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Elemental analysis as statistical preliminary study of historical musical instruments

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Abstract

The history of bowed string instruments includes centuries of experimentation performed by violin makers with different manufacturing processes and several natural materials. The characterization of the material components can therefore often help researchers to identify the construction period of an instrument, its geographical origins or, if possible, the name of the violin maker. In a few cases, musical instruments, especially bowed ones, that were played frequently over time suffered severe damage (e.g. cracks, woodworms), and some parts of the instruments needed to be replaced to repair such damage. Gaetano Sgarabotto (1878-1959) and his son Pietro (1903-1990), two of the most eminent violin makers and restorers of the 20th century, collected many replaced parts in a group of fragments from musical instruments manufactured between the 16th and the 19th century by some of the most important Italian and European violin makers.

In this work, non-invasive and micro-destructive analyses could be combined through portable X-ray fluorescence spectrometry (PXRF) and scanning electron microscopy (SEM) with an EDAX spectrometer (SEM-EDX) on 24 fragments of the Sgarabotto collection. Principal Component Analysis was applied to classify relics, highlighting the most relevant and particular elements in the dataset. The principle of transformation is the extraction of maximum variance for each successive new variable. This procedure leads to the separation of valuable information from noise and to the selection of a small number of influential and statistically significant variables. The application of this analytical procedure leads to (i) assessing the existence of elemental markers of specific historical periods and/or manufacturing areas; (ii) characterizing the materials that the layers of a selected group of fragments are composed of; (iii) identifying any correlations between different fragments.

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