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Non-destructive analysis of pigments in the Koran of the P.P. Escolapios Library (Granada, Spain) by a laboratory-made portable XRD/XRF system

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Abstract

The heritage left by the Arab world in the history of religion, sciences and arts is directly related to the documentary sources, including manuscripts of the different historical periods. Until a few years ago, sampling and analysis with destructive techniques was the most usual procedure for the pigments recognition in this type of artworks (Espejo Arias *et al.* 2008). Nowadays, non-destructive techniques such as μ -Raman and X-ray fluorescence are currently performed. A new portable X-ray diffraction/X-ray fluorescence (XRD/XRF) equipment has been designed and constructed in the *Centre de Recherche et de Restauration des Musées de France* (C2RMF laboratory) at the Louvre Palace (Giannoncelli *et al.* 2008, Duran *et al.* 2009).

Our special focus in this article will be to report on novel results from the Koran of the P.P. Escolapios Library at Granada, which presents some peculiar characteristics that lead us to speculate on the possibility of a transitional codicological typology from the Arabic to the Christian book in Al-Andalus during the 15th century. We have used the portable XRF attached to the XRD that gives access to the crystalline structure of the pigments. X-ray tube with copper anode was used. The experimental set up is shown in Figure 1.

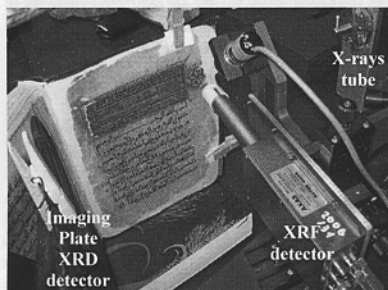


Figure 1. Experimental set up implemented for this work

The measurements were performed in some of the colours of the manuscript on the Arab characters and on the marks of *hizb*. The presence of mercury and sulphur by XRF and cinnabar (HgS) by XRD were detected in the red zones. XRF spectra of light brown and yellow colours showed an elemental composition very similar to the red ones, with the addition of arsenic. Cinnabar and orpiment (As₂S₃) phases were clearly detected by XRD in these zones. No diffraction patterns attributed to crystalline compounds were found in the green and blue colours, possibly due to the low concentration of pigments in these zones. Regarding the XRF spectra, copper was detected in both colours. In all the cases, broad peaks of the cellulose paper were detected by XRD.

The performance of in situ and non-destructive XRD measurements, coupled to XRF, has contributed to the knowledge the materials present in the Koran studied. Moreover, this work shows one of the first case studies on the application of XRD portable systems for the study of Spanish cultural heritage.

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