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Effect of stone consolidants on the physical properties of Hungarian rhyolite tuff monumental stones

L.Z. Forgó (1), Á. Török (1), S. Siegesmund (2), J. Ruedrich (2), H. Stück (2)

(1) Budapest University of Technology and Economics, Department of Construction Materials and Engineering Geology, H-1111 Budapest, Stoczek u. 2, Hungary, forgo.lea@gmail.com, torokakos@mail.bme.hu

(2) Geoscience Centre of the University of Göttingen, Goldschmidtstr. 3, D-37077 Göttingen, Germany

The rhyolite tuff is an extrusive acid pyroclastic rock, which has been used as building and ornamental stone in NE Hungary. Emblematic monuments, churches and castles, such as Eger Castle were made of rhyolite tuff are now display signs of severe deterioration. Lithology controls the rate of deterioration and explains the variations in weathering forms. On pumice-rich tuff ashlars selective weathering, weathering crusts, multiple flakes and scales occur, while crumbling is common on layered flow tuffs. Conversely, cemented tuff types do not show deep weathering. Petrographical tests (XRD, microscopy) showed the heterogeneous fabric and variations in mineral phases. The high glass content of the tuff is susceptible to weathering and thus swelling mixed-layered clay minerals are formed during decay. The preservation and conservation efforts of the tuffs date back to more than one century. The main goal of our experiments was to asses the performance of modern-day consolidants under laboratory conditions. Three types of consolidants, silica-acid ester (SAE), elastic silica-acid ester (eSAE) and an acrylate resin (PMMA) were used on cylindrical test specimens of two quarries of Eger area. Changes in physical properties such as effective porosity, pore-size distribution, capillary water uptake, indirect tensile strength, ultrasonic sound velocity, hygric- and thermal dilatation and were tested before and after conservation trials. Effective porosity decreased by 15 % when SAE was used, while for eSAE a decrease of 25% in porosity was documented. PMMA reduced the original porosity by 35 %. The amount of capillary pores was decreased with concurrent increase in micro-porosity. The strength has been increased after the treatment and consolidants have magnified the existing fabric related differences in strength. No significant changes in ultrasonic sound velocities were recorded. The hygric dilatation has been increased notably, while only minor changes in thermal dilatation were documented after treatments. Our tests have shown that both consolidants and other solutions such as salts can easily penetrate into larger pores, while smaller pores seem to slow down water and consolidant absorption. Consequently, tuffs with smaller pores are more resistant to weathering. The obtained data set provides valuable information when stone replacement and conservation of historic tuff sites are considered.