In situ non-destructive analysis of various materials on precious medieval manuscripts

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Illuminated medieval manuscripts are complex multi-material objects. Their analysis is as exciting and multifaceted as the different materials used for their manufacturing, such as stones, glass, precious metal inks and pigments. Since there is often little or no information available about the production, handling, damage, and repair of the manuscripts in past centuries, analysis is often the only way to answer material-specific questions.
Today's common laboratory analysers usually allow very precise measurements with small measuring spots in the µm range. To use these, however, the objects must be brought to the laboratory.
Given the enormous value of some of these manuscripts, and their fragility, their transport is unconceivable. The analysis must be carried out in situ in the library where they are stored. This approach was also implemented in the project “Textures of sacred scripture” [1].

Covers made of precious metal with elaborately set gemstone and glass decorations, as well as gold and silver inks for writing and ornament, were analysed on various Carolingian and Ottonian manuscripts (8th – 11th century) in six different European libraries allowing first comprehensive investigations of golden books in the Western Middle Ages.
To characterize the gemstones and to access the chemical composition of glass the precious metal bindings were investigated with a combination of microscopic examination, portable Raman and handheld XRF (h-XRF). While, the investigation of metallic inks was performed by digital microscopy and h-XRF.

Although only simple methods were used, their combination and optimized data evaluation in conjunction with the expertise of art historians made it possible to gain important new insights. For instance, in the case of *Golden Psalter* (Cod. Sang. 22, Stiftsbibliothek St. Gallen) it was possible to distinguish similarities and dissimilarities between different inks and thus differentiate between different production phases. In addition in the *Psalterium Caroli Calvi* (Latin 1152, Bibliothèque nationale de France), evidence has been found of the deliberate colouring of less precious stones, to imitate missing more valuable gemstones as e.g. sapphires. Equally exciting, on the back cover of the same precious binding stones previously described as possibly glass have been found to be a coherent set of valuable garnets of the almandine type.
These findings are of great value today, giving clues of the originality and history of the investigated manuscripts and allowing further understanding of the arts of medieval books.

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[1] https://textures-of-scripture.ch/