Geoheritage (2022) 14:51
https://doi.org/10.1007/s12371-022-00681-0

ORIGINAL ARTICLE

Pietra Alberese: from Traditional Building Material of the Tuscan Countryside to the Present Use (Tuscany, Italy)

Fabio Fratini[1] · Silvia Rescic[1] · Andrea Arrighetti[2] · Emma Cantisani[1] · Elena Pecchioni[3]

Received: 28 October 2021 / Accepted: 9 March 2022

Abstract

In Tuscany, the vernacular architecture of the countryside between Siena and Florence (Chianti territory), and the monumental architecture of towns such as Prato and Pistoia together with the surrounding villages, extensively used a local limestone, the Pietra Alberese. It is a grey marly limestone, very resistant to decay, which takes on a whitish colour upon exposure to atmospheric agents. In addition, the Pietra Alberese was used to produce lime, being the only limestone cropping out in this territory. In this work, the Pietra Alberese is characterized, from a geological, mineralogical and petrographic point of view, highlighting its problems of conservation. Furthermore, the use in the historical architecture (both vernacular and monumental) and in the twentieth century architecture is illustrated.

Keywords Pietra Alberese · Tuscany · Marly limestone · Vernacular architecture · Contemporaneous architecture

Introduction

In Italy, each village and town has a unique identity conferred by the architecture typologies and by the typical colours of its building materials. Indeed, in the past, the building materials were supplied primarily by the local availability (Rodolico 1964) and favoured by the presence of many independent little states. Nevertheless, new stone materials could arrive from outside, favoured by fashions and increasing trades.

Therefore, travellers of the Grand Tour (the educational trip through southern Europe undertaken by young people of the upper-class from the seventeenth century up to the mid-nineteenth century to discover the art and culture of antiquity) met very different urban habits along the peninsula, from the grey slate of the Ligurian roofs, the cold white colour of the Trani stone, used in central Apulia and the yellowish soft limestones of Salento and Sicily, which allowed the expression of the local Baroque architecture.

In Tuscany, the traditional buildings of the countryside between Siena and Florence (Chianti territory) and of the monumental architecture of Prato and Pistoia are the Pietra Alberese. Traditionally, the term Alberese has been used for the marly limestones belonging to the Ligurian tectonic units without a clear stratigraphic significance. These ambiguities have been resolved in the 70 s with the attribution of the Alberese stone s.s. to the Monte Morello Formation (Eocene age), from the locality close to Florence where this marly formation shows the typical outcrop.

The Tuscan naturalist Targioni Tozzetti (1768) described the Alberese as a fine-grained stone, grey to hazelnut in the fresh cut that becomes lighter for alteration, with conchoidal fracture and rich in calcite veins (Fig. 1). The name Alberese was traditionally given because of the presence of 'small tree figures' (tree = *albero* in Italian) due to concentrations of iron oxides and manganese in the form of dendrites.

Around the tectonic basin Florence-Prato-Pistoia the Pietra, Alberese can be found in Mt. Morello (northwest of Florence), in the Calvana ridge (north of Prato) and in the hills around Pistoia. Other small outcrops are located south of Florence, near Grassina and Galluzzo and in the west (Soffiano, Scandicci, Lastra a Signa) (Fig. 2) (Carmignani

This article is part of the Topical Collection on Global Heritage Stone Resource: The sustainable way forward

✉ Fabio Fratini
fabio.fratini@cnr.it

[1] CNR- ISPC - Institute of Heritage Science (Florence Unit), via Madonna del Piano, 10, Sesto Fiorentino, Italy

[2] Ecole Normale Superieure, Université PSL (AOROC UMR 8546), Paris, France

[3] Department of Earth Sciences, University of Florence, via La Pira 4, 50125 Florence, Italy

Published online: 14 April 2022

Fig. 1 Pietra Alberese ashlars with evident conchoidal fracture in a country house near Sesto Fiorentino (Florence)

and Lazzarotto 2004). Other important outcrops in Tuscany are in the Chianti Mountains, in Casentino, in Val Tiberina and, outside Tuscany, in Val Marecchia (Montefeltro-Marche) and in the Tolfa Mountains (Northern Latium).

In the Florentine historical architecture, the Pietra Alberese is rarely mentioned, overshadowed by Pietra Serena (the stone of the Renaissance) and Pietraforte (the stone of the Medieval Florence) (Fratini and Rescic 2014). Nevertheless, Florence could not have been built without this material, because it is the only limestone present in this territory to produce lime. Prato and Pistoia on the contrary show a large use of this stone in the structures and façades (e.g., as ashlars) of many public and religious buildings.

Geological Setting of Pietra Alberese

Pietra Alberese belongs to the Eocene Mt. Morello Formation of the Calvana Supergroup (Abbate and Sagri 1970) or Morello Tectonic Unit (Bortolotti et al. 2008, 2010) which deposed in the Ligurian-Piedmontese Ocean. This tectonic unit represents the more eastern Ligurian succession, the

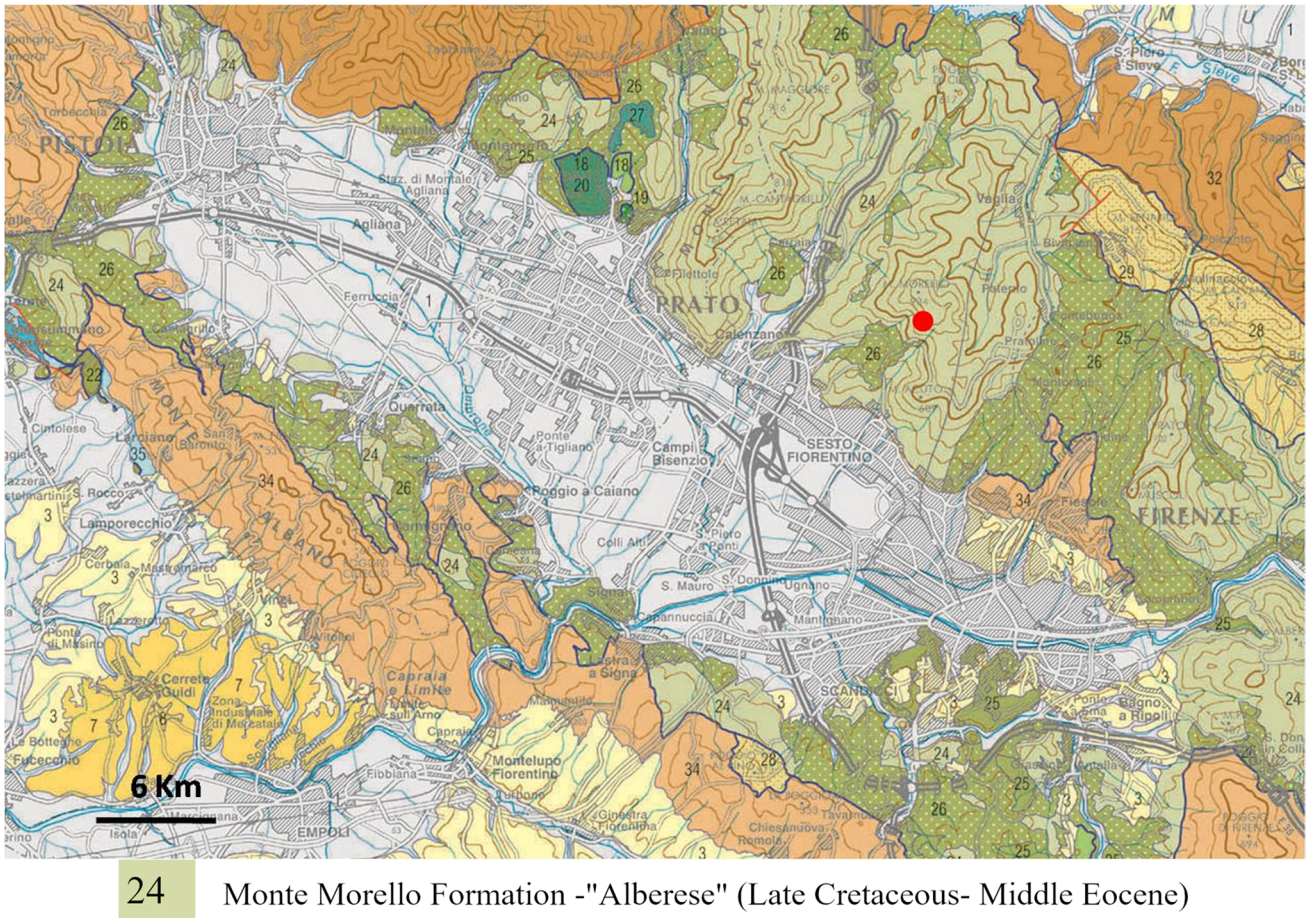

Fig. 2 Geological map of the tectonic basin Florence-Prato-Pistoia with indication of the type series of Mt. Morello Formation (red dot) (geological map 1:250,000 modified after Carmignani and Lazzarotto 2004)

so-called External Ligurids or Helminthoid Flysch Units. It is mostly made up of turbiditic sequences of marly limestones, marlstones, limestones and minor argillites (Fig. 3) (Bortolotti 1962, 1963, 1964; Ponzana 1993).

The beds are centimetric to some meters thick, rarely enclosing bands and nodules of grey to black cherts. The marly lithotypes are grey in colour with "soap"-type splitting whose thickness is from decimetres to about 15 m. The fossiliferous content is in the range 6–20% with respect to the micritic groundmass. Locally, grey decimetric biocalcarenite beds at the base of the marly beds and rare dark grey, middle- to fine-grained sandstone are present. The Lower to Middle Eocene fossiliferous content in the calcareous-marly beds is represented by microforaminifera (e.g. Globorotaliæ and Globigerinæ and calcarereous nannofossils, sometimes with reworked Late Cretaceous and Paleocene species), while in the calcarenitic beds, macroforaminifera (e.g. Nummulites, Alveolina and Discocyclina) are also present (Bortolotti et al. 2010; Bortolotti 1962). The thickness of the formation is more than 700 m. The depositional environment is an oceanic basin, likely placed above the CCD and fed mainly by intrabasinal pelagic sources.

Mineralogical-Petrographic and Physical Characteristics of Pietra Alberese

Two main typologies with different macroscopic characteristics have been used in architectonic:

- The variety traditionally called *sasso alberese* (Fig. 4), light grey in the fresh cut, with smooth conchoidal cut surfaces and whitish colour of alteration

Fig. 4 Variety of Pietra Alberese named *sasso alberese*, light grey in the fresh cut

- The variety *sasso porcino* (Fig. 5), grey/dark grey in the fresh cut, with rough and a scaly cut surfaces and whitish/bluish colour of alteration (Paggetti 2002)

These macroscopic differences reflect different petrographic characteristics. *Sasso alberese* is a middle/fine-grained micrite with small percentages of fossils (3–5%) (Fig. 6) ranging in size from 10 to 80 µm, consisting of Globigerinæ, Globorotaliæ and Radiolarian. According to these characteristics, the rock can be classified as mudstone (Dunham 1962) or micrite (Folk 1959). The material is often crossed by numerous thin veins of spatic calcite and sometimes shows weak concentrations of ochre pigments in dendritic structure (Paggetti 2002). *Sasso porcino* is a

Fig. 3 Mt. Morello Formation, made up of an alternance of limestones, marly limestones and argillites

Fig. 5 Variety of Pietra Alberese named *sasso porcino*, dark grey in the fresh cut

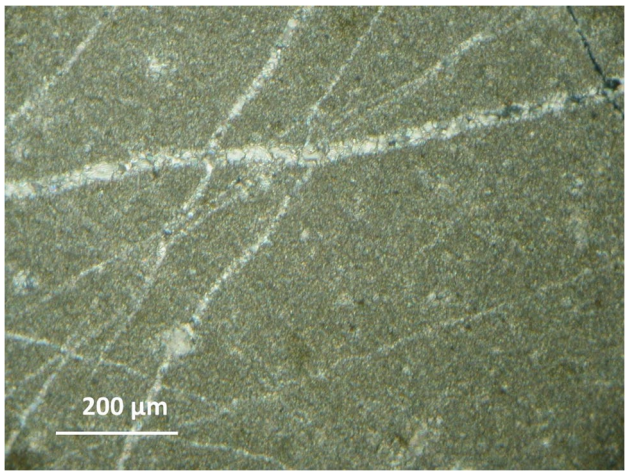

Fig. 6 Image in thin section at the optical microscope (xpl) of *sasso alberese* variety, characterized by a fine-grained micrite with small percentages of fossils

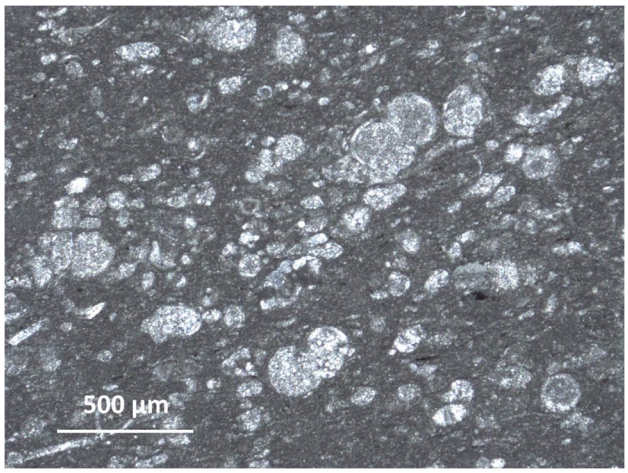

Fig. 7 Image in thin section at the optical microscope (xpl) of *sasso porcino* variety, with fossils ranging between 20 and 25%, consisting of Globigerinæ, Globorotaliæ and Radiolarian

biomicrite with fossils ranging between 20 and 25%. Their size ranges from 40 and 200 µm and consist of Globigerinæ, Globorotaliæ and Radiolarian (Fig. 7). The rock can be classified as wackestone (Dunham 1962) or biomicrite (Folk 1959). In the micrite mass, a dispersion of semi-opaques materials referred to the clay component is often evident. Sparitic lenses 40 µm thick and small clay pockets 60 µm thick (possible intra formational pelitic clasts) are also present. Muscovite, quartz, and feldspar are sometimes present in the carbonate framework with dimensions of 40 µm. The stone is crossed by rare calcite veins sometimes with concentrations of ochre pigments.

The mineralogical composition is different between the two varieties. *Sasso alberese* shows a calcite content of 84–88% (from calcimetry) with, as secondary minerals, quartz, feldspars, micas and clay minerals (illite, chlorite, chlorite vermiculite, kaolinite). *Sasso porcino* shows a calcite content of 70–74% (from calcimetry) and quartz, feldspars, micas and clay minerals (kaolinite, illite, chlorite, chlorite-smectite) (Paggetti 2002). The total open porosity is 3–5% for *sasso alberese* and 6% for *sasso porcino* (Paggetti 2002).

The different characteristics of the two kinds of materials affect the behaviour of Pietra Alberese, used as building material towards alteration and decay phenomena (Fratini & Rescic 2014).

In general, Pietra Alberese has a very high durability towards the action of atmospheric agents as testified by the monumental buildings realized with the most calcareous beds (*sasso alberese*). A slight exfoliation can be present when the ashlars are positioned perpendicularly to the layering (Fig. 8). Moreover, fracturing along calcite veins may occur (Fig. 9). With respect to this high durability observed in high-quality masonries, in vernacular architecture, sometimes, ashlars obtained from more marly beds show decay phenomena like 'soap' flaking (Fig. 10). A chromatic alteration is instead always present more frequently with a whitening (Fig. 11), with a yellowish patina (Fig. 12) or with the formation of a brown dusty patina (Fig. 13).

Fig. 8 Slight exfoliation developed when the ashlars are laid perpendicularly to the stratification

Fig. 9 Fracturing along calcite veins

Fig. 10 Decay developed through 'soap' flaking in an ashlar realized from more marly beds of Pietra Alberese

Fig. 11 Whitening phenomena

Fig. 12 Yellowish oxalate patina from ancient treatments

Fig. 13 Brown dusty patina

Historical Use of Pietra Alberese as Building Material

The first use of Pietra Alberese in the Florentine territory was made by the Etruscans, as it is possible to observe in the tombs of Mula and Montagnola in Sesto Fiorentino, six miles northwest of Florence. The Romans used it in the aqueduct realized in the first century BC that started on the slopes of the Calvana ridge near Calenzano (about 7 miles northwest of Florence) reaching the centre of Florence (Villani 1991; Sartori 2007).

In Florence, the presence of Alberese is negligible with respect to Pietra Serena and Pietraforte sandstones. Archaeological findings of Alberese slabs of certain streets are in accordance with Villani's Nuova Cronica (second book, 1991) which underline that part of the main streets

of the town was paved (glazed, he writes) particularly in front of important buildings (Villani 1991; Del Panta 1993). Other few examples are:

- The Alberese river pebbles used in the *filaretto* masonry of the Visdomini Tower and in the Pagliazza Tower
- Two long strips in the floor of Santa Maria Novella church and in the 'Cappellone degli Spagnoli' (in the cloister of the convent adjoining the church)
- The paving of the churchyard of the Santissima Annunziata (seventeenth century)
- Rare elements are also in the decorated floor of Santa Maria del Fiore Cathedral (fourteenth century) and in the portal of Santissimi Apostoli Church (eleventh century)

This scarce use in Florence depends on the relative distance of the Alberese outcrops compared to those of Pietraforte which were a few hundred meters away, on the hills close to the left bank of Arno River. Furthermore, unlike Pietraforte, the Pietra Alberese is a material difficult to work, the processing to make regular blocks requiring expert stonecutters, because of the hardness and the tendency to chip. Nevertheless, in the shaping of the stone ashlars, it is possible to take advantage of the beds more suitable in thickness, like those less than 30 cm.

On the contrary, the use of the Pietra Alberese is widespread in the surrounding of Florence. To the south-southeast of the city, it was employed as a building material in:

- The Certosa of Florence (fourteenth century) (Fig. 14)
- The Vallombrosan church of San Michele a San Salvi (twelfth century)
- Many parish churches of the Florentine countryside: Abbazia di San Bartolomeo a Ripoli (twelfth century), Pieve di San Pietro a Ripoli (twelfth century), Santa Maria a Quarto (thirteenth century), San Donnino a Villamagna (thirteenth century), San Tommaso a Baroncelli (thirteenth century), Santa Maria all'Antella (twelfth century), San Francesco all'Incontro (eighteenth century), Spedale del Bigallo (thirteenth century).

Northwest of Florence, it can be found in the churches of Santo Stefano in Pane (twelfth and thirteenth centuries), in San Donato in Polverosa (twelfth century), in Sant'Andrea in San Donnino (eleventh century) and in Sesto Fiorentino village. This is a big village located at the slopes of Monte Morello, where the Pietra Alberese was widely used as dressed stones (Fig. 15), roughly shaped blocks, for lintels, jambs, thresholds, sills, slabs for paving of courtyards (Fig. 16), stair steps and water channels (Fratini 2010). Few

Fig. 14 Certosa of Florence (fourteenth century)

Fig. 15 Tower house of Villa San Lorenzo (fourteenth century) in Sesto Fiorentino (Florence)

Fig. 16 Traditional paving with slabs of Pietra Alberese in a courtyard of Sesto Fiorentino (Florence)

Fig. 17 City walls of Calenzano Castle (Florence) (twelfth century)

kilometres westward of Sesto Fiorentino is the fortified village of Calenzano, completely built in Pietra Alberese (Fig. 17). All the above-mentioned churches and buildings of the Florentine countryside are located near the outcrops of Pietra Alberese (Fig. 18).

Twenty kilometres northwest of Florence is Prato where Pietra Alberese is the main building material. Indeed, this town is located close to the slopes of the Calvana ridge where the stone crops out extensively (Fig. 19). In this town, the use of Pietra Alberese reached a great importance in the Middle Ages as demonstrated by the Emperor Castle (1237–1245) with its imposing walls in dressed stones (Fig. 20) as well as in the most recent part of the Palazzo Pretorio, added in the fourteenth century. The Santo Stefano Cathedral (twelfth-fourteenth century) in Pisan-Romanic style has an external cladding in alternating strips of serpentinite and Pietra Alberese (Fig. 21). The same decoration with alternating strips of Pietra Alberese and serpentinite is also present in the façades of the Middle Ages churches of S. Francesco, S. Domenico and S. Niccolò (Fig. 22).

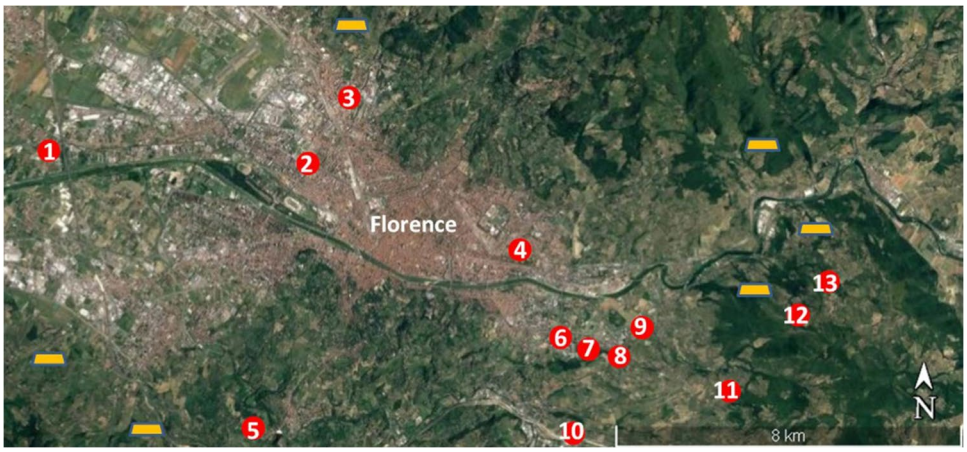

Fig. 18 Map of religious buildings in Pietra Alberese in the Florentine territory: 1 S. Andrea in San Donnino; 2 San Donato in Polverosa; 3 Santo Stefano in Pane; 4 San Michele a San Salvi; 5 Certosa of Florence; 6 Abbazia di San Bartolomeo a Ripoli; 7 Pieve di San Pietro a Ripoli; 8 San Tommaso a Baroncelli; 9 Santa Maria a Quarto; 10 Santa Maria all'Antella; 11 Spedale del Bigallo; 12 San Francesco all'Incontro; 13 San Donnino a Villamagna

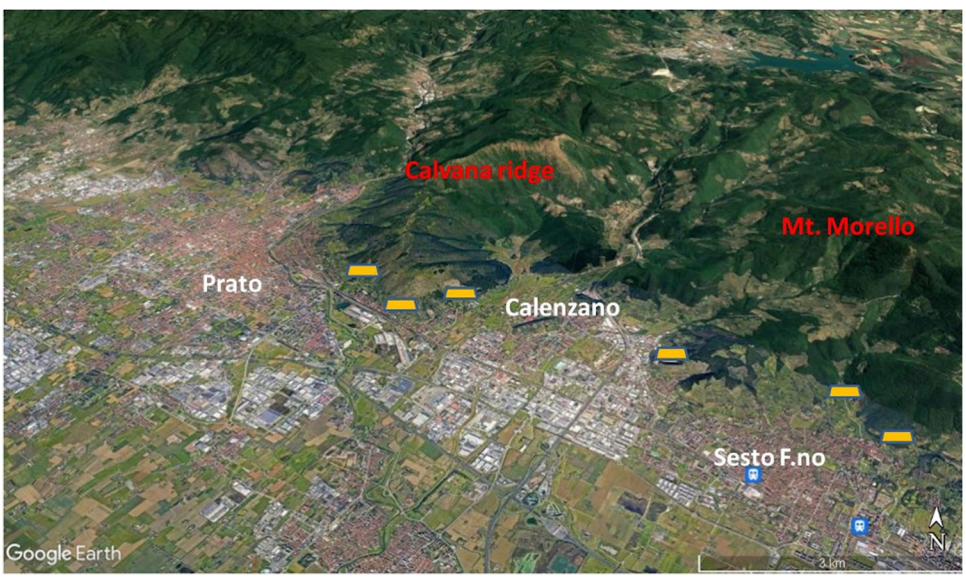

Fig. 19 The outcrops of Alberese stone in the territory of Prato, Calenzano and Sesto Fiorentino

Fig. 20 Emperor Castle in Prato (thirteenth century)

Fig. 21 Santo Stefano Cathedral in Prato (twelfth to fourteenth century) with the Donatello pulpit (fifteenth century). The green strips are made of serpentinite

The Renaissance masterpiece of the Santa Maria delle Carceri Church, designed by Giuliano da Sangallo at the end of the fifteenth century, with Greek cross plan, is also cladded in Pietra Alberese, but the linear serpentinite decorations highlight the architectural parties. The city walls are also completely built in Pietra Alberese, both in roughly shaped blocks and pebbles.

In Pistoia, 16 km northwest of Prato, the Pietra Alberese (Fig. 23), while not the main building material, was utilized as dressed stone in civil buildings, and in the most important Romanic religious buildings such as the San Zeno Cathedral (twelfth to thirteenth century) (Fig. 24), in the lower part of the façade of Sant'Andrea (twelfth century), prototype of the Pistoia Romanic style, in the churches of San Francesco

Fig. 22 Map of the monuments in Pietra Alberese in Prato: 1 San Niccolò; 2 San Domenico; 3 Santo Stefano Cathedral; 4 Palazzo Pretorio; 5 San Francesco; 6 Santa Maria delle Carceri; 7 Emperor Castle

and San Salvatore. As well as in Prato, the Pietra Alberese is often associated in bichromie with the green serpentinite.

Masonry and Workmanship of the Ashlars in Pietra Alberese from the Middle Ages to the Modern Age

The Pietra Alberese has always been a stone of great value in the construction of medieval and post-medieval architecture in Northern Tuscany. As underlined in the previous paragraph, this stone was used as construction material around Florence before the Middle Ages, but it is in the latter period that its use in historical building is attested with processing and finishing of the individual construction elements in diversified forms. Unlike the architecture of the classical period, when the circulation of raw materials took advantage of well-established channels and communication routes, the way of using the Pietra Alberese in medieval times was often bound to two main factors: the location of the outcrop areas and the technical skills in the processing and installation of the stone blocks by the masons. For the municipality of Sesto Fiorentino (Arrighetti 2012), a close relationship can be observed between the outcrop areas of the two lithotypes present in the territory (Pietra Alberese and calcarenites of the Sillano Formation) and the construction materials used in the medieval buildings, tangible sign of exploitation/collection, and not selection, of these two stones. In this way, moreover, the price and logistical problems associated with transport were considerably reduced. In turn, the physical and mechanical characteristics of the stones were also decisive in their processing, therefore influencing the ways of building in the medieval period, with reference to the following factors: the worked shape and finishing of the individual stone elements, the size of the rows and mortar joints, the size of the stone elements used in the openings

Fig. 23 The outcrops of Pietra Alberese near Pistoia

Fig. 24 San Zeno Cathedral in Pistoia (twelfth to thirteenth century)

Fig. 25 The Baracca tower, one of the best-preserved examples of thirteenth century architecture within the Municipality of Sesto Fiorentino (Florence)

and corners. For example, considering the central and late Middle Ages, there are some periods in which the coexistence or choice between well squared and roughly shaped Alberese is established by the degree of specialization of the workers involved. In the thirteenth to fourteenth century architecture, for example, there are religious buildings built entirely in squared Alberese, and construction yards of Florentine noble families where at the same time, local and specialized workers were employed, the former for the realization of roughly shaped blocks for the masonries, and the latter for the realization of well squared blocks for architectural elements (openings, corners, shelves, etc.) (Fig. 25); finally, there are more modest construction yards, such as those in the villages, where the presence of local workers influenced the ways of working the stone, which was roughly hewn. From the sixteenth century onwards, with the entry of bricks and Pietra Serena among the building materials of the Florentine territory, the trend changes, leading to a preference for the use of the latter as raw materials in construction.

A similar situation is found in Mugello, a territory located 30 km north of Florence, where a study conducted from 2010 to 2013 in the municipalities of Scarperia, San Piero a Sieve, Borgo San Lorenzo and Vicchio, highlighted a rather clear situation as regards the use of Alberese and other building materials in early medieval construction sites (Arrighetti 2016).

The analysis of the historic buildings in in this territory clearly showed that the choice of a specific building material was linked exclusively to technical-practical or availability factors. Also in this area, the proximity to the quarrying areas of Pietra Alberese or Pietra Serena sandstone, exploited from the eleventh to the fourteenth century,

determined the specific use of the stone material in the surrounding area. Similarly, the introduction, in some historical periods, of constructive knowledge economically and technically more advantageous than those in use, determined the choice of new building materials made by clients and workers of Mugello both in the Middle Ages and in subsequent periods. This is the case of the introduction of bricks which, from the thirteenth century, over the course of about three hundred years, replaced the Pietra Alberese until then used extensively together with the Pietra Serena.

To summarize, the use of Alberese in this part of Tuscany is closely linked to the presence of easily accessible outcrops, which allow it to be quarried specifically for the construction of architectural complexes linked to aristocratic families. At the same time, the presence in some cases of horizontal layers of little thickness (10–15 cm), the *filaretto*, allowed an easier supply and setting even for smaller buildings, where the poor technical skills of the local workers could be counterbalanced by the structure already prepared in rows of blocks.

Use of Pietra Alberese in Contemporary Architecture

In the twentieth century, the Pietra Alberese was extensively quarried to produce modern hydraulic binders and as brecciated material for concrete and embankments, as evidenced by the numerous disused quarries present in the area. On the contrary, its use as building material for load-bearing walls drastically collapsed in favour of the modern standardized construction techniques in reinforced concrete, prefabricated blocks and bricks. However, an interesting example of use is represented by the access buildings to Villa Peragallo in Calenzano Castello (Florence). It is a neo-medievalist architecture dating back to the early twentieth century, enriched with ornamental details of Art Nouveau style where the Pietra Alberese was worked as rusticated ashlar to be used as cornerstones and in the masonry (Fig. 26). Another example is the Church of Santi Pietro and Girolamo, in the hills south of Pistoia, destroyed during the Second World War and rebuilt in 1952, based on a project by Giovanni Michelucci, the architect who designed the Florence railway station, a masterpiece of rationalist architecture. In this case, the roughly hewn Pietra Alberese ashlars were used together with Pietraforte sandstone (Fig. 27). As for other sacred buildings designed by Giovanni Michelucci such as the Church of San Giovanni Battista (also called the Church of the Autostrada) and the Church of the Immaculate Heart of Mary on the northern outskirts of Pistoia, the use of the Alberese stone is reported in an erroneous way since limestones from other geological formations were used.

More recently, the Pietra Alberese was used above all in buildings built in the 1960s and 1970s. Sometimes, it is present as rusticated ashlars at the base of the buildings

Fig. 26 Rusticated Alberese ashlars in the cornerstones and in the masonry of the access buildings to the Villa Peragallo in Calenzano Castello (Florence)

Fig. 27 The Church of Santi Pietro and Girolamo, in the hills south of Pistoia with roughly hewn ashlars of Pietra Alberese used together with Pietraforte sandstone

(Fig. 28), more frequently as a cladding in imitation of false bases (Fig. 29), as cladding of the ground floor and decorative structures (Fig. 30), in the frames of portals and windows (Fig. 31). In addition, the Pietra Alberese, up to the 1970s, was used in the border walls of villas both in blocks and as cladding (Fig. 32).

At present, the material is no longer extracted and marketed as construction/decoration stone, and this can be observed both from some restoration-reconstruction interventions of Alberese masonries (Fig. 33) and from new buildings where different carbonate stones were used, with a fairly similar appearance to Pietra Alberese.

Fig. 28 Rusticated ashlars at the base of a building in Settimello (Florence)

Fig. 30 Cladding of a decorative structure in Sesto Fiorentino (Florence)

Fig. 29 Cladding in imitation of false bases in Calenzano (Florence)

Fig. 31 Frames of portal in Calenzano (Florence)

Conclusions

The Pietra Alberese is a material that strongly characterizes the vernacular architecture of the countryside between Siena and Florence (the Chianti territory), Mugello and the monumental architecture of some Tuscan towns such as Prato and Pistoia together with the surrounding villages. It is a grey marly limestone very resistant to decay which takes on a whitish colour upon exposure to atmospheric agents. In addition, the Pietra Alberese was also used to produce lime, being the only limestone cropping out in this territory. In the twentieth century, its use as building material for load-bearing walls drastically collapsed in favour of the modern standardized construction techniques that no longer use the local materials. Few examples of use can be observed in Villa Peragallo in Calenzano Castello (Florence) and as decoration material in the civil architecture of the sixties and seventies. At present, the Pietra Alberese is no longer extracted and marketed, due to the closure of the quarries, although there is an abundance of outcrops. The consequence is that in the restoration/refurbishment of historic buildings, other materials available in the market are used. This causes serious damage to the image and material culture of the villages that up to 60 years ago were completely characterized, from the masonries to the paving, by the presence of this stone, compared to the towns and villages of neighbouring areas but located on different geological substrates.

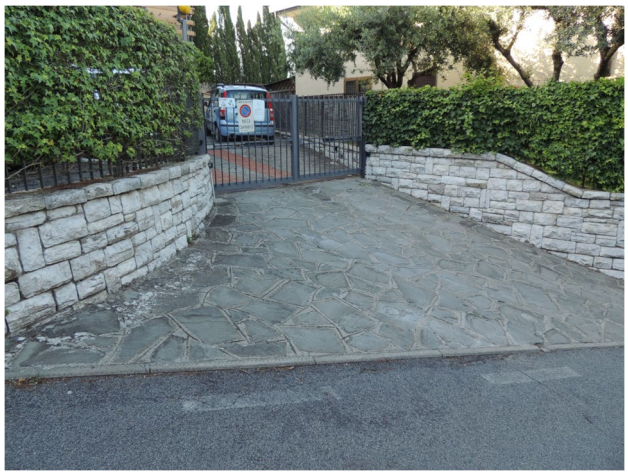

Fig. 32 Boundary wall of a villa from the 70 s in Calenzano (Florence)

Fig. 33 Recent reconstruction of a boundary wall where a carbonate stone different from Pietra Alberese was used (Calenzano, Florence)

These reasons lead us to affirm that this architectural heritage is in danger to lose its authenticity. In this sense, the only way forward would be to raise awareness among public administrations, those who manage the architectural heritage and those who intervene on it in order to favour the use of historical materials. A survey of the actual availability of these materials on the territories would be desirable as to be able to create a specific supply centre where to store such materials for future interventions. Alternatively, specific guidelines should be drawn up on the type of material to be used to replace the original if it is out of stock. These measures could limit the damage caused by interventions not aware about the preservation of the image of the places.

Data Availability Not applicable.

Code Availability Not applicable.

Declarations

Competing Interests The authors declare no competing interests.

References

Abbate E, Sagri M (1970) The eugeosynclinal sequences. Sed Geol 4:251–340

Arrighetti A (2016) Materiali e tecniche costruttive del Mugello tra Basso Medioevo e prima Età Moderna, "Arqueologia de la Arquitectura", 13/2016, Madrid/Vitoria 2016, https://doi.org/10.3989/arq.arqt.2016.001

Arrighetti A. (2012) Archeologia dell'Architettura e ricognizione di superficie nel comune di Sesto Fiorentino (FI). "Archeologia dell'Architettura", XVII, Firenze, pp 173–190

Bortolotti V (1962) Contributo alla conoscenza della stratigrafia della serie Pietraforte-Alberese. Bollettino Società Geologica Italiana 81:226–304

Bortolotti V (1963) Contributo alla conoscenza della stratigrafia della serie Pietraforte-Alberese. Bollettino Società Geologica Italiana 81:225–304

Bortolotti V (1964) Note illustrative alla carta della distribuzione geografica della Formazione di Monte Morello (Alberese). Bollettino Società Geologica Italiana 83:155–190

Bortolotti V, Mannori G, Principi G, Sani F (2008) Note Illustrative della Carta Geologica d'Italia alla scala 1: 50.000 foglio 278 Pieve Santo Stefano. ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale – Servizio Geologico d'Italia. La Nuova Lito: Firenze, Italy, p. 96

Bortolotti V, Poccianti C, Principi G, Sani F (2010) Note Illustrative della Carta Geologica d'Italia alla scala 1: 50.000 foglio 264 Borgo San Lorenzo. ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale – Servizio Geologico d'Italia. La Nuova Lito: Firenze, Italy, p. 103

Carmignani L, Lazzarotto L (2004) Carta Geologicadella Toscana 1:250.000. Direzione delle politiche territoriali ed ambientali – Servizio Geologico d'Italia: Regione Toscana, Firenze, Italy

Dunham RJ (1962) Classification of carbonate rocks according to depositional texture. In: Classification of Carbonate Rocks, Ham, W.E., Ed.; AAPG, Tulsa, USA, pp 108–121

Folk RL (1959) Practical petrographic classification of limestones. Am Ass Petr Geol Bull 43:1–38

Fratini F, Rescic S (2014) The stone materials of the historical architecture of Tuscany, Italy. Geological Society, London, Special Publications 391:71–92

Fratini F (2010) Le pietre da costruzione e decorative di Sesto Fiorentino. In Sesto Medievale, Quaderni di Studio Il Medioevo alle

porte di Firenze; Arrighetti, A. Ed.; Associazione Turistica Pro Loco, Sesto Fiorentino, Italy: pp. 17–38.
Paggetti G. (2002) Caratterizzazione del legante in malte confezionate dalla Pietra Alberese e confronto con malte dell'architettura storica fiorentina. Dissertation, University of Florence
Del Panta A (1993) Pietre fiorentine. Proceedings of Giornata di Studi in onore di Francesco Rodolico. Le pietre delle città d'Italia, Firenze, Italy, 25 Ottobre 1993; Le Monnier, Firenze, Italy, pp 41–45.
Ponzana L (1993) Caratteristiche sedimentologiche e petrografiche della Formazione di Monte Morello (Eocene inferiore-medio, Appennino Settentrionale. Bollettino Società Geologica Italiana 112:201–218
Rodolico F. (1964) Le pietre delle città d'Italia. 2nd ed., Le Monnier, Firenze, Italy
Sartori R (2007) Alberese: zone di estrazione, suoi impieghi nel passato e sue varietà. Bollettino Degli Ingegneri 12:15–18
Targioni Tozzetti G (1768) Relazioni d'alcuni viaggi fatti in diverse parti della Toscana. Anastatic reproduction of original 1768; Forni, Bologna, Italy, 1971, vol.1, pp 13–14
Villani G (1991) Nuova Cronica. Edizione critica del testo del 1322, Porta G. Ed.; Ugo Guanda Editore, Parma, Italy