The Relationship between Inherent Material Evidence in Cultural Heritage and Preservation Treatment Planning: Solving the Ptolemy Puzzle, Part II

ABSTRACT

The ongoing technical study and conservation of an important historic atlas, a 1513 hand-colored edition of Ptolemy’s *Geographia* in the Library of Congress’ Lessing J. Rosenwald Collection, is discussed from the point of view of how technical analysis, in particular elemental analysis by X-ray fluorescence, contributes to an understanding of the provenance, method of manufacture, treatment history, and present condition. Results strongly suggest that a subset of maps were treated with a potash alum-gelatin sizing or coating, which appears to have had a major role in the degradation of both the paper substrate and a green copper-based pigment.

INTRODUCTION

It is a given that curators, conservators and cultural heritage scientists are united in their endeavor to preserve and maintain access to cultural heritage. It is also a given that these experts tend to approach collection items with different sets of questions and viewpoints, variously placing value on aesthetics, historical evidence and condition. Amid the balancing act between intrinsic value, condition, and intended use that is part of preservation planning, the question arises as to whether there is inherent tension between preservation of both intangible material “evidence” and the tangible object. Conservation protocols include many physical treatments that are applied using current knowledge and materials. While interventions purposely alter chemical and/or physical properties of an object to enhance stability and handling, as conservators and scientists are keenly aware, treatments may also subtly alter material evidence. The advent of improved, non-invasive analytical tools, such as X-ray fluorescence (XRF) and spectral imaging, has raised our awareness of what this trade-off may entail. The body of analytical evidence these techniques gather without sampling and time consuming analysis can add valuable information regarding an artifact’s provenance, history of manufacture and treatment history. Yet, the window of opportunity to collect this somewhat vulnerable evidence is most often before treatment. Are, then, scientific analysis and conservation protocols driven by conflicting values or mutually beneficial?

EXPERIMENTAL

XRF was conducted using a Bruker Tracer TurboSD energy dispersive XRF spectrometer. The instrument has a miniature X-ray tube, Rhodium anode and silicon drift detector; it was operated on a tripod with vacuum pumping at either 15 kV and 55 µA or 40 kV and 20 µA, with or without a titanium filter; exposures were 180 seconds. The instrument beam spot has a size of approximately 3 x 4 mm. All XRF data are analyzed qualitatively as difference spectra from the average paper spectrum background; spectra shown below are not normalized, since scattering is essentially equivalent for comparison. XRF analysis was augmented by spectral imaging, conducted using an Artist® Multispectral Imaging System in the Conservation Division. Results obtained by these two non-invasive methods lead to further analysis of several microsamples. Fourier-transform infrared (FTIR) microscopy was conducted using a Thermo Nicolet Nexus 670 spectrometer equipped with a Smart DuraScope attenuated total reflectance (ATR) accessory with a diamond crystal and DTGS CsI detector. Spectra

were collected at 4 cm⁻¹ for 128 to 1064 scans. In addition, micro-X-ray diffraction (µXRD) was carried out on a Rigaku D/Max Rapid instrument at The Smithsonian National Museum of Natural History. The equipment has an image plate area detector, and was run using monochromatic molybdenum Kα (λ = 1.42 Å) radiation at 200 kW. Samples were mounted on glass fibers in a collimated beam (0.3 or 0.1 mm); goniometer parameters were: chi fixed at 45°, omega fixed at 1°, 2°, or 3°, and phi spun through 360° rotation at 1° s⁻¹. Patterns were integrated with AreaMax software and qualitatively matched using Jade 7.5 software and the International Center for Diffraction Data database.

RESULTS AND DISCUSSION

Materials analysis of the 1513 Rosenwald Ptolemy atlas has been an integral part of its technical study. Analysis initially focused on solving why only seven out of the 47 maps are in poor condition. Figure 1 illustrates the difference in visual appearance of a map in relatively pristine condition, the Quinta Europa Tabula (left), and one in poor condition, the Septima Asiae Tabula (right). The images also show that an overly tight rebinding led the volume to be pinched in the gutter region and difficult to open without causing damage, which was why the volume was sent for conservation (Albro et al. 2011). As seen in figure 1, the Septima Asiae map exhibits yellow-brown and embrittled paper, with green pigment that has turned muddy or brown and caused both offset staining and strikethrough. These features are typically associated with verdigris syndrome, i.e., deteriorated copper acetate-based pigment that has induced cellulose degradation (Scott et al. 2001). While XRF analysis readily provided proof that the green pigment found throughout mountain details of the atlas is copper-based, XRD, FTIR, and Raman analyses have yet to confirm that the pigment is actually verdigris. On the other hand, no evidence has been obtained that the pigment is another likely copper-based pigment, such as malachite or azurite plus an organic yellow colorant. Whether the green pigment is verdigris or not, however, does not explain Fig. 1. Quinta Europa Tabula map (left) and Septima Asiae Tabula map (right) from Ptolemy Geographia, 1513, Rosenwald Collection, Library of Congress, showing a map in good condition compared to one in relatively poor condition with visible offset from green pigmented areas.
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why a select number of maps exhibit advanced degradation, including, in some cases, a whitish accretion over the surface.

XRF analysis was conducted on a group of maps and text pages in various conditions to further explore this question. Figure 2 compares spectra from uncolored and unstained areas of the paper substrates of the Quinta Europa and Septima Asiæ maps (fig. 1). Results show that the paper in poor condition is associated with relatively higher concentrations of iron (Fe) and copper (Cu). These transition elements are well known to be catalysts for cellulose degradation and may provide at least partial explanation for the observed differences in condition (Shahani and Hengemihle 1986). In addition, it is noted that calcium (Ca), which is generally associated with a beneficial effect on paper longevity, appears somewhat higher in the Quinta Europa map. A better statistical sampling of Ca in the papers would, however, be required to make firm conclusions about whether this element plays a positive role in the condition of some maps. What is most noteworthy, however, is that the map paper in poor condition is also associated with relatively high amounts of potassium (K) and sulfur (S). This suggests the presence of potash alum, KAl(SO₄)₂. While relatively minor amounts of K and S, as detected in the Quinta Europa map, could reasonably be ascribed to an alum-hardened sizing on the paper, the finding of much higher detected levels of K and S in the Septima Asiæ Tabula map requires more explanation.

Figure 3 shows XRF spectra of the paper substrates in five additional maps overlaid with that of the Quinta Europa. Together, these spectra reveal two distinct groups in terms of elemental composition, where Group I contains relatively lower levels of Cu, K and S, and Group II contains relatively higher levels of these elements. These two groups correspond fairly neatly, in fact, to maps in good or poor condition, the latter three (Tabula Prima Asiæ, Nona Asiæ Tabula, and Tabula Secunda Africae) having symptoms similar to those described in the Septima Asiæ Tabula. These results lead to the hypothesis that the substance associated with K and S, presumably potash alum, has had a direct impact on the condition of the map paper and that this is not typical verdigris syndrome.

Figure 4 shows the FTIR spectrum of a sample of the whitish accretion from the Nona Asiæ Tabula map. Comparison to reference spectra shows that the removed sample matches well with a combination of potash alum and gelatin. Additional XRF analysis of the in situ accretion without a Ti filter (not shown) reveal the presence of aluminum (Al), plus even higher detected levels of K and S than in other areas of the paper. These results confirm that the white surface accretion and paper substrates of maps in poor condition contain a highly concentrated potash alum-gelatin sizing or coating. This solution was evidently brushed onto the maps, as evidenced by brushstrokes that are clearly visible in UV imaging (Albro et al. 2011). This may correspond to a “strengthening treatment,” which is known to have been popular until relatively recently in areas such as Eastern Europe (Khan 2011). Brushing of the solution over the face of the maps would explain the presence of elevated Cu in all of the treated map papers (figs. 2–3): in other words, the treatment most likely spread copper from the pigment throughout the
modern rebinding and treatment, maps on unwatermarked paper were beginning to show browning, weakening and copper staining. These maps would have been especially prone to tearing from handling in the restrictive binding. However, a few maps on good quality paper also experienced handling tears, which explains their removal for pulp repairs. These two conditions, deteriorated paper and handling tears, provide rationale for removal and overall treatment of a select group of maps, possibly at the same time as the twentieth century rebinding (Albro et al. 2011).

There are several important implications of this treatment history. First, XRF analysis of removed guards shows that the potash alum is easily removed by washing; this will directly impact the conservation treatment strategy for the maps. Second, the revelation of the potash alum treatment not only helps our understanding of the condition, but is part of the volume’s history and provenance. Third, analysis reveals important potential causes of “verdigris” syndrome, which will impact its treatment and lead to a better understanding of this commonly observed phenomenon. The treatment plan, which is still evolving, will take into account this intangible material evidence, which is now documented. Results of this ongoing study will be elaborated in an upcoming publication.

CONCLUSION

Ongoing technical study and conservation of an important historic atlas, a 1513 hand-colored edition of Ptolemy’s Geographia in the Library of Congress’ Lessing J. Rosenwald Collection, has been analyzed non-invasively by XRF, in combination with some other techniques. Results show the presence of a potash alum-gelatin sizing or coating, which was likely applied during a later intervention, possibly a twentieth century rebinding. This treatment appears to have had direct and dramatic impact on the condition of seven maps, which are now in quite poor condition in terms of both the paper substrate and a green, copper-based pigment. Further study of the relationship between inherent paper quality, current condition and past treatment in the 1513 Ptolemy atlas is expected to lead to a better understanding of the substrates’ condition and a reappraisal of what was at first thought to be typical “verdigris” syndrome. These results assist in the treatment planning and execution of this important volume, and also have made significant contributions to decipherment of the object’s provenance, method of manufacture, treatment history, and present condition.

REFERENCES

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Evidence suggests an intricate relationship between complex and mediating processes of, for instance, income, parental stress, disrupted parenting practices and neighbourhoods and environments, as opposed to a simplistic causal relationship between poverty, parenting and child outcomes. The article then proceeds to suggest responses to enhance the evidence and research. Lastly, it considers the implications for child poverty policy, arguing that current responses are too simplistic and do not sufficiently reflect the evidence base.

Conventional wisdom concerning the relationship between heritage preservation and tourism development have shifted dramatically over the last four to five decades, however, the challenges facing planners, archaeologists, architects and conservators of decades past seem surprisingly similar to those of today. Tourism also affects heritage locations in multiple ways, some more obvious than others. For instance, the impact high rise buildings have on a landscape and the communities living within that landscape is usually self evident. Most often governments and those involved in planning for tourism focus on the predicted growth in international tourism, (i.e. those forms of tourism that involve the crossing of national borders).