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Anisotropy in Alpedrete granite cutting (Rift, Grain and Hardway directions) and effect on bush hammered heritage ashlars

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Many monuments and cities that are part of humanity's heritage have been built with carved granite ashlars. This dimension stone is one of the most used due to its abundance and durability. Traditional quarrymen have used anisotropic planes to cut granite blocks in the quarry for improved cutting performance. These planes are called Rift, Grain and Hardway (R, G, H) according to the ease of cutting.

The aim of this study is to determine the response of each of the three orthogonal cutting planes R, G and H to the craft styling with bush hammer, based on their decay. Alpedrete granite was selected for this research, it is a monzogranite quarried in the Sierra de Guadarrana (Spanish Central System) foothills, in the province of Madrid, Spain. It is one of the most representative of Madrid's heritage granites. Alpedrete granite is also used as building stone in other European cities.

From an Alpedrete granite bush hammered ashlar, three thin sections were cut parallel to the H plane; these thin sections cut R and G bush hammered planes. Also three thin sections have been cut parallel to the R plane at a distance of 2 mm, 10 mm and 30 mm from the bush hammered surface. All thin sections have been treated with fluorescein. In each of the thin sections a micrograph mosaic was performed covering the entire area (about 10 cm2, 300 photomicrographs) and printed with 120 increases. The length and spacing of inter-, intra- and trans-crystalline microcracks were quantified and measured. Microcracks were subdivided based on affected minerals in each R, G and H planes.

Through these observations it was found that Alpedrete Granite R plane (easier to cut) is determined by exfoliation microcracks orientation. That is, R plane is parallel to the exfoliations microcracks, which are intra-crystalline and straight.

The cutting of stones in the R plane is due to the coalescence of straight microcracks in the plane. This plane minimizes the effort and cost of subsequent carving so it has been used preferably as wall façades in heritage building ashlars. That is, the ashlars exposed surface. In other words, the exfoliation microcracks are oriented vertically in heritage ashlars.

R planes bush hammering produces many new microcracks and propagation of exfoliation microcracks, generating significant decay with parallel and oblique microcracks to the bush hammered surface to a depth of more than 10 mm.

G and H planes bush hammering generates coalescence and increased length of intra-crystalline exfoliation microcracks in the R plane; although, with less generation of new microcracks and less surface decay.

To understand the decay in bush hammered granite ashlars and sculptures it is essential to study the orientation and distribution of exfoliations microcracks, which follow the R orientation stone in the quarry. This orientation should be reproduced when performing artificial accelerated ageing tests, especially with stones used in heritage buildings.

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