

Verde Macael



www.macaelmarmol.com

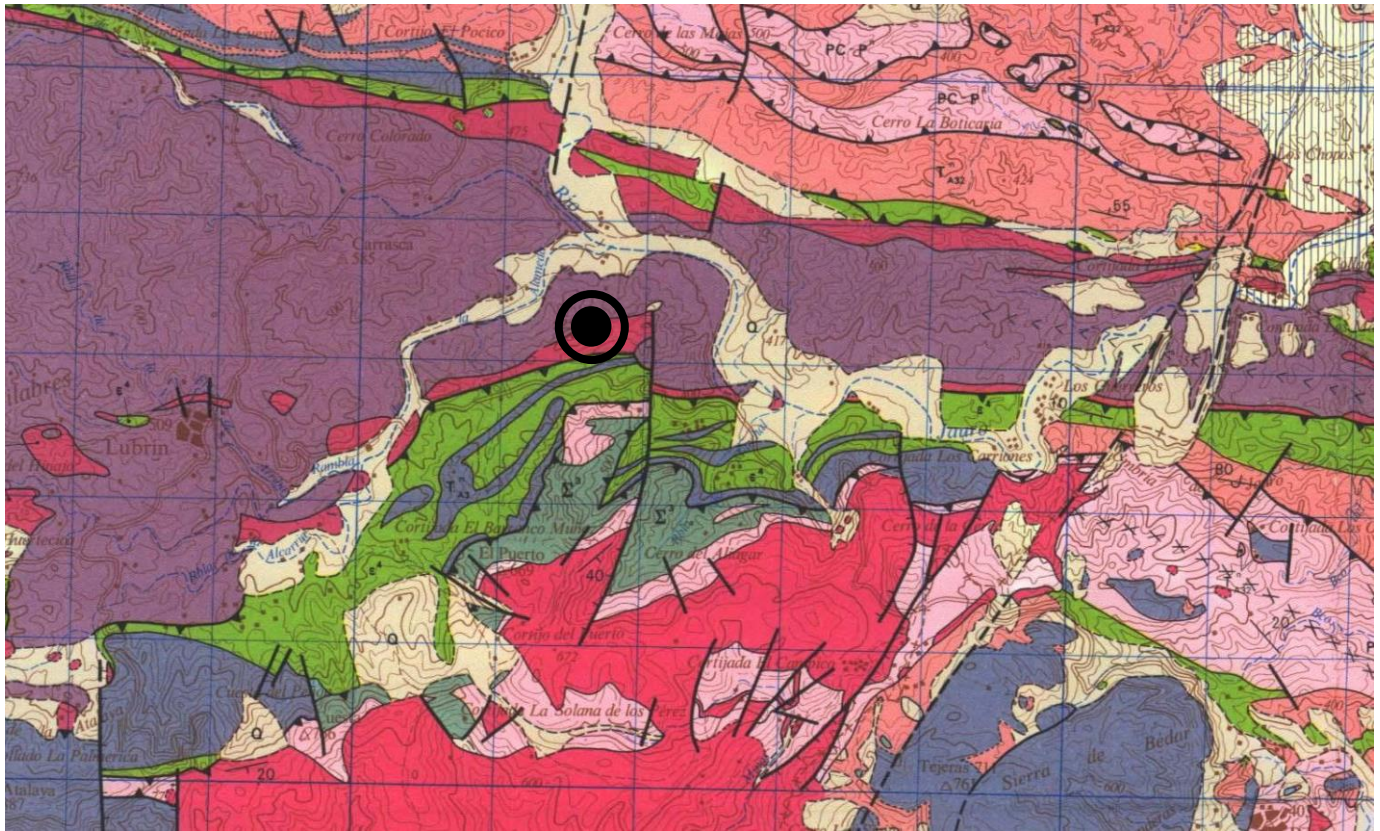
2 cm

Short description:

Dark green serpentinite characterized by a fine-grained massive texture. Light-green to white areas included in the rock corresponds to carbonated areas. Centimeter-sized fractures filled by serpentine and carbonate, or only by carbonate, can be found. This rock is located in discontinuous and irregular, highly deformed bodies, intercalated with thick beds of pale mica-schists and small layers of white marble.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
marble	serpentine	green	Spain	Almería	Lubrín Macael	Lubrín Macael

Geological setting



Geology:

The Verde Macael quarries are contextualized in the Betic mountain range, in the south-east of the Iberian Peninsula. The marbles exploited belong to the Las Casas Formation, included within the Nevado-Filábride Complex (internal zonas of the Betic mountain range). The lithological sequence of the Nevado-Filábride Complex can be divided into four formations. From bottom to top the first corresponds to dark schists and quartzites of about 3600 m thick. Above lie the quartzites of Benitagla and then the Tahal light schists, and at the top lies the schists and marbles (Las Casas Fm.). The thickness of the upper formations is on the order of 2000 m. The passage between the formations is stratigraphic and transitional. The metamorphism is inverted, being of higher grade to the top. This feature led to the proposal of superposition of tectonic units, with a higher grade of metamorphism in the upper ones, but the tectonic contacts between these units, according to our data, simply do not exist. The deposit of the lower formation had a syntectonic-compressional character while the other ones formed in extensional and post-tectonic environment in relation to the Variscan orogeny. New faults then formed permitted the extrusion of igneous rocks, including some ultrabasic ones.

Geological age: Triassic

Geological unit: Tahal Formation

Application, use and heritage

Description:

The use of marble from Macael region (Almería, Spain) began more than 5000 years ago. The first small objects are from the Neolithic period and the first known sculptures are from the Phoenicians period. Since then, the marble's use has been continuous, especially since the eleventh century. Some of the best known examples of Macael marble in Spain can be observed in Roman cities (e.g. Itálica), in Muslim buildings (e.g., mosque of Córdoba or the Alhambra palace) or in Renaissance buildings such as the monastery of El Escorial, among many others. Some are declared World Heritage Sites by UNESCO. This makes the region one of the most important extraction centers in Spain, both at present time and historically.

Regarding the specific case of the Verde Macael serpentinite, it is currently marketed and it is used in modern building both indoors and outdoors. This serpentinite is part of the marbles exploited in the Macael region and has a wide distribution, especially at the national level. Historically, this serpentinite has been highly appreciated and it has been used in numerous buildings of the cultural heritage of Granada (i.e., Chancillería Palace) or Madrid (cathedral of Sta. María de la Almudena), among others.

Petrography

Description:

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Verde Macael serpentinite constituted by antigorite, magnetite and/or carbonates (magnesite and calcite). Talc, chlorite and pyroxene can appear as secondary (sometimes, as accessory) minerals. Carbonates replace the original phase and filling shears and fractures. Opaque minerals and acicular amphiboles are also found as accessory minerals. The most common texture is an interpenetrated pseudomorphic mesh, with fractures filled mainly by carbonates, but also by serpentine. The opaques tend to concentrate parallel to the fractures. Some pyroxene crystals have been completely transformed into pseudomorphic serpentine and carbonate, leaving some magnetite grains within the mineral clavage.

Source of information:

- 1) Geological Survey of Spain (IGME)
- 2) Navarro, R., Pereira, D., Gimeno, A., del Barrio, S. (2013): Verde Macael: A Serpentinite wrongly referred to as a marble. *Geosciences*, 3: 102-113.

Mineral composition

If no accurate number, use MM=main minerals, SM = Subordinate minerals, AM=accessory minerals

Mineral 1 (%)	Mineral 2 (%)	Mineral 3 (%)	Mineral 4 (%)	Mineral 5 (%)		
Serpentinite (89%)	Opaque (11%)	Pyroxene (<1%)	Chlorite (>1%)	Calcite (<1%)		

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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
2680	0.7	0.3	252.0	

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

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	

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: -) %

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- 2) Navarro, R., Pereira, D., Gimeno, A., del Barrio, S. (2013): Verde Macael: A Serpentinite wrongly referred to as a marble. Geosciences, 3: 102-113.
- 3) RockMaquina – Piedras naturales, maquinaria y equipos.

Sources of more information

Type of information	Name of provider	URL
This data sheet	Spanish Geological Survey RockMaquina – Piedras naturales, maquinaria y equipos. Navarro, R., Pereira, D., Gimeno, A., del Barrio, S. (2013): Verde Macael: A Serpentinite wrongly referred to as a marble. Geosciences, 3: 102-113.	
Non-commercial directory	Spanish Geological Survey	
Commercial directory	Fundación Mármol de Macael	https://macaelmarmol.com/
Scientific publication		
Other publication		

Compiled by:	Instituto Geológico y Minero de España (IGME) http://www.igme.es/	 Instituto Geológico y Minero de España
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