JOURNEYS OF OUR ANCESTORS:

CONSERVATION SCIENCE APPROACHES TO THE ANALYSIS OF CULTURAL MATERIAL

by

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As members of the Dissertation Committee, we certify that we have read the dissertation prepared by Caitlin Rose O'Grady entitled Journeys of Our Ancestors: Conservation Science Approaches to the Analysis of Cultural Material and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy

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ABSTRACT

The application and use of non-destructive portable x-ray fluorescence (XRF) analysis is a critical tool in the preservation and interpretation of cultural material. Portable XRF instrumentation produce elemental compositional data that is used to reconstruct current artifact composition, which can be related to materials and methods of manufacture, technological practice, as well as object condition and presence of corrosion surfaces. Portable XRF analysis is used to assess a variety of material classes utilized in artifact manufacture. The dissertation research is based on a series of three case studies that represent typical groups of material culture commonly encountered in conservation and conservation science research.

Conservators and conservation scientists frequently undertake analysis and interpretation of disparate groups of materials. Often, these objects are tied together by research questions or themes directed by outside influences including preservation issues requiring action; curatorial research interests; museum exhibition programs; as well as many other cultural heritage stakeholders. To this end, both non-destructive and destructive tools that provide measurements of interest play critical roles in analysis. The case studies have been designed to answer common compositional questions relating to (a) bulk analysis of Chinese coins, (b) characterization of Southwestern ceramic colorants, and, (c) chemical examination of post-depositional manganese dioxide accretions occurring on archaeological ceramic materials. They evaluate the value of data produced using effectiveness of non-destructive portable XRF analysis for the interpretation of archaeological materials. The case studies provide a template for the

development of conservation science research, predicated on object preservation, which produce meaningful data for the interpretation and conservation of the analyzed archaeological artifacts. Portable XRF provides useful data that is used to successfully interpret archaeological materials through (a) classification of metal alloys that can be related to published coin data, (b) identification of ceramic colorants and production technologies, and, (c) characterization of post-depositional product composition when used with established visual typologies.

CHAPTER 1. INTRODUCTION

The research described in this dissertation is based on a series of three case studies that represent typical groups of material culture commonly encountered in conservation and conservation science research. The case studies evaluate the interpretive value of portable x-ray fluorescence (XRF) analyses in the analysis of archaeological metal and ceramic materials including (a) Asian cast metal objects dating to the 17th – 20th centuries, (b) prehistoric ceramic colorants used on Southwest low- and high-fired ceramics, and (c) post-depositional products found on low-fired ceramics. Conservation science is devoted to the preservation of archaeological, artistic and historic artifacts, sites and structures through the analysis and interpretation of the artifact/site/structure composition, technology, degree of degradation and its associated environment. The discipline investigates conservation materials and treatment techniques; as well as evaluates and develops new analytical methods (non-destructive and destructive) for use and application in conservation and conservation science research.

Conservators and conservation scientists frequently undertake analysis and interpretation of disparate groups of materials. These objects are tied together by research questions or themes directed by outside influences including preservation issues requiring action; curatorial interests or research; museum exhibition programs; as well as those identified by other cultural heritage stakeholders. Frequently, research may focus on object interpretation through identification of materials and technological production processes- both of which heavily influence object preservation. Conservation science research utilizes compositional data in order to relate material properties and

manufacturing methods to condition, degradation and appropriate preservation practice. To this end, both non-destructive and destructive tools that provide measurements of interest play critical roles in analysis.

Tailoring the tool to the question and the available data – be it scientific, empirical, both, or tools derived from other disciplines – is the critical step towards effectively utilizing non-destructive methods of analysis in cultural heritage conservation. The scope of conservation science research is broad and requires an "incremental and iterative approach" (Cather 2006:90) towards producing effective and meaningful research that is beneficial to the preservation and interpretation of artifacts, sites and structures. Therefore, the presented case studies have been chosen to reflect this important aspect of conservation science research and practice. Compositional data provides critical information regarding raw materials and technologies used in artifact manufacture; current deterioration and artifact stability; as well as the existence of possible repairs (ethnographic, curatorial or conservation) and past interventions. This type of data informs any decision made to conserve and interpret the artifact. The case studies have been designed to answer common compositional questions relating to (a) bulk analysis of metals, (b) characterization of layered ceramic colorants, and, (c) chemical examination of post-depositional changes occurring on archaeological ceramics. They evaluate the effectiveness of non-destructive portable XRF analysis for the interpretation of a variety of archaeological materials and provide meaningful data for the conservation of the analyzed archaeological artifacts. The first case study focuses on the application of portable XRF instrumental techniques to a group of Chinese copper-alloy

coins excavated in Tucson, Arizona. The second case study reports compositional analysis of ceramic surface colorants produced by paints, slips and pastes on low-fired ceramics from the Southwestern United States and Northern Mexico. The third and final case study examines the presence of post-depositional manganese dioxide accretions found on low-fired ceramics from Mexico.

Introduction and Analysis Summary

Conservation science focuses on the preservation of tangible and intangible data associated with artifacts through the application of technical study and instrumental analyses. Tangible data includes scientifically measured physical and chemical properties, while intangible information is associated with the cultural significance, meaning, and importance of artifacts (Odegaard 1995). Object preservation incorporates long-term preservation conservation of the object itself, as well as associated analytical data, object cultural meanings and research potential. Non-destructive evaluation (NDE) techniques are critically important to conservation and conservation science research of cultural heritage materials. NDE methods do not require object sampling and are compliant with established, ethical guidelines for practice, as developed by the American Institute for Conservation of Historic and Artistic Works (AIC), the American professional conservation organization. NDE techniques refer to "test methods used to examine an object, material or system without impairing its future usefulness" and "evaluate the properties of a material, component or system without causing damage" (American Society for Non-destructive Testing 2009; Cartz 1995). NDE technologies, as used in industry, are quantitative techniques that measure and analyze physical and