects, who used only local rocks, in order to emphasize the importance of regional culture. This list is classified according to the genesis of rocks: intrusive and effusive igneous rocks, metamorphic rocks and sedimentary rocks (Figs. 6 and 7). In addition to this main division, based on scientific parameters, listed rocks may also be grouped using other keys of interpretation as to their origin (24 sourced

from the Western Alps, while 16 are extracted in other Italian areas), the color, the hardness. The form of each rock is organized according to the following fields: macroscopic photo of the rock, petrographic name, commercial name, quarry district, simplified geological map where the quarrying district is indicated, geological setting, main usage in Torino: monuments, churches or palaces of great importance where the rock has been employed (Fig. 8).

4) **Geological setting**. This item provides a brief description of the geology of the Piemonte region and the key to understand the geological information that is reported in the rock types card (see Fig. 1). There is also a short introduction to the main geological framework of Italy (see Fig. 2).

5) **Glossary**. This section provides definitions, in alphabetical order, of all words highlighted in bold in both the stone forms and points of interest.

6) In the "**To find out more"** section the quotations that were used in the texts and captions of figures are reported.

The mobile application can be downloaded free from the App Store or Google Play respectively for Apple and Android devices".

THE TOURS

The tours are the heart of the app, allowing tourists, walking under the arcades of the city, or relaxing on a bench in its squares, to step on and observe granite, porphyry, gneiss, marble and limestone, in a rich collection displayed in an open-air museum, and travel to curious and unexpected journeys through time, across geological ages, millions of years ago. There are four proposed itineraries, each with eight different stops, with some stops common to different itineraries. The choice of stops and itineraries was made primarily on the basis of geographical proximity of interest points in the historic center of the city. From the list of itineraries, by clicking on them, it is possible to view the map of the center of Torino with the itineraries traced and numbered. The "i" symbols facilitate additional information about the chosen itinerary, and the "position" symbol allows access to guided navigation (via Google maps) from the stop where the tourist is situated .

Tour 1: Scuse me, for the Cathedral? (Fig. 9)

One of the unique features of Torino is the presence of monumental arcades which have primarily been constructed of stone material. These arcades, characterized by more than 12 km of interconnected paths, represent one of the widest city promenade of Europe and are an architectural,

aesthetic and socio-economic example unique in the world. The street characterized by monumental arcades is Via Roma, rebuilt in the 1930s during the Fascist period. A significant increase of Piemonte quarrying activity occurred during its reconstruction, when columns, pillars, walls and flooring, were made exclusively with domestic stone materials as directed by the autocratic government. So the arcade of the Via Roma urban axis is a representative example where local stone has been effectively used both as a structural and a decorative element.

Thanks to the direct coordination of Piacentini, detailed rules for engagement of the new Via Roma in the neoclassical Carlo Felice square were specified. In front of the square is located the Porta Nuova station (**stop 1**). The façade shows, with high arches in stone (*Balma Syenite and Malanaggio Stone*) and large windows, its monumentality in keeping with the style of the surrounding buildings. Like all great voyages, the train station is the starting point of this route, which heads straight to the cathedral of the city. Leaving from Porta Nuova Railway station the arches of the first sector of Via Roma show mainly silicate rocks from Western Alps, as in the Santa Cristina block (**stop 2**), where only three types of ornamental stones were employed: the *Serizzo Antigorio* orthogneiss for the colonnade and the *Alzo Granite* and the *Balma Syenite* for the pavement. The architectural elements are characterized by the adoption of an entablature supported by a monotonous sequence of 180 columns in *Serizzo Antigorio,* expressing a rationalistic and monumental style.

In the C.L.N. (Comitato di Liberazione Nazionale) square (**stop 3**), marked by the statues of the Po and Dora Rivers in white *Carrara Marble,* the cladding slab in *Ornavasso Marble* of the San Carlo and Santa Cristina apses can be observed. Continuing beyond, the San Carlo square is reached (**stop 4**), the "living room of Turin", where in front of the twin churches petrography can help to understand which is exactly the Church that gives its name to the square. The church of Santa Cristina, designed by Filippo Juvarra in the early 18th century, is characterized by the use of the *Gassino Stone* for the facade and the *Vaie Stone* for the four columns. In contrast the entire facade of the church of San Carlo, a century younger, utilises *Pink Baveno Granite*.

The tour continues under the arcades along the second part of Via Roma. The two sectors of the arcades differ significantly for both architectural styles and the number and type of the materials used, some of them having been used for the first time. In particular, in the second section of the arcades, the silicate materials were mainly used for the main structural elements such as columns and pilasters, whereas the pavement was mostly made of polychrome carbonate rocks as in the Sant'Emanuele block (**stop 5**), where the *Vicenza stone*, the *Travertine*, the *Botticin*o, the *Canavese*

Diorite, the *Rosso Verona* for the colonnade, and the *Malanaggio Stone*, the *Trani Stone*, the *Verde Roja* and the *Bigio di Moncervetto* for the pavement were employed.

When Piazza Castello is reached the Palazzo Madama (**stop 6**) can be admired. It is a UNESCO World Heritage site, characterized by a spectacular internal staircase in *Frabosa marble* designed by Juvarra and by the façade cladded by *Chianocco and Foresto Marble*. Here at the seat of the Savoy Senate, the "Albertine Statute", reference document of the Italian Constitution, was approved. In front there is the Palazzo Reale (**stop 7**) that still preserves all his majesty, materialized by the austere bronze gate supported by pillars made of *Prali Marble*. Finally, the Cathedral of the city (**stop 8**) reveals itself: discreet as the people of Torino, elegant and refined with its ivory-colored facade, entirely made of *Chianocco and Foresto Marble*.

Tour 2: Under the Gallery, beyond the River (Fig. 10)

This itinerary starts in front of the Carignano Palace (**stop 1**), which hosted the first Italian Parliament. Its 19th century façade, built to commemorate the unification of Italy, is made up of several stone materials including the *Pink Baveno* and the *White Montorfano* granites. Passing through the Subalpina Gallery (**stop 2**) the historic stone *Verde Alpi*, an ophicalcite coming from the Monginevro ophiolitic massif located at the head of the Susa Valley, along the Italian-French border, can be viewed. Leaving the arcades of Piazza Castello, the Emanuele Filiberto Monument appears (**stop 3**), built entirely in *Balma Syenite*. Walking along Via Verdi the route passes into the courtyard of the Rectorate Palace of Torino University (**stop 4**) with the columns carved in *Gassino Stone*. At the sides of the courtyard the spectacular staircases give access to the main floor, with steps carved on *San Basilio Stone* and a balustrade made of *Travertine*. Leaving behind the Rectorate, the Mole Antonelliana appears (**stop 5**), characterized by the dome made in *Luserna Stone*. When it was constructed in 1889 it was the tallest masonry building in the world. Returning to Via Po the façade of the Santissima Annunziata Church can be admired (**stop 6**), the only one in the city constructed of *Travertine*. Then a stop on the Vittorio Emanuele I Bridge (**stop 7**), with its tangible sign of the Napoleonic domination in the "Ville de Turin", allows tourists to look out over the Po River. Here *Cumiana Stone* resists the vagaries of Italy longest river. Finally the Gran Madre Church (**stop 8**) can be reached, where *Malanaggio Stone* is utilised at the foot of the columns.

Tour 3: A matter of bridges (Fig. 11)

The bridges are the most loved and, in rush hours, most hated constructions by Torino inhabitants. This tour starts from the French Castle of Valentino (**stop 1**), located along the shores of the Po River and characterized by a suitable court designed at the beginning of 17thcentury by Carlo and

Amedeo di Castellamonte by order of Maria Cristina of France, who wanted the pitched French roofs made of *Ligurian Slate*. Until the decline of the French monarchy the Castle was a place of parties, parades, deer hunting, and home to diplomatic meetings. It is now the seat of the architecture faculty of the city. The courtyard is paved with the original cobblestones made of river pebbles in *quartzite* and *serpentine*, whereas the internal colonnade is composed of *Baveno Granite*, *Malanaggio Stone* and *Macchia Vecchia Svizzera*, a spectacular multi-colored carbonate breccia. Crossing the Valentino Park the monumental Umberto I Bridge, built at the beginning of the 20th century (1903–1907), can be reached (**stop 2**). The structure of the bridge consists of three semielliptical arches built on pillars with a semicircular rostrum and made of different Alpine stones, including *Malanaggio Stone*, *San Basilio Stone* and *Vaie Stone*. The decorations and the lining of the fronts, the cornice and frieze are made of *Alzo Granite*, while the pillars of the parapet are made of white *Carrara Marble*. From the bridge the Church of San Massimo is easily reached (**stop 3**); it was built in the 18t^{h} century in Neoclassical style and is characterized by a portico consisting of four columns of *Baveno Granite*, the same rock in which were made the pronao columns of the Mole Antonelliana (**stop 4**), symbol of the Torino city and currently the site of the Cinema Museum. Just two blocks further the "Palazzo Nuovo" (**stop 5**), seat of the humanities departments of the University of Torino, is encountered. The lobby at the ground floor is paved in *Val Malenco Serpentinite* and *Euganean Trachite*. Leaving the building and following the bell tower the front façade of the Santissima Annunziata Church (**stop 6**) can be reached, characterized by a low entry staircase built with *Anzola black granite*. From Via Po the Napoleonic Vittorio Emanuele I Bridge (**stop 7**) is crossed. It has been entirely built of *Cumiana Stone*, and represents the first great modern stone bridge built in Italy since the Renaissance. Finally the Gran Madre Church (**stop 8**) is reached. It was commissioned by citizens to welcome the return of the Savoy after the restoration; it was inaugurated in 1831 and was inspired by the Roman Pantheon. The predominant architectural element are the six monolithic columns formed by *Malanaggio Stone* and related capitals carved in *Frabosa Marble*.

Tour 4: City institutions (Fig. 12)

This tour starts from the Regional Natural Science Museum, a treasure trove of ancient fossils and precious gems, and touches some of the most important monuments and buildings of the city. The Museum (**stop 1**) is hosted in the 17th-century building of the old San Giovanni Battista Hospital. This building has many architectural elements made of *Gassino Stone*, the most prominent stone material used in the city until the 19th century. Notable are also the floors of the interior landings paved with the *Barge Quartzite*. Leaving the Museum, the San Filippo Church (**stop 2**) can be

reached after a short walk. It is the largest religious building in Torino, home to solemn Holy music performances. It is characterized by a neoclassical portico with *Brossasco Marble* columns and a pediment of *Frabosa Marble*. Continuing toward the Subalpina Gallery (**stop 3**), numerous shop windows bordered with *Giallo Siena* can be identified including the historic coffee shop of "Baratti & Milano", attended by the Count of Cavour. The foyer of the Teatro Regio (**stop 4**) is the entrance to Torino temple of opera. Along the side that overlooks on Via Verdi, exterior stone cladding is made of *Peperino* lava stone with *Verde Roja* pelite for the plinth. Crossing Piazza Castello the Emanuele Filiberto monument (**stop 5**) can be observed, which is entirely made with the *Balma Syenite*. The San Giovanni cathedral (**stop 6**) has a candid Renaissance façade featuring *Chianocco and Foresto Marble*.Nearby is the Basilica Mauriziana (**stop 7**) where the statues of *Prali Marble* portal occur. Finally, the tour stop in front of the Palazzo di Città façade (**stop 8**), site of town hall, utilizing *Gassino Stone* and *Verde Alpi*. .

CONCLUSIONS

Stone has strongly characterized the architectural identity of the city of Torino with more than 150 varieties in use. This is a significant richness at a national level. Recently this heritage is being promoted from a touristic point of view - setting up cultural routes not only targeting geological professionals but also the geotourist, and more generally a wider audience.

The TourInStone application aims to disseminate knowledge about stone on both scientific and educational sides by making available a tool easy to use by those who work in planning. In particular it is aimed at: 1) scientific community in the field of earth sciences and cultural heritage, 2) institutions dealing with the promotion and preservation of historical and architectural heritage, 3) organizations and local authorities.

In Europe, for some years, concepts such as Responsible Research and Innovation (RRI) have spread, whose main axes are public engagement and science education, intended as innovative ways of doing research and training. TourInStone is an application of this innovative way to educate and interest a wider public as well as a university one. The technical-scientific study of materials, its simplification and dissemination, the combination with the cultural aspect and the territory represent a new way of doing research in line with the objectives of universities across Europe.

This work represents a prototype that can be integrated and expanded, and it is the basis for a further development on a larger scale (thematic or geographical) as well as a good example of enhancement of heritage stone aimed to promote simultaneously alternative forms of tourism.

In addition to the most famous monuments (churches, palaces, theaters, etc.), other sites will be also considered, located in the less touristic areas of the city (for example new residential settlements in peripheral areas of the city or along main roads that cross the city). In fact, the proposed specific thematic itineraries can also be seen as an opportunity to promote a new interpretations of the city by targeting lesser-known areas.

In conclusion, it can be recognised that the rocks provide the most significant moments of Torino history and, in many cases, of Italy. A walk through the austere buildings of the historic centre offers the chance to see a quick overview of the main ornamental rocks of Italy, and also retrace the main steps of its short, but intense political and social history.

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CAPTIONS

Fig. 1 - Geological sketch map of the Western Alps and quarrying site location of the Alpine ornamental stone reported in the application.

Fig. 2 - Geological sketch map of Italy and quarrying site location of the ornamental stone from other Italian regions reported in the application

Fig. 3 Image of the main menù of TourInStone application

Fig. 4 - Location of the twenty-six sites of interest of the application on the Torino toponomastic map.

Fig. 5 - Example of description card for the “Valentino Castle” site.

Fig. 6a - Representative images of the ornamental stones described in TourInStone application (first part).

Fig. 6b - Representative images of the ornamental stones described in TourInStone application (second part).

Fig. 8 - Example of description card for the *Luserna Stone*.

Fig. 9 - Description and illustration of Tour n. 1:Excuse me, for the Cathedral? The stops are reported on the toponomastic map of Torino.

Fig. 10 - Description and illustration of Tour n. 2: Under the Gallery, beyond the River. The stops are reported on the toponomastic map of Torino.

Fig. 11 - Description and illustration of Tour n. 3: A matter of bridges. The stops are reported on the toponomastic map of Torino.

Fig. 12 - Description and illustration ofTour n. 4: City institutions. The stops are reported on the toponomastic map of Torino.

Table 1 Description of the selected hornamental stones

Table 2 list of the selected sites

Figure1

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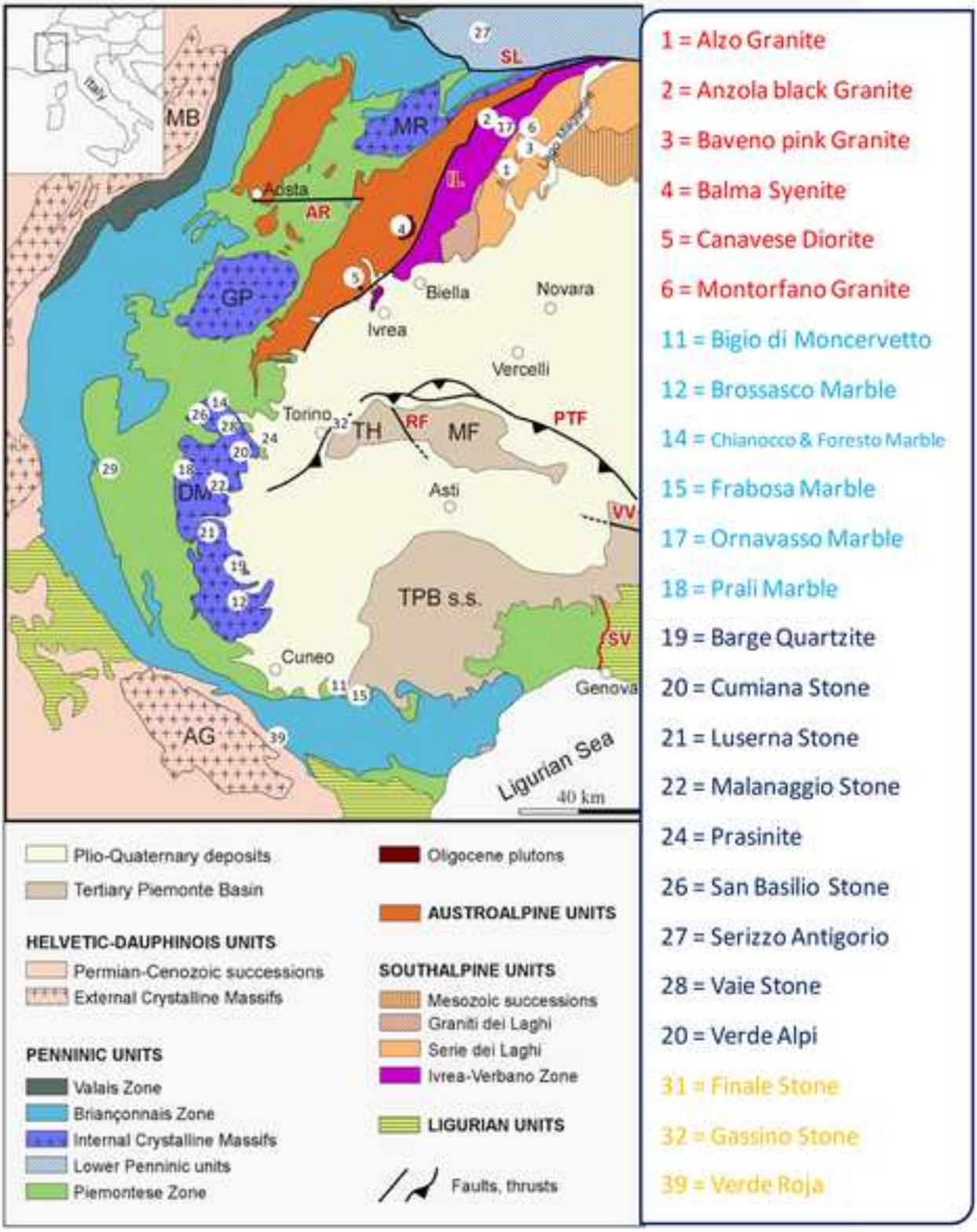

Figure2

Click here to download Figure fig_2.jpg

Legend: 7 = Sardinian Granite; 8 = Euganean Trachyte; 9 = Peperino; 10 = Trentino Porphyry; 13 = Carrara Marble; 16 = Giallo Siena; 23 = Malenco Serpentinite; 25 = Rosso Levanto; 30 = Botticino; 33 = Istria Stone; 34 = Ligurian Slate; 35 = Macchia Vecchia; 36 = Rosso Verona; 37 = Trani Stone; 38 = Travertine; 40 = Vicenza Stone.

Figure3

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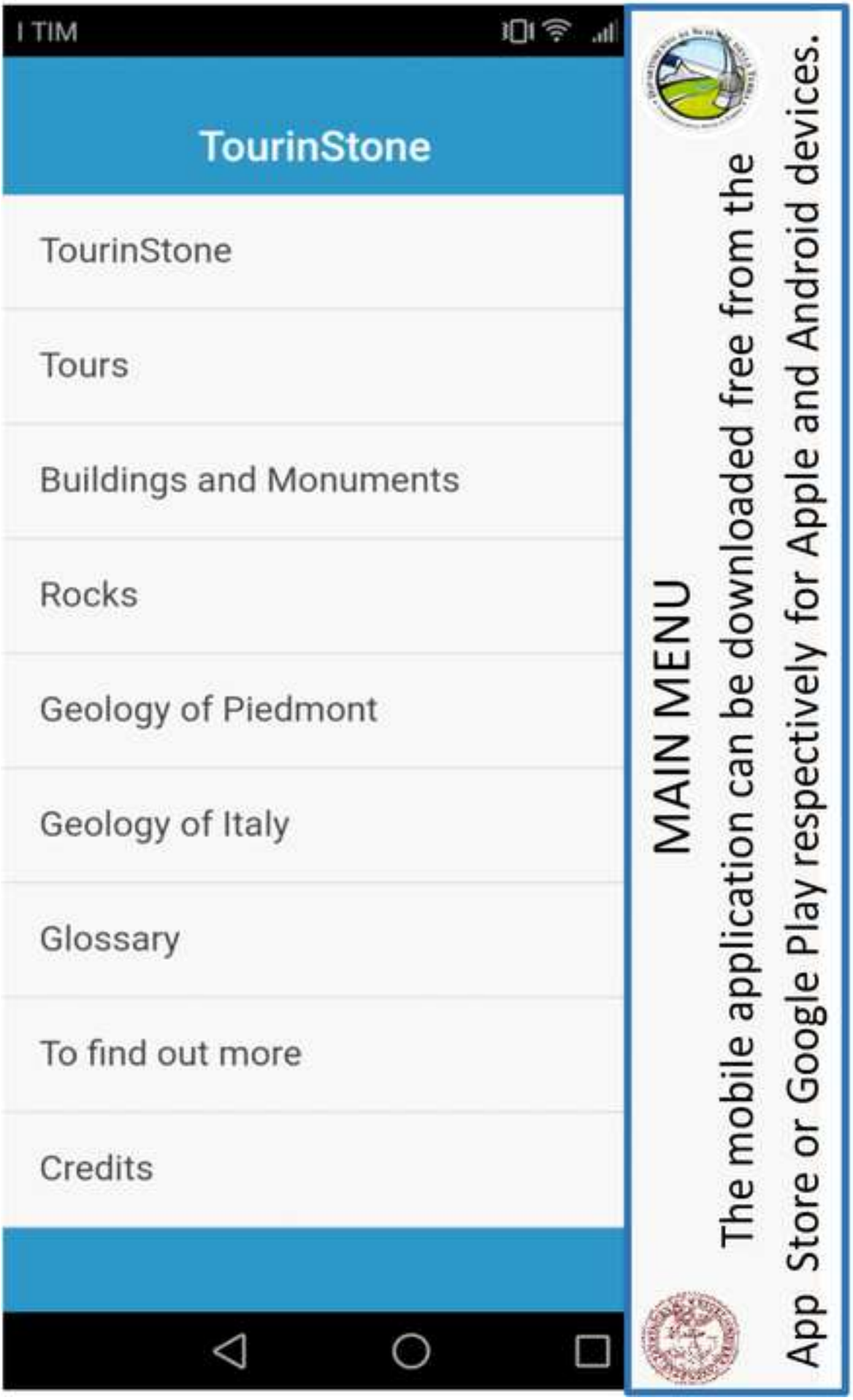
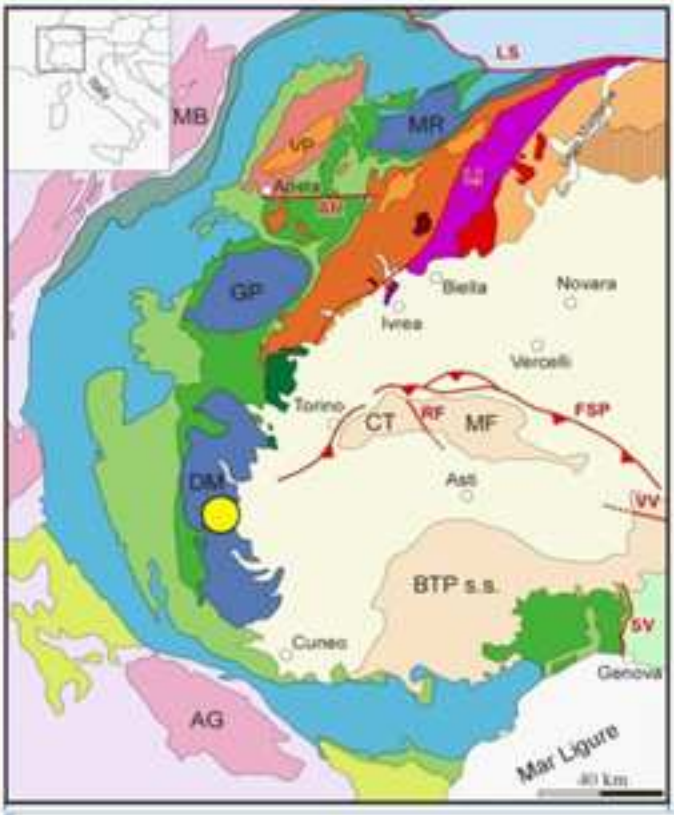


Figure4

Click here to download Figure fig_4.jpg

1 – Basilica Mauriziana
2 – Cathedral of San Giovanni
3 –C.L.N. Square
4 – Emanuele Filiberto Monument
5 – Gran Madre di Dio Church
6 – Mole Antonelliana
7 – Palazzo Carignano
8 – Palazzo di Città (Town hall)
9 – Palazzo Madama
10 – Palazzo Nuovo (Umanities Faculty)
11 – Palazzo Reale
12 – Palazzo dell'Università (Rectorate)
13 – Porta Nuova rail station
14 – Regional Museum Natural Science
15 – San Carlo Square
16 – San Filippo Neri Church
17 – San Massimo Church
18 – Santissima Annunziata Church
19 – Subalpina Gallery
20 – Umberto I bridge
21 – Teatro Regio
22 – Valentino Castle
23 – Via Roma – S. Federico block
24 – Via Roma – S. Emanuele block
25 – Via Roma – S. Cristina block
26 – Vittorio Emanuele I bridge

21 Luserna Stone



Petrographic name: *Orthogneiss*

Commercial name: Luserna Stone, Bagnolo Stone, Rorà Stone

Quarry district

It outcrops in a quite large area (approximately 50 square kilometers) in the Cottian Alps, on the border between Torino and Cuneo provinces. The main quarry district was historically located near the municipality of Luserna San Giovanni, Rorà and Bagnolo Piemonte.

Geological setting

This stone belongs to the Penninic unit of the Dora Maira Massif, a tectonic unit of continental crust which suffered an eclogitic metamorphic event during the Alpine orogeny. It represents the Alpine metamorphic product with fine to medium grained size, of early Permian age (290-245 Ma) granitoids.

Main usage in Turin

- The slabs covering the dome of the Mole Antonelliana
The façade of the Automobile Museum
Paving of Piazza Castello and other squares of the city
The sidewalk of Vittorio Emanuele I and Umberto I bridges

Macroscophic description

The Luserna Stone shows a light grey color and a good fissility, being easy to split along the schistosity planes, defined by white mica crystallized under high pressure conditions and, in smaller quantities, biotite, and chlorite. The stone is characterized by micro-augen texture and medium-fine grained size. Magmatic porphyroclasts of K-feldspar, in addition to quartz and albite are clearly visible.

22 Valentino Castle

ADDRESS: Viale Pier Andrea Mattioli 39 – TORINO

ITINERARY n. 3: A matter of bridges

HISTORICAL DESCRIPTION: The Valentino Castle is located in Valentino Park, one of the most loved park in Turin. This building was designed at the beginning of '600 by Carlo and Amedeo di Castellamonte by order of Maria Cristina of France, who wanted the slate pitched roofs inclined like French style. Until the decline of the French monarchy was a place of parties, parades, hunting deer, and home to diplomatic meetings. For the industrial exhibition of 1858 two side sleeves were built. In 1859 it hosted the first seat of the Polytechnic and today is home to the Department of Architecture.

ORNAMENTAL STONES employed :

- Baveno Granite
- Ligurian Slate
- Macchia Vecchia
- Quartzite
- Finale Stone
- Luserna Stone
- Malanaggio Stone
- Serpentinite

Figure7

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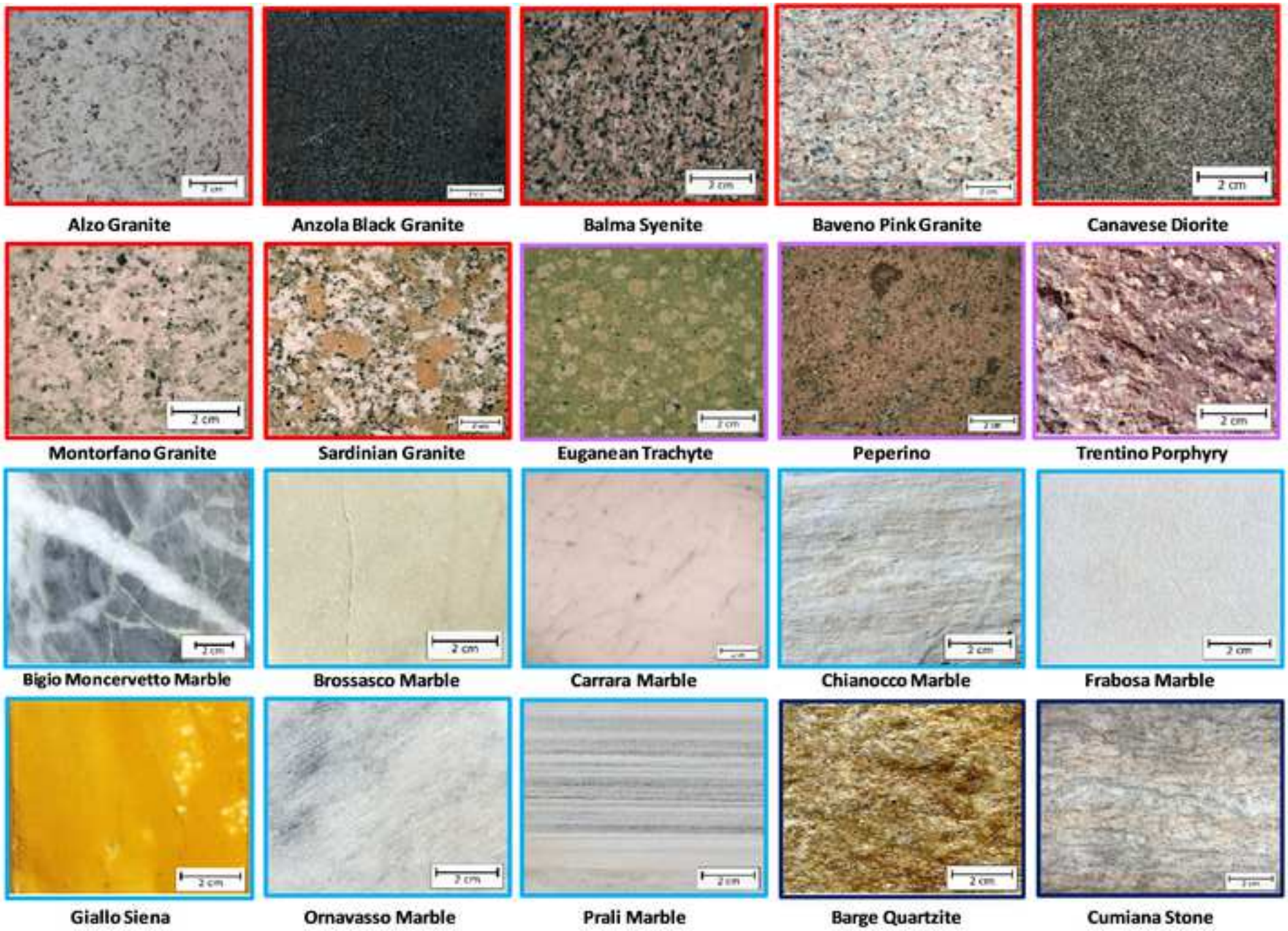

Figure8

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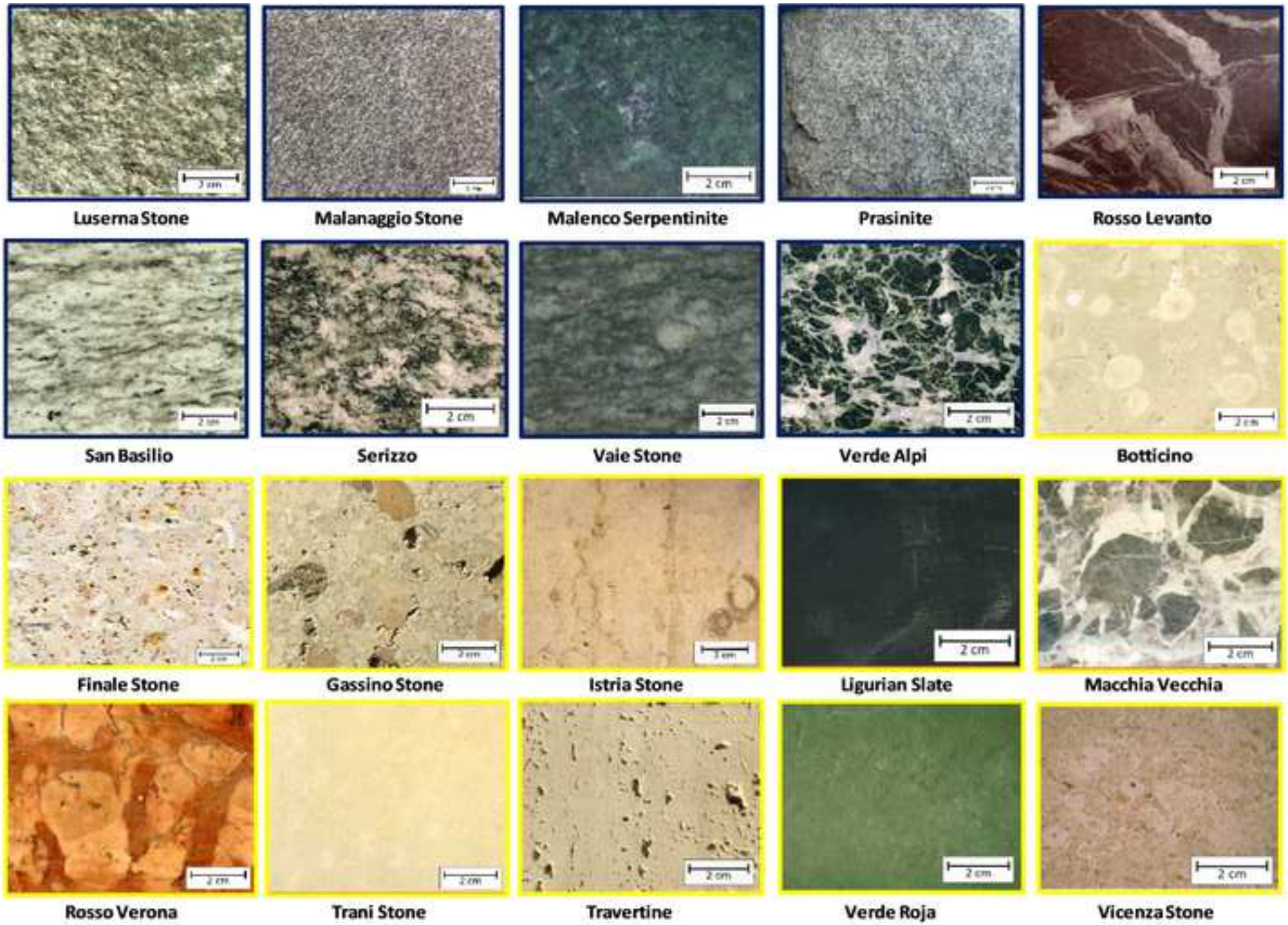

Figure9

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Figure10

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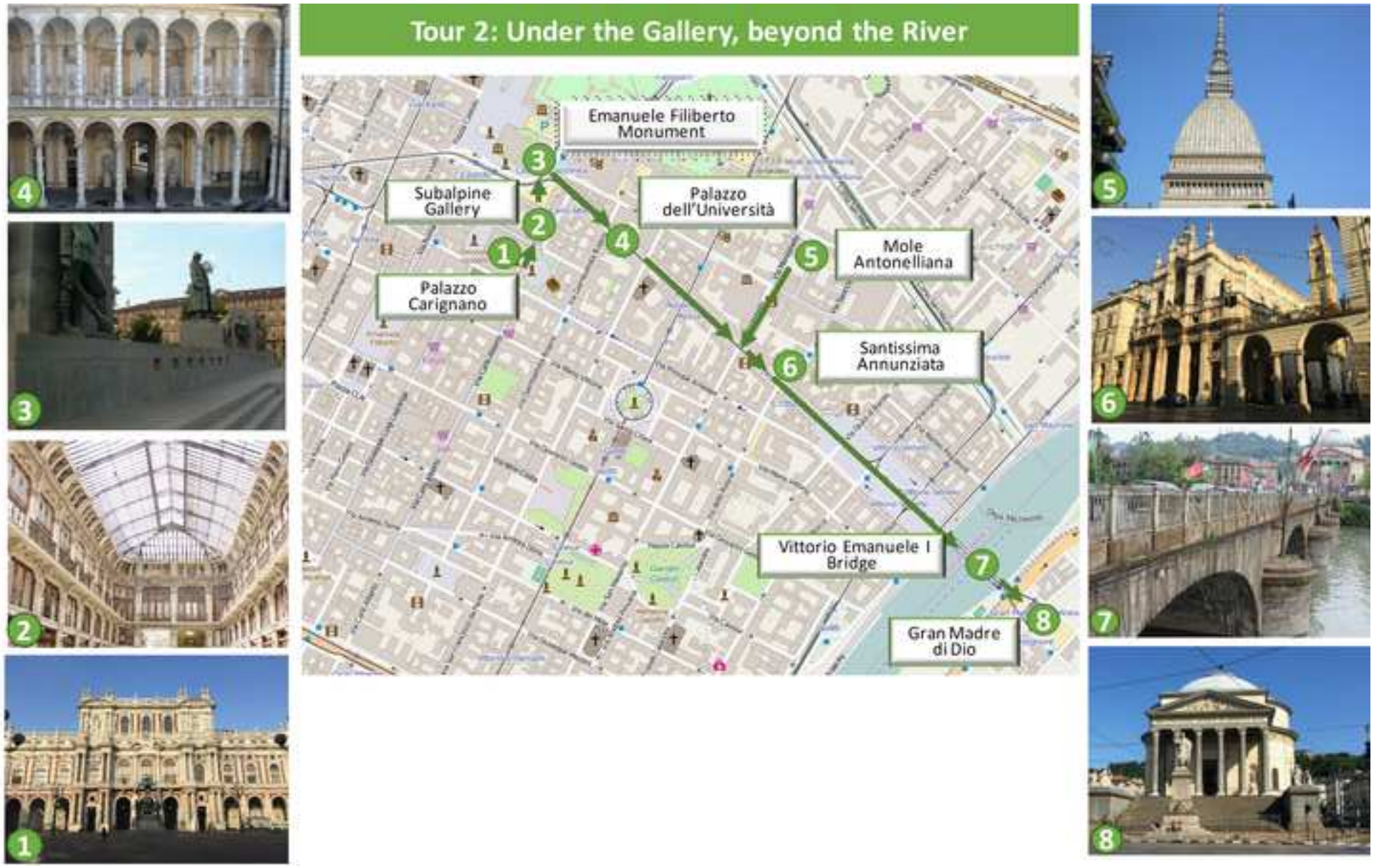

Figure11

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Figure12

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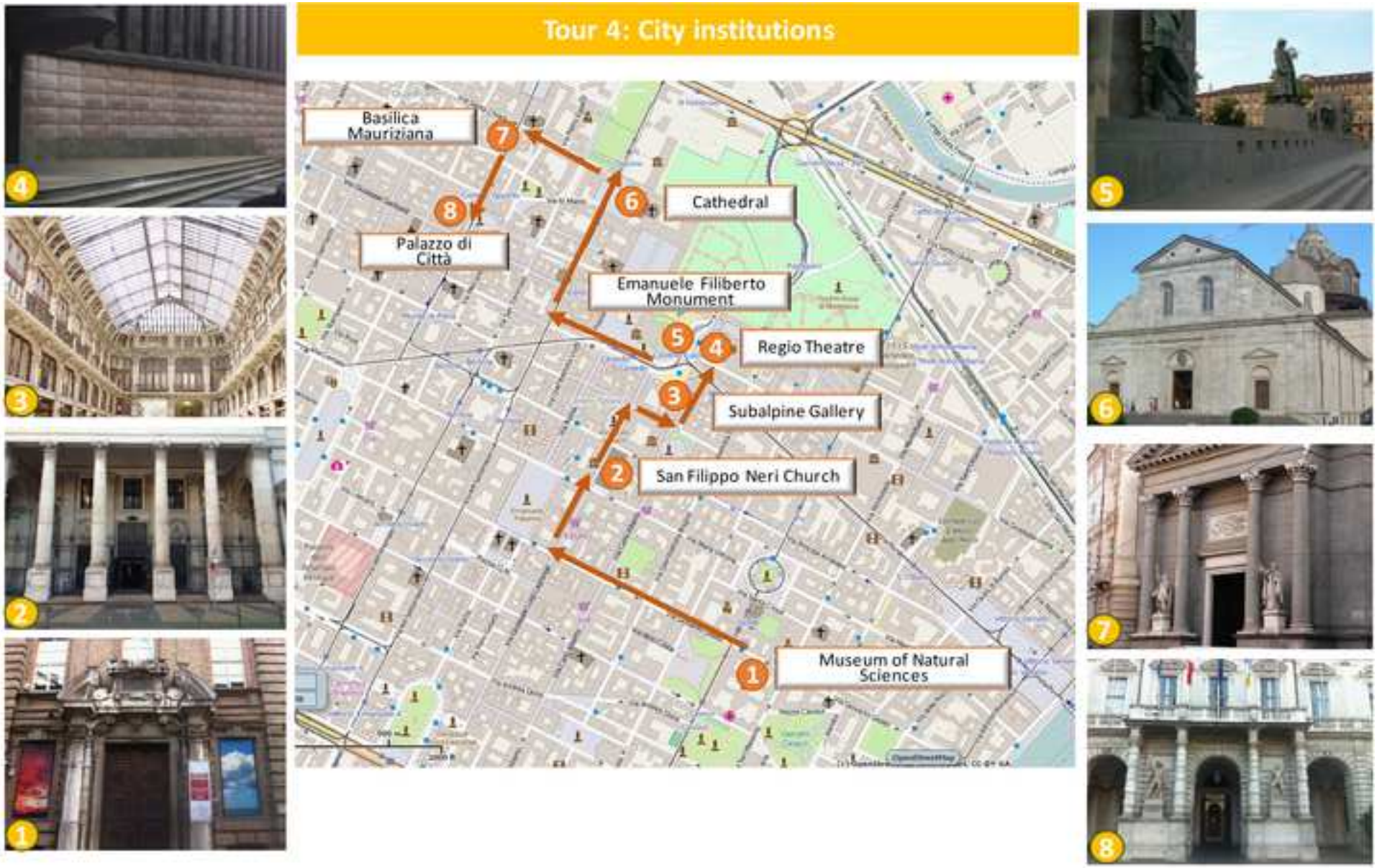

Table1

#	HISTORIC NAME	PETROGRAPHIC NAME	GEOLOGIC UNIT	AGE	NATURE	HARD NESS
1	Alzo Granite	Granite	Serie dei Laghi	Permian	Igneous intrusive	Hard
2	Anzola Black Granite	Gabbro –norite	Ivrea Verbano Zone	Permian	Igneous intrusive	Hard
3	Balma Syenite	Syenite	Sesia Lanzo Zone	Oligocene	Igneous intrusive	Hard
4	Baveno Pink Granite	Granite	Serie dei Laghi	Permian	Igneous intrusive	Hard
5	Canavese Diorite	Quartz-diorite	Sesia Lanzo Zone	Oligocene	Igneous intrusive	Hard
6	Montorfano Granite	Granite	Serie dei Laghi	Permian	Igneous intrusive	Hard
7	Sardinian Granite	Granite	Sardinian Plutonic Complex	Permian	Igneous intrusive	Hard
8	Euganean Trachyte	Trachyte	Euganean Hill	Oligocene	Igneous effusive	Hard
9	Peperino	Ignimbrite	Roman province	Pleistocene	Igneous effusive	Soft
10	Trentino Porphyry	Riodacite	Atesine Porphyric Platform	Permian	Igneous effusive	Hard
11	Bigio di Moncervetto	Marble	Briançonnais Zone	Triassic	Metamorphic	Soft
12	Brossasco Marble	Marble	Dora Maira Massif	Palaeozoic	Metamorphic	Soft
13	Carrara Marble	Marble	Apuan Alps	Jurassic	Metamorphic	Soft
14	Chianocco & ForestoMarble	Marble	Dora Maira Massif	Triassic	Metamorphic	Soft
15	Frabosa Marble	Marble	Briançonnais Zone	Triassic	Metamorphic	Soft
16	Giallo Siena	Marble	Tuscan Nappe	Jurassic	Metamorphic	Soft
17	Ornavasso Marble	Marble	Ivrea Verbano Zone	Palaeozoic	Metamorphic	Soft
18	Prali Marble	Marble	Dora Maira Massif	Palaeozoic	Metamorphic	Soft
19	Barge Quartzite	Quartzite	Dora Maira Massif	Permian	Metamorphic	Hard
20	Cumiana Stone	Orthogneiss	Dora Maira Massif	Permian	Metamorphic	Hard
21	Luserna Stone	Orthogneiss	Dora Maira Massif	Permian	Metamorphic	Hard
22	Malanaggio Stone	Orthogneiss	Dora Maira Massif	Permian	Metamorphic	Hard
23	Malenco Serpentinite	Serpentinite	Malenco Ophiolitic Unit	Jurassic	Metamorphic	Soft
24	Prasinite	Metabasite	Piemontese Zone	Jurassic	Metamorphic	Hard
25	Rosso Levanto	Ophicarbonate	Ligurian Units	Jurassic	Metamorphic	Soft
26	San Basilio Stone	Orthogneiss	Dora Maira Massif	Permian	Metamorphic	Hard
27	Serizzo	Orthogneiss	Lower Penninic Units	Permian	Metamorphic	Hard
28	Vaie Stone	Orthogneiss	Dora Maira Massif	Permian	Metamorphic	Hard
29	Verde Alpi	Ophicarbonate	Piemontese Zone	Jurassic	Metamorphic	Soft
30	Botticino	Limestone	Lombardian Basin	Jurassic	Carbonate sedimentary	Soft
31	Finale Stone	Limestone	Tertiary Piemonte Basin	MIocene	Carbonate sedimentary	Soft
32	Gassino Stone	Limestone	Tertiary Piemonte Basin	Eocene	Carbonate sedimentary	Soft
33	Istria Stone	Limestone	Istrian Platform	Eocene	Carbonate sedimentary	Soft
34	Ligurian Slate	Marly limestone	Ligurian Units	Cretaceous	Carbonate sedimentary	Soft
35	Macchia Vecchia	Carbonate Breccia	Lombardian Basin	Triassic	Carbonate sedimentary	Soft
36	Rosso Verona	Limestone	Trento Plateau	Jurassic	Carbonate sedimentary	Soft
37	Trani Stone	Limestone	Apulia platform	Cretaceous	Carbonate sedimentary	Soft
38	Travertine	Travertine	Acque Albule Basin	Pleistocene	Carbonate sedimentary	Soft
39	Verde Roja	Mudrock	Dauphinois Units	Permian	Terrigenous sedimentary	Soft
40	Vicenza Stone	Limestone	Lessini Platform	Oligocene	Carbonate sedimentary	Soft

Table2

#	HISTORIC NAME	POSITION	AGE	STYLE	STONE MATERIALS
1	Basilica Mauriziana	45°04’29”N 7°40’57”E	1718 - 30	Baroque	Malanaggio Stone, Carrara Marble, Prali Marble, Frabosa Marble
2	Cathedral of San Giovanni	45°04’24”N 7°41’06”E	1491	Renaissance	Balma Syenite, Chianocco and Foresto Marble, Ormea Black Marble,
3	C.L.N. Square	45°03’59”N 7°40’54”E	1935 - 38	Decò	Trentino Porphyry, Carrara Marble, Ornavasso Marble, Serizzo Antigorio
4	Emanuele Filiberto Monument	45°04’14”N 7°41’11”E	1933 - 35	Rationalism	Balma Syenite
5	Gran Madre di Dio Church	45°03’45”N 7°41’56”E	1818 - 31	Neoclassicism	Montorfano Granite, Baveno Granite, Frabosa Marble, Prali Marble, Malanaggio Stone
6	Mole Antonelliana	45°04’08”N 7°41’35”E	1862 - 88	Neoclassicism	Baveno Granite, Luserna Stone
7	Palazzo Carignano	45°04’07”N 7°41’09”E	1864-84	Eclecticism	Baveno Granite, Montorfano, Frabosa Marble, Cumiana Stone, Prasinite, Gassino Stone
8	Palazzo di Città (Town hall)	45°04’23”N 7°40’51”E	1659 - 65	Baroque	Carrara Marble, Verde Alpi, Gassino Stone
9	Palazzo Madama	45°04’15”N 7°41’08”E	1718-21	Baroque	Chianocco and Foresto Marble, Luserna Stone, Vaie Stone, Botticino, Gassino Stone, Travertine
10	Palazzo Nuovo	45°04’04”N 7°41’39”E	1961 - 66	Contemporary	Euganean Trachyte, Val Malenco Serpentinite
11	Palazzo Reale	45°04’18”N 7°41’08”E	1649 - 58	Baroque	Trentino Porphyry, Brossasco Marble, Prali Marble, Malanaggio Stone, San Basilio Stone
12	Palazzo dell’Università (Rectorate)	45°04’10”N 7°41’20”E	1713 - 20	Baroque	Pont Canavese Marble, Gassino Stone, Travertine
13	Porta Nuova rail station	45°03’45”N 7°40’43”E	1861	Eclecticism	Montorfano Granite, Balma Syenite, Malanaggio Stone
14	Regional Museum of Natural Science	45°03’52”N 7°41’19”E	1680	Baroque	Cumiana Stone, Prasinite, Gassino Stone
15	San Carlo Square	45°04’01”N 7°40’55”E	1637 - 42	Baroque	Baveno Granite, Balma Syenite, Vico Sienite, Carrara Marble, Chianocco and Foresto Marble, Frabosa Marble,Vaie Stone, Gassino Stone
16	San Filippo Neri Church	45°04’04”N 7°41’04”E	1716 - 30	Baroque	Baveno Granite, Brossasco Marble, Carrara Marble,Frabosa Marble, Luserna Stone, Barge Quartzite, Gassino Stone
17	San Massimo Church	45°03’42”N 7°41’15”E	1845	Neoclassicism	Baveno Granite, Balma Syenite
18	Santissima Annunziata Church	45°04’00”N 7°41’32”E	1648 - 56	Baroque	Anzola Black Granite, Botticino, Travertine, Verde Roja
19	Subalpina Gallery	45°04’29”N 7°40’57”E	1873	Eclecticism	Baveno Granite, Carrara Marble, Giallo Siena, Verde Alpi, Rosso Verona
20	Regio Theatre	45°04’14”N 7°41’14”E	1965-73	Contemporary	Sardinian Granite, Peperino, Verde Alpi, Verde Roja
21	Umberto I bridge	45°03’28”N 7°41’31”E	1907	Liberty	Alzo Granite, Balma Syenite, Carrara Marble, Luserna Stone,

					Malanaggio Stone, San Basilio Stone
22	Valentino Castle	45°03’14”N 7°41’11”E	1620 - 60	Baroque	Ligurian Slate, Baveno Granite, Lserna Stone, Malanaggio Stone, Macchia Vecchia, Finale Stone
23	Via Roma – S. Emanuele block	45°04’12”N 7°41’03”E	1931 - 33	Decò	Montorfano Granite, Vico Diorite, Moncervetto Marble, Botticino, Rosso Verona, Trani Stone, Travertine, Vicenza Stone, Verde Roja
24	Via Roma – S. Federico block	45°04’07”N 7°41’00”E	1931 -33	Decò	Baveno Granite, Carrara Marble, Rosso Levanto, Verde Alpi, Finale Stone
25	Via Roma – S. Cristina block	45°03’58”N 7°40’53”E	1935 - 38	Rationalism	Alzo Granite, Balma Syenite, Serizzo Antigorio
26	Vittorio Emanuele I bridge	45°03’48”N 7°41’51”E	1810 - 13	Neoclassicism	Vico Diorite, Balma Syenite, Luserna Stone, Cumiana Stone

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TourinStone: a free mobile application for promoting geological heritage in the city of Torino (NW Italy)

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ABSTRACT

The Piemonte mountains surrounding the city of Torino comprise a wide variety of rocks, characterized by a multitude of minerals, structures and colors. The Alps, for their long and complex history, offer a wide variety of ornamental stone used in the town, over the centuries, for both aesthetic and structural reasons. TourinStone is an application for mobile that allows geotourists to walk in the center of Torino, where the visitor can find out Alpine rocks used in palaces and historical monuments, witnesses and tangible symbols of the city. The application consists of twenty-six historical site of interest in each of which you can observe in detail a lot of ornamental stones of historical and scientific interest. The sites are grouped in four thematic itineraries through which the user can discover the city from the cultural and architectural point of view. By a numbered list of the stones used in all described monuments you can access the specific data of each rock as quarry district, petrographic description and main usage in Torino. The mobile application can be downloaded free from the App Store or Google Play respectively for Apple and Android devices.

KEY WORDS: applied petrography, multimedia application, ornamental stones, cultural heritage, Torino

INTRODUCTION

Dimension stones have always been recognized as one of the most important natural resources for construction and building; in particular, as they have been used as raw materials for masterpieces of sculptures and for architectural elements, they are representative of worldwide cultural heritage. Therefore, the knowledge of stone resources (the minero-petrographic features, their use and exploitation techniques from ancient times to the present) can provide a broad overview of the historical and cultural significance of such materials, highlighting the relevance of an economic

activity so important for the history and traditions of the different cultures developed through the centuries all over the Mediterranean area (Cooper 2015).

The abundance of stone materials coming from different areas in the Piemonte territory and employed over the centuries to realize paving, monuments and public buildings, to embellish churches, storefronts and commercial shops, shows the close link between the city of Torino and the surrounding territory, emphasizing the role that stone has played on the culture and economic wealth of Torino during the centuries: first as capital city of Savoy kingdom, then as the Italian capital, and finally as the main center of the domestic industry. In recent decades, however, because of the economic situation, also Torino, headquarter of the XX Olympic Winter Games in 2006, has undergone a deep transformation that has led it to become a tourist town full of cultural attractions. Its monuments and stone buildings built over the centuries represent now a major excellence of the city. In this framework, the knowledge and enhancement of historic ornamental stones from Torino can lead to a new geotouristic approach for the development of urban geological heritage. Over the last century, the petrographic description of Torino ornamental stones has been the subject of several papers (e.g., Sacco 1907; Peretti 1937; Rodolico 1953; Chiari et al. 1992; Fiora et al. 2002; Borghi et al. 2014, 2015; Poretti et al., 2015). Recently, a multimedia CD petrographic guide of the city was performed by Fiora et al. (2007). However, a tour guide, easy to use and which allows to enjoy the geodiversity offered by the historical buildings of the city, is not yet available.

The purpose of this paper is to describe an app recently delivered which has the target to locate in the Torino city some itineraries that offer to visitors the opportunity to learn, in addition to the historical and architectural aspects of the building, their lithological component. In tourist and popular publications, in fact, this issue is rarely addressed and many tour guides are not prepared to expose it properly or to answer questions on the stone materials that are encountered in the various itineraries. It is also believed that this should be interesting from many points of view: the various ornamental stones used in architecture play a structural function and an important color component, but it can also be viewed in a broader perspective, as a transformation element of the territory, through the quarrying activity, the peculiar geological characteristics of the stone materials and the characteristics of the site of origin.

TourinStone is an application for smartphones and tablets in which twenty-six selected sites are reported in order to provide an overview of the main ornamental stones used in historical buildings, churches and streets of the city center, that compose an open-air petrographic collection. The development of itineraries and the simplified texts for non-experts can bridge a gap between the geology of the Alps and the city, its citizens, its students and its tourists.

GEOLOGICAL SETTING

The great variety of ornamental and building stones used in Torino for architectonic elements is certainly due to the highly composite geological nature of the region. In Piemonte, indeed, very different geological units occur: the western portion of the metamorphic Alpine Chain and the sedimentary Tertiary Piemonte Basin. The large variety of rocks outcropping in the Alpine system are grouped into four main units separated by tectonic contacts and characterized by similar paleogeographic origin and geological history. These units are named (outwards along the chain): Southalpine, Austroalpine, Penninic and Helvetic–Dauphinois Units. On the Alpine territory quarrying districts of particular importance exist for the sector of natural stones, some of which were employed in the Torino architecture (Fig. 1 and Tab. 1). In the Southalpine Unit the Verbano district is characterized by the exploitation of some magmatic rocks as Alzo, Baveno and Montorfano granites besides the Anzola black granite (actually a gabbro- norite). From the Austroalpine domain the Balma Syenite and Vico Diorite are coming. The quarrying district of Cusio-Ossola, located in correspondence of the deep geological structures of the Alps, is rich in ortogneiss such as “Serizzo”. In the Penninic domain, the most important quarrying district is represented by the Dora Maira (DM) Massif, from where many different stones (Cumiana, Luserna, Malanaggio, San Basilio and Vaie), as well as the Barge quartzite, come,.From the oceanic crust unit (Piemontese Zone) instead the prasinite and the “Verde Alpi” ophicarbonate are quarried . In the past also other parts of the Piemonte region were the subject of intense production of stone materials: an example is the quarrying district of the Briançonnais Zone, from where came the most Piemontese colored marbles, as Bigio di Moncervetto and Ormea black marbles. Finally, many Piemontese white marbles were exploited, generally, from small lenses of different Alpine geological units, such as the Brossasco, Chianocco, Foresto and Prali marbles (from Dora -Maira Massif), the Pont Canavese marble (from Sesia Lanzo Zone), the Ornavasso marbles (from the quarrying district of the Ossola Valley, Borghi et al. 2009). Only one sedimentary rock (Verde Roja) was exploited from the Alpine chain, and precisely from the Dauphinois Unit. More abundant were the sedimentary ornamental stones coming from the Tertiary Piemonte Basin (TPB) developed in the internal part of the Western Alps from Eocene to Miocene. Among them limestone such as the Gassino Stone and the Finale Stone were employed.

A smaller amount of ornamental stones from other Italian regions, in particular sedimentary rocks, were also employed in Torino monuments and buildings (Fig. 2 and Tab. 1). The leading position of Italy in the natural stone field is a result of its extremely composite geological nature. Italian geology is characterized by the presence of several mountain chains and their associated

sedimentary basins. From North to South the orogenic belts are: the Alps (Northern Italy), the Apennines (central Italy), the Calabrian – Peloritan Arc (Southern Italy) and, finally, a portion of Maghrebid belt (Sicily). In these orogenic chains are exposed igneous and metamorphic rocks (in the Alps and Calabrian-Peloritan Arc), or sedimentary successions (Alps, Appennines and Maghrebid belts). The associated sedimentary basins are made up of sedimentary rocks of Paleogene (65 million years) to Recent ages. The geologic framework of Italy is completed by the Sardinian-Corsican block that represents a segment of the Paleozoic belt preceding the formation of the Alpine chain. The great variety of natural stones quarried in Italy therefore includes rocks of very different kinds, coming from various geological units. Between the ornamental stone employed in Torino, many carbonate sedimentary rocks as Botticino, Macchia Vecchia Svizzera, Vicenza Stone, Rosso Verona and Istria Stone came from the Mesozoic to Paleogene successions of the Southern Alps (Southalpine Domain). Other carbonate sedimentary rocks noticeable at Torino are the Trani Stone and the Roman Travertine (Southern and central Italy, respectively). Between magmatic stone employed in Torino there are the Sardinian Granite, coming from Sardegna, the Peperino from Apennines, the Trentino Porphyry and the Euganean Trachyte from Southern Alps. Finally the metamorphic rocks used in Torino are the Valmalenco Serpentinite (from Southern Alps), the Rosso Levanto, the Giallo Siena and the Carrara marbles, coming from Apennines.

THE STRUCTURE OF THE APPLICATION

TourinStone is an innovative instrument to promote, increase and enhance the urban geological heritage of Torino, thanks to which the visitor at the same time can enjoy the cultural aspect and the scientific one. The development of a multimedia application, indeed, provides access to some basic qualities of the web: effectiveness, accessibility, user attention, responsiveness, information management and content.

TourinStone is an application in which the selected sites are part of four thematic itineraries through which the user can discover the city from the cultural and architectural point of view, and at the same time know the stone materials used in buildings and monuments.

The target is to propose some geotouristic walks in the historic center of Torino that tell some important moments in the history of the city, described by its main buildings and monuments, but also the natural history that during tens and hundreds million years saw the formation of the Alps.

Opening the app, an introductory page can be displayed in which the TourinStone project is briefly described. From here you can access an index that contains the following items: 1) Buildings and Monuments, 2) Rocks, 3) Itineraries, 4) Geological setting, 5) Glossary, 6) Bibliography (Fig. 3).

1) **Buildings and Monuments**. The use of various types of stone in architecture is never neutral or random. It, in fact, results from the expressive choise of artist (and architect), or the economic or social importance of the artifact. A remarkable variety of relationships among materials, processing techniques, types of artifacts and formal results follows.

Thanks to this, the Torino architectural landscape allows the potential geotourist of ranging from monuments consisting of a single stone, such as the monument to Emanuele Filiberto in Balma Syenite placed in front of the Teatro Regio in Piazza Castello, to architectural works where the materials used are disparate such as the archades of Via Roma in the block of Sant'Emanuele, where as many as nine different ornamental stones were employed.

Taking into account the requirements of both artistic and scientific representativeness, twenty-six peculiar sites of Torino architectural history were selected and listed in alphabetical order in the application (Tab. 2 and Fig. 4). The numbering allows us to find sites on the city map; clicking on them the respective card can be opened. The selected sites are also linked to some information obtained through the literature as the time of construction, the former quarries of stone materials and other historical and architectural aspects useful to place them in the urban context of Torino. The card of each monument is organized according to the following fields: name, photos of the site of interest, address, itinerary in which it is included, artistic and historical description. At the bottom of the form there is a list of ornamental stones used for the specific site, from which their descriptions can be accessed (Fig. 5). The execution of photographs of monuments and buildings was performed in correspondence of particular architectural elements in which it is possible to highlight the use of stone quality materials.

2) **Rocks**. All the rocks used as stone materials, in addition to (as well as?) being appreciated from an aesthetic and architectural point of view, can tell us important "stories", both about their genesis and geological evolution in the millions of years, both on the subsequent historical periods during which the different rocks were distinguished on the basis of the methods of cultivation, transport and use as an ornamental stone. By a numbered list of the stones used in all described monuments you can access the specific data of each rock (Tab 1). Looking at the list of selected rocks you can also notice that it includes only Piemontese or Italian rocks. This deliberate choice was made on the one hand for restricting the set of selected rocks, on the other hand it is the result of choices made by the architects of the past, who used only local rocks, in order to emphasize the importance of territory culture. This list is divided according to the genesis of rocks: intrusive and effusive igneous rocks, metamorphic rocks and sedimentary rocks (Fig. 6 and 7). In addition to this main division, based on scientific parameters, listed rocks may also be grouped using other keys of interpretation

as to their origin (26 coming from the Western Alps, while 16 are extracted in other Italian areas), the color, the hardness. The form of each rock is organized according to the following fields: macroscopic photo of the rock, petrographic name, commercial name, quarry district, simplified geological map where the quarrying district is indicated, geological setting, main usage in Torino: monuments, churches or palaces of greater importance where the rock has been employed (Fig. 8).

4) **Geological setting**. This item shows a brief description of the geology of the Piemonte and the key to understand the geological information that is reported in the rock forms (see Fig. 1). There is also a short introduction to the main geological setting of Italy (see Fig. 2).

5) **Glossary**. This section provides definitions, in alphabetical order, of all words highlighted in bold in the stone forms and points of interest.

6) In the **find out more** section the quotations that were used in the texts and captions of figures are reported.

The final result is the mobile application that can be downloaded free from the App Store or Google Play respectively for Apple and Android devices.

THE TOURS

The tours are the heart of the app, allowing tourists, walking under the arcades of the city, or relaxing on a bench of its squares, to step on and observe granite, porphyry, gneiss, marble and limestone, in a rich collection displayed in an open-air museum, and travel to curious and unexpected journey through time, across geological ages, back millions of years ago. There are four proposed itineraries, each with eight different stops, with some stops common to different itineraries. The choice of stops and itineraries was made primarily on the basis of geographical proximity of interest points in the historic center of the city. From the list of itineraries you can, by clicking on them, view the map of the center of Torino with the itineraries traced and numbered. The "i" symbols allows to get more information about the chosen itinerary and the "position" symbol allows to access the guided navigation (via Google maps) from the stop where the tourist is until the next stop.

Tour 1: Scuse me, for the Cathedral? (Fig. 9)

One of the peculiarities of Torino lies in the presence of monumental arcades which mainly consist of stone material. These arcades, characterized by more than 12 km of interconnected paths, represent one of the widest city promenade of Europe and are an architectural, aesthetic and socio-

economic example unique in the world. The street characterized by monumental arcades is Via Roma, rebuilt in the '30s of the 20th century, during the Fascist period. A significant increase of Piemonte quarrying activity occurred during its reconstruction, when columns, pillars, walls and flooring, because of autarchy imposed by Italy fascist dictatorship, were made exclusively with domestic stone materials. So the arcade of the Via Roma urban axis is a representative example where the stone has been effectively used both as a structural and a decorative element.

Thanks to the direct coordination of Piacentini, detailed rules for engagement of the new Via Roma in the neoclassical Carlo Felice square were laid down. In front of the square is seated the Porta Nuova station (**stop1**). The façade performs, with high arches in stone (*Balma Syenite and Malanaggio Stone*) and large windows, its monumentality in keeping with the style of the buildings in front. Like all great voyages, the train station is the starting point of this route, which heads straight to the cathedral of the city. From Porta Nuova Railway station you walk under the arches of the first sector of Via Roma, where the silicate rocks from Western Alps dominate, as in the Santa Cristina block (**stop 2**), where only three types of ornamental stones were employed: the *Serizzo Antigorio* orthogneiss for the colonnade and the *Alzo Granite* and the *Balma Syenite* for the pavement.The architectural elements are characterized by the adoption of an entablature supported by a monotonous sequence of 180 columns in *Serizzo Antigorio*, expressing a rationalistic and monumental style.

In the C.L.N. (Comitato di Liberazione Nazionale) square (**stop 3**), marked by the statues of the Po and Dora Rivers in white *Carrara Marble*, the cladding slab in *Ornavasso Marble* of the San Carlo and Santa Cristina apses can be observed. Continuing beyond the San Carlo square is reached (**stop 4**), the "living room of Turin", where in front of the twin churches we will wonder which is exactly the Church that gives to the square its name. In this case petrography can help us. The church of Santa Cristina, designed by Filippo Juvarra in the early 18th century, is characterized by the use of the *Gassino Stone* for the facade and the *Vaie Stone* for the four columns. Instead, the entire facade of the church of San Carlo, a century younger, is covered by the *Pink Baveno Granite*.

The tour continues under the arcades along the second part of Via Roma. The two sectors of the arcades differ significantly for both architectural styles and the number and type of the materials used, some of them having been used for the first time. In particular, in the second section of the arcades, the silicate materials were mainly used for the main structural elements such as columns and pilasters, whereas the pavement was mostly made of polychrome carbonate rocks as in the Sant'Emanuele block (**stop 5**), where the *Vicenza stone*, the *Travertine*, the *Botticin*o, the *Canavese*

Diorite, the *Rosso Verona* for the colonnade, and the *Malanaggio Stone*, the *Trani Stone*, the *Verde Roja* and the *Bigio di Moncervetto* for the pavement were employed.

Between a shop and the other you reach Piazza Castello where the Palazzo Madama (**stop 6**) can be admired. It is a UNESCO World Heritage, characterized by the spectacular internal staircase in *Frabosa marble* designed by Juvarra and by the façade cladded by *Chianocco and Foresto Marble*. Here, the seat of the Savoy Senate, the "Albertine Statute", reference document of the Italian Constitution, was approved. In front there is the Palazzo Reale (**stop 7**) that still preserves all his majesty, materialized by the austere bronze gate supported by pillars made of *Prali marble*. Finally, the Cathedral of the city (**stop 8**) reveals itself: discreet as the people of Torino, elegant and refined with its ivory-colored facade, entirely made of *Chianocco and Foresto marble*.

Tour 2: Under the Gallery, beyond the River (Fig. 10)

This itinerary starts in front of the Carignano Palace (**stop 1**), which hosted the first Italian Parliament. Its 19th century façade, built on the unification of Italy occasion, is made up of several stone materials including the *Pink Baveno* and the *White Montorfano* granites. Passing through the Subalpina Gallery (**stop 2**) you can view the historic stone *Verde Alpi* an ophicalcite coming from the Monginevro ophiolitic massif located at the head of the Susa Valley, along the Italian-French border. Getting out of the arcades of Piazza Castello, the Emanuele Filiberto Monument appears (**stop 3**), built entirely in *Balma Syenite*. Walking along Via Verdi the itinerary enters in the courtyard of the Rectorate Palace of Torino University (**stop 4**) with the columns carved in *Gassino Stone.* At the sides of the courtyard the spectacular staircases give access to the main floor, with steps carved on *San Basilio Stone* and a balustrade made of *Travertine*. Left behind the Rectorate, the Mole Antonelliana appears (**stop 5**), characterized by the dome made in *Luserna Stone:* it became the tallest masonry building in the world when it was inaugurated in 1889. Going back to Via Po you can admire the façade of the Santissima Annunziata Church (**stop 6**), the only one of the city made on *Travertine*. Then a stop on the Vittorio Emanuele I Bridge (**stop 7**), tangible sign of the Napoleone domination in the "Ville de Turin", allows to look out over the Po River. You will realize how the *Cumiana Stone* resists the vagaries of Italy longest river. You have arrived at the Gran Madre Church (**stop 8**), just at the feet of the columns in *Malanaggio Stone*.

Tour 3: A matter of bridges (Fig. 11)

The bridges are the most loved and most hated by Torino inhabitants. To pass from one to the other side of the river during peak hours you must always take into account the traffic and when, for some reason, one of the city bridges is closed, double the calculation. On the night of St. John, however, to

have a nice view of the fireworks you should go as close as possible to the bridges. This tour starts from the French Castle of Valentino (**stop 1**), located along the shores of the Po River and characterized by a suitable court designed at the beginning of 17thcentury by Carlo and Amedeo di Castellamonte by order of Maria Cristina of France, who wanted the pitched French roofs made of *Ligurian slate*. Until the decline of the French monarchy the Castle was a place of parties, parades, hunting deer, and home to diplomatic meetings. It is now the seat of the architecture faculty of the city. Walking through the courtyard you can step on the original cobblestones made of river pebbles in *quartzite* and *serpentine*, and admire the internal colonnade composed of *Baveno Granite*, *Malanaggio Stone* and *Macchia Vecchia Svizzera*, a spectacular multi-colored carbonate breccia. Crossing the Valentino Park the monumental Umberto I Bridge, built at the beginning of the 20th century (1903–1907), can be reached (**stop 2**). The structure of the bridge consists of three semielliptical arches built on pillars with semicircular rostrum and made of different Alpine stones, including the *Malanaggio Stone*, the *San Basilio Stone* and the *Vaie Stone*. The decorations and the lining of the fronts, the cornice and frieze are made of *Alzo Granite*, while the pillars of the parapet are made of white *Carrara Marble*. Frome the bridge you can reach the Church of San Massimo (**stop 3**), built in the 18t^{h} century in Neoclassical style and characterized by a portico consisting of four columns of *Baveno Granite*, the same rock in which were made the pronao colums of the Mole Antonelliana (**stop 4**), symbol of the Torino city and currently seat of the Cinema Museum. Just two blocks over you meet "Palazzo Nuovo" (**stop 5**) seat of the humanities departments of the University of Torino. If you enter the lobby on the ground floor you can walk on a pavement made up of *Val Malenco Serpentinite* and *Euganean Trachite*. Leaving the building, follow the bell tower and you will find in front of the façade of the Santissima Annunziata Church (**stop 6**), characterized by low entry staircase built with *Anzola black granite*. From Via Po you cross the Napoleonic Vittorio Emanuele I Bridge (**stop 7**), entrerely made of *Cumiana Stone*, which represents the first great modern stone bridge built in Italy after the Renaissance. Finally you reach the Gran Madre Church (**stop 8**), commissioned by citizens to welcome the return of the Savoy after the restoration; it was inaugurated in 1831 and is inspired by the Roman Pantheon. The predominant architectural element are the six monolithic columns formed by *Malanaggio Stone* and related capitals carved in *Frabosa white marble*.

Stop 4: City institutions (Fig. 12)

This tour starts from the Regional Natural Science Museum, a treasure trove of ancient fossils and precious gems, and touches some of the most important monuments and buildings of the city. The Museum (**stop 1**) is hosted in a 17th-century building of the old San Giovanni Battista Hospital and

sees the employment in many architectural elements of the *Gassino Stone*, the stone material more used in the city until the 19th century. Notable are also the floors of the interior landings paved with the *Barge quartzite*. Going out of the Museum, after a short walk you reach the San Filippo Church (**stop 2**), the largest religious building in Turin, home to solemn Holy music performances. It is characterized by a neoclassical portico with *Brossasco Marble* columns and a pediment of *Frabosa marble*. You continue toward the Subalpina Gallery (**stop 3**), where you can see the numerous shop window borders on *Giallo Siena* of the historic coffee "Baratti & Milano", attended by the Count of Cavour. Stop off in the foyer of the Teatro Regio (**stop 4**), breathe the air of the temple of opera. Along the side that overlooks on Via Verdi, you can observe the exterior stone cladding made of *Peperino* lava stone and *Verde Roja* pelite for the plinth. Crossing Piazza Castello you can observe the Emanuele Filiberto monument (**stop 5**), entirely made with the *Balma Syenite*, and reach the San Giovanni cathedral (**stop 6**), with his candid Renaissance façade in *Chianocco and Foresto white marble*. Lastly, you can head to Basilica Mauriziana (**stop 7**) where the statues of *Prali marble* portal occur. Finally, the façade of the Palazzo di Città (**stop 8**), site of town hall, in *Gassino Stone* and *Verde Alpi*, welcomes you.

CONCLUSIONS

Stone has strongly characterized the architectural identity of the city of Torino with more than 150 varieties. It is a significant richness at the national level. Only recently we are trying to promote this heritage from a touristic point of view - setting up cultural routes not only targeted to professionals but especially to geotourist, and more in general, to a wider audience.

The TourinStone application aims to disseminate knowledge on stones by scientific and educational field, making available a tool easy to use to those who work in planning territory. In particular it is aimed at: 1) scientific community in the field of Earth Sciences and Cultural Heritage, 2) institutions dealing with the promotion and preservation of historical and architectural heritage, 3) organizations and Local Authorities.

The identification of these targets would leave the way open for a wider audience, it could affect the Alpine tourism and perhaps broaden the horizons to the cultural one.

In Europe, from some years, concepts such as Responsible Research and Innovation (RRI) are spread, whose main axes are public engagement and science education, intended as innovative ways of doing research and training. *TourinStone* is an application of this innovative way to educate and intrigue a wider public than the university one. The technical-scientific study of materials, its

simplification and dissemination, the combination with the cultural aspect and the territory represent a new way of doing research in line with the objectives of universities across Europe

This work represents a "prototype" that can be integrated and expanded, and it is the basis for a further development on a larger scale (thematic or geographical) as well as a good example of enhancement of heritage stone aimed to promote simultaneously alternative forms of tourism.

In addition to the most famous monuments (churches, palaces, theaters, etc.), other sites will be also considered, located in the less touristic areas of the city (as some New Residential Areas in peripheral areas of the city or the recent sliding fast roads that cross the main neighborhoods of the city). In fact, the proposed specific thematic itineraries can also be seen as an opportunity to promote a different fruition of the city, which aims to promote lesser-known areas.

In conclusion, you can see that the rocks mark the most significant moments of the city history and, in many cases, of Italy. A walk through the austere buildings of the historic center of Torino, then, offers the chance to see a quick overview of the main ornamental rocks of Italy, but also to retrace the main steps of his short but intense political and social life.

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CAPTIONS

Fig. 1 - Geological sketch map of the Western Alps and quarrying site location of the Alpine (Piemontesi) ornamental stone reported in the application.

Fig. 2 - Geological sketch map of Italy and quarrying site location of the ornamental stone from other Italian regions reported in the application

Fig. 3 Image of the main menù of TourinStone application

Fig. 4 - Location of the 25 sites of interest of the application on the Torino toponomastic map.

Fig. 5 - Example of description form for the “Valentino Castle” site.

Fig. 6a - Representative images of the ornamental stones described in TourinStone application (first part).

Fig. 6b - Representative images of the ornamental stones described in TourinStone application (second part).

Fig. 8 - Example of description card for the *Luserna Stone*.

Fig. 9 - Description and illustration of Itinerary n. 1: Sorry for the Cathedral. The stops are reported on the toponomastic map of Torino.

Fig. 10 - Description and illustration of Itinerary n. 2: Under the Gallery, beyond the River. The stops are reported on the toponomastic map of Torino.

Fig. 11 - Description and illustration of Itinerary n. 3: A matter of bridges. The stops are reported on the toponomastic map of Torino.

Fig. 12 - Description and illustration of Itinerary n. 4: City institutions. The stops are reported on the toponomastic map of Torino.

Table 1 Description of the selected hornamental stones

Table 2 list of the selected sites