SEM/EDX-Analysis of a Portrait of Joachim II. Elector of Brandenburg (1505-1571) by Lukas Cranach the Younger

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Keywords: SEM, EDX, x-ray mapping

The scientific laboratory of the "Stiftung Preußische Schlösser und Gärten Berlin-Brandenburg (SPSG)" is engaged in the material analysis of German paintings from the 16th century, especially the works of Lukas Cranach the Elder and the Younger. These examinations will give information on the way and techniques of painting by the Cranachs, in particular on the pigments and filling materials used and the composition of the layers of their paintings. Other main subjects are the changes of pigments caused by ageing and the mechanisms involved in these processes. Questions like "What was the original colour of the background which is nowadays grey?" or "Why turned blue into grey?" are of special importance in art history and conservation science.

In this particular case, a portrait of Joachim II. Elector of Brandenburg (1505-1571) from about 1555 was analysed, (Fig. 1). SEM/EDX-investigations were performed in addition to XRF analysis, optical spectroscopy and light microscopy. A Hitachi-SEM (S-2700) equipped with an XFlash-SDD-Detector was used for SEM/EDX. For this purpose, a small particle from the upper edge of the painting was extracted, embedded in resin, ground and polished on one side, coated with carbon and analysed in cross section.

Here we present results of the analysis of the grey-blue background of the portrait. A comparative observation of the light microscope image, (Fig. 2), and the EDX element mappings, (Fig. 3), enables the reconstruction of the composition of the paint layers: On the chalk ground (high content of Calcium) an inter layer was identified that contains white lead ($2\ PbCO_3\ .\ Pb(OH)_2$) and some red lead (Pb_3O_4, orange coloured particles in the light microscope image). The next layer, a grey underpaint layer, consists of white lead and plant black. Particles of white lead and widely discoloured smalt can be seen in the uppermost blue paint layer.

Smalt is a potassium silicate glass coloured blue due to the presence of cobalt ions. It is known for poor ageing properties in oil binding media that result in the loss of blue colour in the pigment. As can be seen in the cross section, only a few pieces of smalt are still blue while the others appear grey. The element mappings clearly show that the content of potassium in the grey coloured smalt particles is significantly lower than that in the blue ones. Therefore the discoloration is probably caused by a diffusion of potassium ions from the glass matrix into the binding medium.

Due to the good spatial resolution and the high speed of the SDD-detector, SEM/EDX analysis is a powerful tool for the investigation of cross-sections of paintings and other art objects. Useful information concerning the layer composition, the pigments and filling materials used by the artists as well as the deterioration processes of painting materials can be gained.

W. Grogger, F. Hofer, P. Pölt (Eds.): MC2009, Vol. 3: Materials Science,
DOI: 10.3217/978-3-85125-062-6-644 , © Verlag der TU Graz 2009

Figure 1. Portrait of Joachim II. Elector of Brandenburg (1505-1571) by Lukas Cranach the Younger, around 1555 (Grunewald hunting lodge, Berlin: SPSG GK I 1113), photo: W. Pfauder

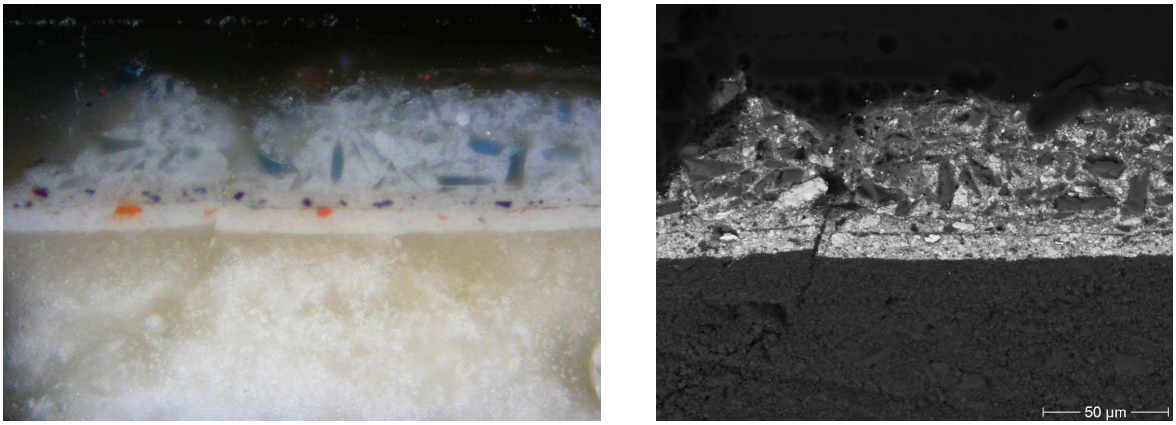

Figure 2. From the grey-blue portrait background, light microscope image and BSE image of a particle cross section

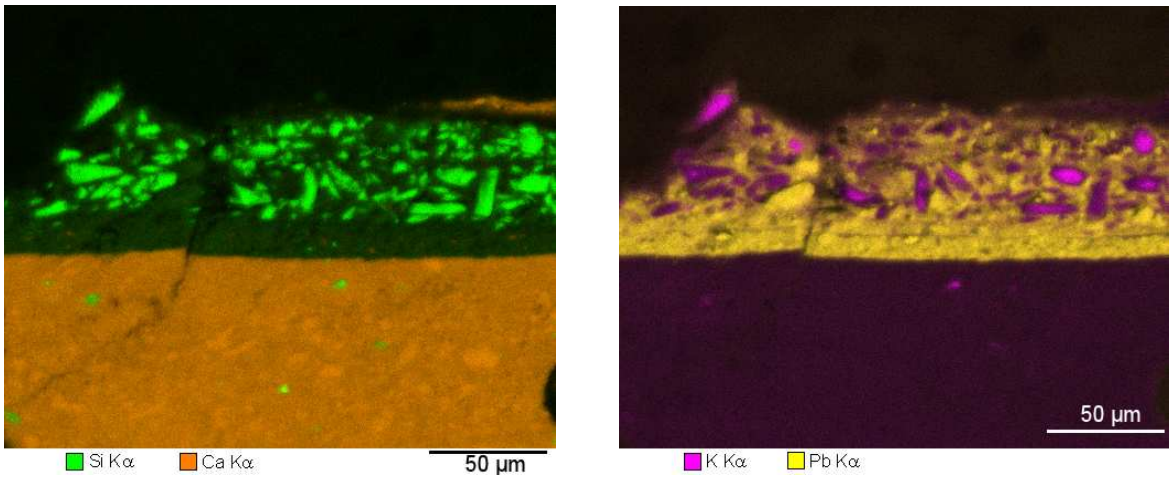

Figure 3. Ca/Si- and Pb/K-Map of the cross section

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