Identifying facies with different weathering properties in Malta's Lower Globigerina Limestone

T. Zammit[1], J. Cassar[1], A.J. Vella[2], A.Torpiano[1]

1 Institute for Masonry and Construction Research, University of Malta, Msida, Malta.
2 Department of Chemistry, University of Malta, Msida, Malta.
Contact e-mail: timmaz@keyworld.net

Geologically the Maltese Islands are characterized by a slightly tilted stratigraphy composed of five sedimentary rock formations (Table 1), formed over a period of 25 million years during the Oligocene and Miocene epochs of the Tertiary period (Pedley et al., 2002). The distinct rock types are a result of varying marine environments in which they were formed.

Table 1 Lithostratigraphical subdivisions on the Maltese islands (Oil Exploration Directorate, 1993)

Formation/Member	Thickness
Upper Coralline Limestone formation	
Gebel Imbark Member	4-25 m
Tal-Pitkal Member	30-50 m
Mtarfa Member	12-16 m
Ghajn Melel Member	0-13 m
Greensand formation	0-11 m
Blue Clay formation	15-75 m
Globigerina Limestone formation	
Upper Globigerina Limestone Member	8-26 m
Middle Globigerina Limestone Member	15-38 m
Lower Globigerina Limestone Member	0-80 m
Lower Coralline Limestone formation	
Il-Mara Member	0-20 m
Xlendi Member	0-22 m
Attard Member	10-15 m
Maghlaq Member	>38 m

The main source of Malta's building stone is the Lower Globigerina Limestone member, which is a typical bioclastic limestone. It has been used as a building stone for over 5000 years. Its apparent homogenous appearance on extraction is no indication of the notably variable weathering behaviour it exhibits with time. Bearing testimony to this are old and abandoned quarry faces which exhibit beds of badly weathered stone, alternating with thicker beds of less weathered stone.

The generic Maltese terms Franka and Soll have been used, since time immemorial, to distinguish between the 'good' and the 'bad' weathering varieties of this stone type.

Past research on these two stone types has indicated that Soll is a physically denser and mechanically stronger stone type, with a total porosity less than that of Franka variety, but with a higher percentage of micro-pores (Saliba, 1990), (Farrugia, 1993), (Muscat, 2006). Geochemical and mineralogical analyses have also indicated that there are significant differences in the non-carbonate fraction of the two stone types (Vella et al. 1997). Indications are that Soll has a richer non-carbonate content, with higher concentrations of quartz and phyllosilicates (Cassar, 1999).

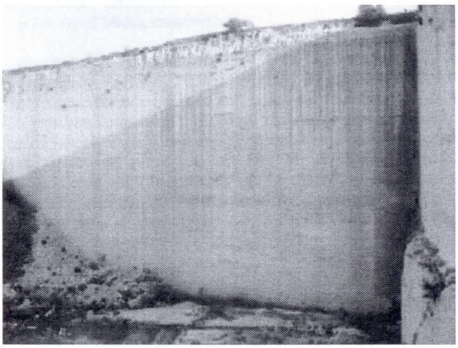

Figure 1: Typical weathered Lower Globigerina Limestone quarry face.

The durability of these stone types against the processes of weathering was investigated in separate research efforts (Vannucci et al., 1994), (Fitzner et al., 1996). Direct observation, together with chemical and petrographical analyses of weathered stone samples, were compared with accelerated testing techniques employing the method of salt-loading of freshly quarried samples (Rothert et al., 2007). From this research, a deterioration process was identified, involving; a) high soluble salt concentrations within the stone, b) the dissolution and re-precipitation of calcite to form a thin superficial crust, and c) the eventual lifting and loss of the crust to expose an already deteriorated surface. These studies also confirmed that stone types with different weathering properties are thus characterized by different micro-pore size distributions.

However, it was also thought that other empirical 'indicators' could be used to distinguish between these two stone types. In this respect, work has been ongoing at the University of Malta for the past 20 years to try to determine whether geochemical indicators can be used to distinguish between the two main Lower Globigerina Limestone types. The result of this research was the strengthening of the hypothesis that characterizing 'good' from 'bad' quality building stone extracted from the Lower Globigerina Limestone member may be achieved by way of geochemical composition. Particularly promising results were obtained by measuring the Acid Insoluble Residue. (Cassar and Vella, 2003)
Current research is focused on the physically measurable parameter of Total Insoluble Residue (TIR), as well as verification of Total Porosity values and Pore Size Distribution.

The initial testing programme has utilized the selected cores originally forming part of the "Mineral Resource Assessment" (Wardell Armstrong, 1996) and will also include stone samples taken from both active and disused quarries.

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