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Laser Cleaning of Black Weathered Obernkirchen Sandstone

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Formation of thin, black, well adhering weathering layers on pure sandstones used as building stone is well known phenomenon, described from several countries and on several types of sandstones. In the Netherlands, sandstones from the Lower Saxony basin in Germany, notably the Bentheim and Obernkirchen sandstones, have been used for many prominent monuments from the 11^{th} century onwards, and especially in the 14^{th} til 17^{th} century. Both sandstones show the formation of thin black weathering layers. Whereas layers on the Bentheim sandstone are generally thicker (up to a few quartz grains), layers on the Obernkirchen sandstone are very thin. In both cases, the layers are made up by opaque matter, such as soot and metallic particles, Fe-(hydr)oxides and gypsum, whereas algae and/or fungi are present in many cases.

The Obernkirchen sandstone itself is a pure sandstone from the Wealden, and is quarried on the Bückeberg, west of Hannover, Germany. It is a fine grained, reasonably well sorted sandstone, mainly composed by quartz and rock fragments, cemented by a primary binder of quartz and clay, and a secondary binder of siderite, quartz, kaolinite, illite and Fe-(hydr)oxides; cement makes up about 15 % of the rock. The sandstone has been used for many Dutch monuments, such as the town hall of Delft, the Royal Palace in Amsterdam and the Martini tower in Groningen. In the present case, samples have been investigated from the building of the House of Representatives of the Staten-Generaal (the Dutch Parliament), in The Hague. The relevant part of the building was constructed in 1777 – 1793, with the upper part of its façade clothed with Obernkirchener sandstone.

After characterization of the black weathering layer, a pilot test was performed to investigate the possiblity of cleaning, and, especially, any harmful effects to the original stone. Commercial firms have been invited to clean test panels on the façade. Two

firms using a Nd-YAG laser have been invited, a third one using EDTA pastes. The latter proved not succesful. In both cases, laser visually succeeded to remove the black layer. Possible deleterious effect of stone cleaning are twofold, viz. direct damage, such as removal of grains from the original stone or patina and damage to working of the stone, or indirect damage, that may arise from a different hygric behaviour of the stone (and façade as a whole) after cleaning. The latter have not been evaluated. Direct damage was evaluated by combination of polarization-and-fluorescence (PFM) and scanning electron microscopy (SEM). Cleaning using a Nd-YAG laser under ommercially realistic conditions did not result in any direct damage on the Obernkirchen sandstone.