

Weathering damage on Pharaonic sandstone monuments in Upper Egypt

Petrographical properties of the Gebel el-Silsila sandstones

Bernd Fitzner, Kurt Heinrichs & Dennis La Bouchardiere

The petrographical properties of a characteristic sample is presented for each of the six groups of Gebel el-Silsila sandstones. The presentation considers provenance, macroscopical characteristics, mineral composition, textural characteristics and porosity properties of the sandstones. The results demonstrate the petrographical range of the sandstones. The results of the petrographical studies provide an important basis for the evaluation and interpretation of the weathering behaviour of the Gebel el-Silsila sandstones, for the rating of their quality / durability, for damage prognosis and for the derivation of appropriate monument preservation measures.

Lithotype	Sample	Group I (I-A)	Group II (II-D)	Group III (III-A)	Group IV (IV-A)	Group V (V-A)	Group VI (VI-A)	
	Provenance	Gebel el-Silsila, west-bank, Ptolomaic quarry	Gebel el-Silsila, east-bank, Ptolomaic-Roman quarry	8. Pylon Karnak Temple, Luxor	Gebel el-Silsila, east-bank, Ptolomaic-Roman quarry	Gebel el-Silsila, east-bank, Great North quarry	1. Pylon Karnak Temple, Luxor	
	Description	White, fine-grained sandstone	Yellow, fine-grained sandstone	Brownish-yellow, fine-grained sandstone	Brownish-yellow, spotted, fine-grained sandstone	Light brown, fine-grained sandstone	Light brown, fine-grained sandstone	
	Stratigraphy	Qoseir Formation - Upper Campanian, Cretaceous						
Composition (%)	<ul style="list-style-type: none"> ■ Quartz ■ Rock fragments ■ Feldspar ■ Mica ■ Heavy minerals ■ Clay minerals ■ Opaque matter ■ Calcite ■ Gypsum 							
	Thin section micrograph (Image width 2.53 mm)							
Texture	Matrix-grain-relation	Matrix-grain-ratio (-)	0.03	0.12	0.16	0.19	0.35	0.26
	Grain size characteristics	Mean grain size (mm)	0.18	0.19	0.15	0.15	0.12	0.13
		Sorting	1.43 - moderate	1.36 - good	1.42 - moderate	1.49 - moderate	1.37 - good	1.29 - good
	Grain contacts	Type of grain contacts	Mainly point-, long- and concavo-convex contacts, rarely sutured contacts	Point-, long-, concavo-convex- and sutured contacts	Mainly point- and long contacts, rarely concavo-convex- and sutured contacts	Point-, long-, concavo-convex- and sutured contacts	Mainly point- and long contacts, rarely concavo-convex- and sutured contacts	Mainly point- and long contacts, rarely concavo-convex- and sutured contacts
Number of grain contacts per cm ² (thin section analysis)		~3200	~2350	~4050	~2650	~5850	~5800	
Grain size distribution								
Porosity properties	Bulk density (g/cm ³)	1.85	1.82	1.84	1.82	2.00	1.80	
	Density (g/cm ³)	2.60	2.70	2.70	2.67	2.69	2.73	
	Total porosity (Vol.-%)	29.1	32.7	31.6	31.8	25.9	34.2	
	Median radius of pore entries (µm)	19.8	19.8	14.7	15.8	1.2	9.0	
	Pore surface (m ² /cm ³) (Nitrogen adsorption)	0.27	0.90	1.26	1.70	4.17	3.29	
	Pore radii distribution (Mercury porosimetry)							
	Pore space (yellow) of a characteristic stone area (Thin section microscopy / image analysis, image width 1.82 mm)							
Pore radii distribution (Thin section microscopy / image analysis)								