Characterization Techniques Used in the Forensic Analysis of a Metal Art Object
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This research presents data from the contributions of X-ray fluorescence (XRF) spectroscopy and X-ray diffraction (XRD) for trace evidence characterization of materials in the context of a forensic investigation in art and archaeology. In this communication we present preliminary results of our investigations in collaboration with special agents from the Department of Homeland Security (DHS) on the analysis of a male bronze-looking sculpture (20.5" x 9") suspected to be looted or forged artwork. XRF in situ analysis provided qualitative information on the elemental composition of the surface and bulk materials, whereas XRD data on cross sectional samples and powders helped identify all crystal phases present. Results suggested that the bulk was made of native copper (Cu) sheets, affected by corrosion denoted by the presence of three of the most common copper corrosion phases: cuprite (copper oxide Cu\textsubscript{2}O), malachite (basic copper carbonate Cu\textsubscript{2}CO\textsubscript{3}(OH)\textsubscript{2}) and atacamite (copper chloride hydroxide CuCl(OH)\textsubscript{3}), the latter being characteristic of the ‘bronze disease’. ‘Bronze disease’ refers to the irreversible corrosion process that occurs when chlorides come into contact with copper or copper metal alloys. Other materials identified included surface deposits of calcite (CaCO\textsubscript{3}) and gypsum (CaSO\textsubscript{4}.2H\textsubscript{2}O), which could be associated with burial environments and weathering or deliberate additions to fake the authentication of the sculpture. The absence of elements such as arsenic (As) and tin (Sn), main components in bronzes, and the identification of copper sheets as the bulk material suggests that the object is not a cast bronze sculpture, typical of ancient production. However, the object shows small windows (holes in the sprueing system) implying a lost-wax bronze casting method. These may have been forged to imitate a bronze casting technology. Despite this evidence, further investigations will be conducted to confirm that these data are representative of the entire object and that the copper sheets are not modern repairs. This research, at the interface of materials science and archaeology, provides a cross-disciplinary effort to better study physical evidence and changes it has undergone due to its age and environment and to aid law enforcement practitioners in combatting crime of archaeological looting and forgery of ancient materials.