



Broccatello di Siena

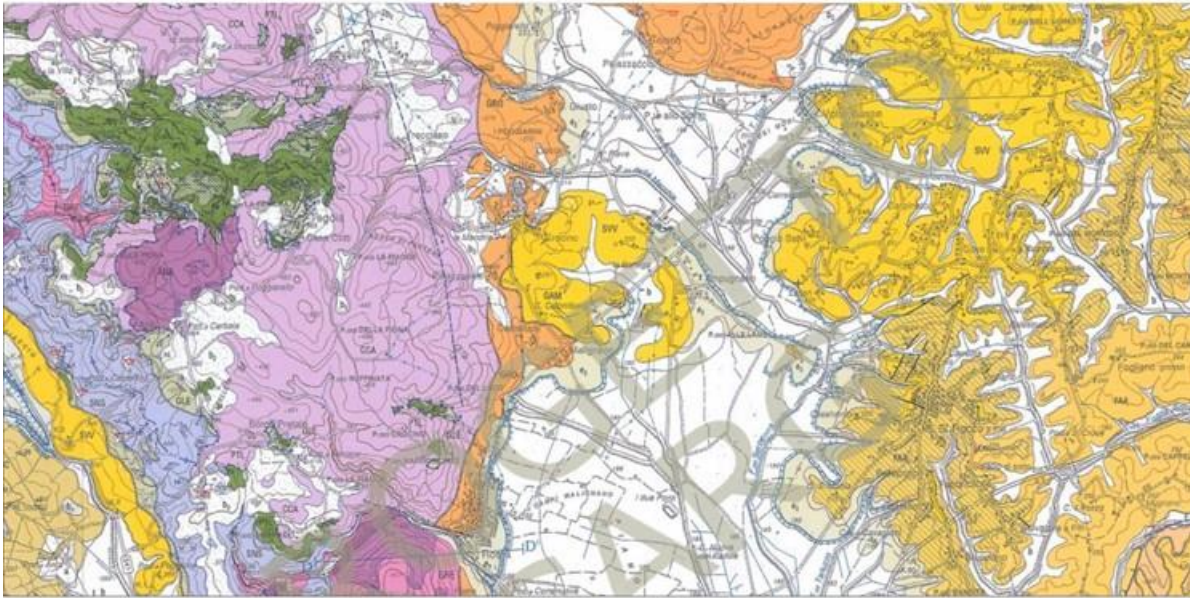


8 cm

Golden yellow breccia marble background with dark or purple spots and stylolitic veins, sometimes very thin.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	Province	Municipality	Village
Broccatello di Siena	marble	yellow	Italy	Siena	Sovicille	Sovicille

Geological setting



scale 1:50,000

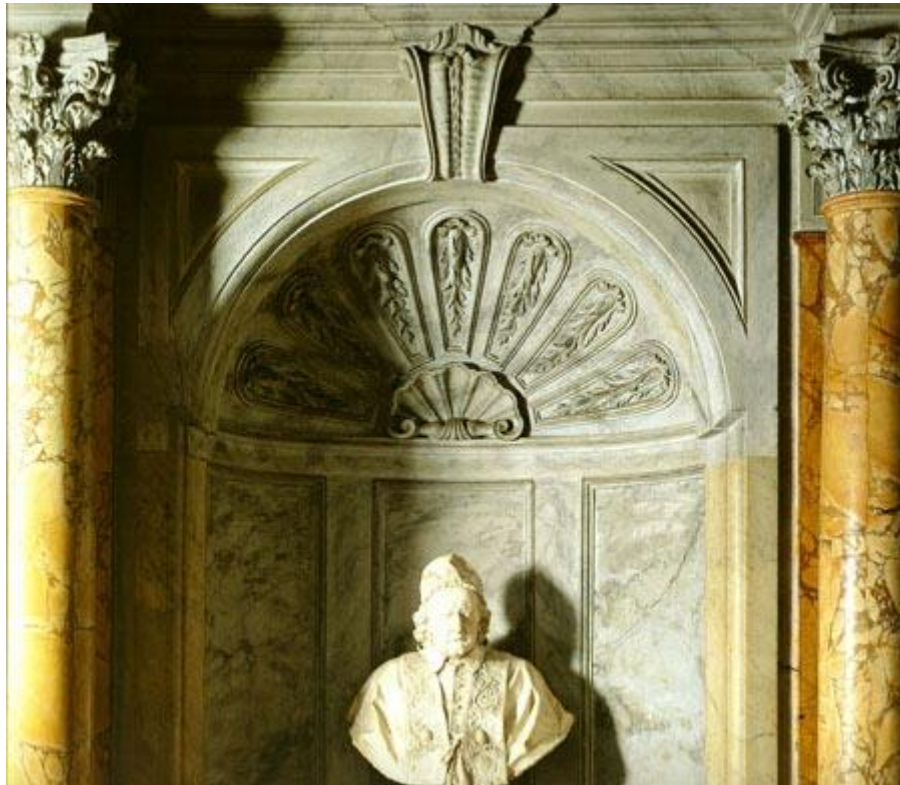
Geology: In this area metamorphic rocks, in facies of green schists, aged between Triassic and Cretaceous, and to a lesser extent, marine and continental sediments, aged between Upper Miocene and Pleistocene, crop out extensively. Stratigraphically beneath the schists, yellow, white and grey marbles outcrop as well. They are non-layered marbles and, towards the top, they assume a color ranging from pink to veined-yellow to ocher-yellow and golden-yellow. The yellow color is ascribed to an epigenetic enrichment of iron oxides and hydroxides by infiltration along fracture lines. In the upper part, locally and for a thickness of a few meters, they show a clear and thin stratification and a more intense yellow color. This ornamental stone was originally formed as a pelagic limestone sedimentary deposit; subsequently it was compacted by diagenesis and affected by a low-stage metamorphism. It has a fine grain size and it has an homogeneous distribution of pigmentation.

Production: About ninety different quarries have been active on the Montagnola Senese Area, mostly very small in size; their development was due, in the seventeenth and eighteenth centuries, to an aesthetic taste oriented towards the search for marked chromatic effects. In modern times, the annual production has reached 15,000 tons. The product varieties extracted are the yellow broccatello (and its modification known as "paonazzo"), ocher-yellow, veined-yellow, ivory-yellow, Covent-type pink, calacatta, white and arabesque-white, pearl-gray and bardiglio; broccatello, ocher-yellow and pink are the rarer varieties. The different colors have been attributed to the presence of different mineral pigments, such as limonite, hematite, pyrite, organic matter.

Geological age: Lower Lias – Cenomanian

Geological unit: "Montagnola Senese" Marbles Formation

Application, use and heritage



Palazzo Corsini, Florence: Columns in Broccatello di Siena.

Petrography



Thin Section X10

Description: Calcite Crystalloblastic lithotype with locally porphyroblastic serial eteroblastic microstructures. The main mineralogical component is calcite (>95%), markedly anisotropic for the alignment of blasts that generate a band foliation. Together with calcite crystals there are also euhedral quartz blasts in correspondence with veins and patches. Coincidentally with the veins the Calcite Crystalloblastic lithotype is associated with opaque minerals composed of limonite, hematite, chlorite, muscovite fragments and tourmaline.

Source of information: The Marble Laboratory of the Department of Territory, Environment and Geotechnologies Engineering of Politecnico di Torino University.

Mineral composition

Calcite (%)	Fe-Mn hydroxydes (%)	Fe-Mn oxydes (%)	Hydrated silicates (%)	Cyclosilicates (%)		
>95	AM	AM	AM	AM		

MM=main minerals, SM = Subordinate minerals, AM=accessory minerals

Source of information: www.granitalsiena.com

Physical properties

Apparent density (EN 1936) kg/m ³	Open porosity (EN 1936) % vol	Water absorption at atmospheric pressure (EN 13755) % wt	Uniaxial Compressive strength (EN 1926) MPa	Flexural strength under concentrated load (EN 12372) MPa
2710	0,24	0,1	69	16,5

Real density (EN 1936) kg/m ³	Total porosity (EN 1936) % vol	Water absorption coefficient by capillary (EN 1925) (g/m ² x s ^{0,5})	Flexural strength under constant moment (EN 13161) MPa
		0,04	

Frost resistance (EN 12371)				
Technological Test (Test A)				Identification Test (Test B): Number of cycles completed prior to stone failure
Flexural strength (EN 12372) after freeze-thaw cycling, MPa	Number of cycles	Uniaxial compressive strength (EN 1926) after freeze-thaw cycling, MPa	Number of cycles	
		160		

Resistance to ageing by thermal shock (EN 14066)			
Change in dynamic modulus of elasticity (increase: +; decrease: -) %	Change in open porosity (increase: +; decrease: -) %	Change in ultrasound pulse velocity (increase: +; decrease: -) %	Change in flexural strength under conc. load (increase: +; decrease: -) %

Abrasion resistance (EN 14157)			Resistance to salt crystallisation (EN 12370)	Breaking load at dowel hole (EN 13364)	
Method A - Wide Wheel Abrasion Test, mm	Method B - Böhme Abrasion Test, cm ³ / 50cm ²	Method C - Amsler Abrasion Test, mm	Change in mass (increase: +; decrease: -), %	Breaking load, N	Thickness of the test specimens, mm

Slip resistance by means of the pendulum tester (EN 14231 / CEN/TS 16165)			Rupture energy (EN 14158), Joule	Thermal Conductivity (EN 1745), W/m·K
Tested surface finish	Slip Resistance Value — SRV			
	Dry test condition	Wet test condition		
Smooth	42	10		

Source of information: Università di Pisa - Politecnico di Torino

Chemical properties

Main elements

SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	TiO ₂ (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	MnO (%)	P ₂ O ₅ (%)	SO ₃ (%)	LOI (%)	CO ₂ (%)	H ₂ O (%)
4,51	1,3	0,5		0,08	52,02							40,97	0,41

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
Ag (ppm)	B (ppm)	Mo (ppm)	W (ppm)	Ga (ppm)	Ge (ppm)	Se (ppm)	Cs (ppm)
Tl (ppm)							

REE

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Gd (ppm)	Tb (ppm)
Dy (ppm)	Ho (ppm)	Er (ppm)	Tm (ppm)	Yb (ppm)	Lu (ppm)		

Methods applied and source of information: Pieri M. (1964) - I Marmi d'Italia. Ed. Hoepli, Milano, pp. 480.

Sources of more information

Type of information	Name of provider	URL
This data sheet	Geological Survey of Italy -ISPRA	https://www.isprambiente.gov.it/en/services/cartography/geological-and-geothematic-maps/geological-map-at-a-scale-1-to-50000
Non-commercial directory	Geological Science Department - University Roma Tre, Italithos 2000	http://www.italithos.uniroma3.it/
Commercial directory		
Scientific publication	Memorie Descrittive della Carta Geologica d'Italia, ISPRA-Geological Survey of Italy	https://www.isprambiente.gov.it/it/pubblicazioni/periodici-tecnici/memorie-descrittive-della-carta-geologica-ditalia/la-geologia-di-roma-dal-centro-storico-alla
Other publication		

Compiled by:	Geological survey of Italy – ISPRA website http://portalesgi.isprambiente.it/	 
---------------------	---	--