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## Development of new techniques to understand marble quality and durability

The international commerce of ornamental stones has grown all over the world in the last years, revealing a decided solid support to the aesthetics of natural stones in buildings construction and urban ornamentation.

Marble is, undoubtedly, the ornamental stone par excellence. All through history, numerous civilizations have architectural or sculptural works which constitute the most important pieces of their historic heritage. Despite this, nowadays we have a very limited understanding about the intrinsic features which affect marble durability/changeability.

This fact is paradoxical in countries such as Spain, with a rich historic heritage in marble and one of the most important producing and exporting countries at a worldwide scale of this type of ornamental stone.

Researchers of the University of Granada, led by Prof Eduardo Sebastián Pardo, and of the University of Gotingen (Germany), led by Prof Siegfried Siegesmund, collaborate in a project to explain the causes for marble physical decay and design new identification and conservation methods.

The study, says Prof Sebastián, permits to "dictate recommendations referred to the specific use of ornamental marble, when they are used in buildings' external coatings and other constructive functions". Selection criteria are based on stone intrinsic features. Therefore, the analysis deals with an exhaustive characterization of materials, their petrography and their physical properties.



Marbles from Macael at the Alhambra.  
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### Studied marbles

The goal is to set an analytical proceeding to determine which types of marble are the most appropriate for construction purposes, as well as the best environment and conditions for their maintenance. The objective is to prevent the phenomenon of marble decay observed in many European buildings, often developed in very short spaces of time (even less than three years after their construction).

The studies have been carried out on different commercial marbles in Spain and Germany, as well as in those marbles historically used for certain constructive and ornamental functions. In the case of Spain, they have analysed the most commercialized varieties of marble in Andalusia, as well as those historically used in emblematic constructions of the Andalusian Architectural Heritage. "Marbles selection has been carried according to their micro-structural and textural features, especially their size and degree preferred crystallographic orientation, mineralogical composition and level of crystallographic and/or physical-mechanical anisotropy. Specifically, marbles from Macael, Almería; Huelva (Blanco Agua, Blanco Aroche and Almaden de la Plata marbles); Blanco Ibérico marble from Alhama de Granada and from Mijas de Málaga".

### Marble prints

Such analysis will also allow to understand the specific features of every stone (their "fingerprints") to determine their origin and, therefore, protect their emblematic prints against others from different geographic origins. "In a globalized sector like that of natural stone –says Sebastián- this is a key factor, as the purchase of stone is very frequent in countries where manpower costs are very cheap, giving rise to a strong loss of competitiveness of higher quality indigenous marbles. One of the most effective ways to compete with the ornamental stone of such countries is the creation of prestigious brands linked to natural stone".

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This research group has been working on durability assessment of ornamental stones through accelerated ageing tests since the nineties (<http://www.ugr.es/~monument>).

**Reference:** European Union – Integrated Action "Anisotropy of marbles: A key in the understanding of marble decay", led by Professors S. Siegesmund (Department of Structural Geology and Geodynamics, Geosciences Centre of the University of Göttingen) and E. Sebastián Pardo (University of Granada, Department of Mineralogy and Petrology).

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