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NEW IDEAS FOR THE TESTING, DOCUMENTATION, AND STORAGE OF OBJECTS PREVIOUSLY TREATED WITH PESTICIDES

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Pesticide residues and chemicals from preservation efforts on museum collections have long been a silent health hazard for museum workers. In recent decades conservators have sought to improve the safety of objects and to protect the health of the people that work with them (Fig. 1).

Figure 1.Old artifacts made of materials known to be susceptible to insect attack that are in perfect condition may be considered suspect for having some form of pesticide treatment.

Specifically, these efforts have included stopping the use of chemical pesticides in museums, the increased use of personal protective equipment, and the removal of treated objects from educational programs. Today, conservators, tribal communities and museum professionals are faced with a particularly urgent situation: sacred objects and objects of cultural patrimony eligible for return under the 1990 NAGPRA law may be contaminated with poisonous residues. This paper will illustrate how standards for testing, documentation, and possible removal of residues

residues are being developed to reduce the threat of physical harm these objects pose to people as a result of repatriation.

By 1998, a concern for the health hazards of the objects being legally transferred from museums to tribes prompted the Arizona State Museum Conservation Lab at the University of Arizona to expand its research into pesticide residues. Various grant funds [1] have allowed a team to expand spot testing techniques, compile historic pesticide formulas and preparations, initiate the analysis of pigments (ancient and contemporary) from the Southwest, incorporate new uses of digital images into the documentation process, investigate new technologies, complete a collaborative study of repatriated objects, publish findings and present numerous seminars.

The University of Arizona team included museum, tribal, medical and scientific specialists. Conservators offered an understanding of past museum pesticide practices, a familiarity with artifact materials and manufacturing technologies, strategies for selecting test techniques, and the establishment of handling procedures. Chemists adapted chemical reagents and analytical instrumentation for use with the museum objects, medical toxicologists interpreted the analytical results and evaluated the potentials for human toxicity, and Tribal representatives related relevant concerns and concepts of cultural use. Our team approach allowed the skills, experiences and knowledge of each specialist to address this problem.

Inspired by the participants that attended a NAGPRA consultation workshop held in Tucson in March 2000, several research projects were initiated. Over ninety chemical pesticides and products have been reportedly used in museums (Fig. 2).

Figure 2. Pesticides including herbicides, fungicides and various other substances have been used to prevent, destroy, repel or mitigate pests in order to preserve museum collections.

These were made in numerous formulations (concentrates, powders, baits, resin strips) and were applied by various methods (spraying, dusting, fogging, fumigating). (Odegaard and Sadongei 2004) However, there is seldom adequate documentation available (reports, notes, tags) to determine the human health risk (Fig. 3).

Figure 3. Occasionally, additional words or marks such as "poison", "arsenic" or a skull and crossbones may be found on labels and tags with an object.

The lab is currently developing appropriate methodologies for the use of a portable X-ray fluorescence (XRF) spectrometer, and the transfer of this environmental technology to a museum application. Non-destructive XRF instruments have been used to study museum objects for metal content (Ferretti and Moioli 1998). Recent studies have indicated that many American Indian objects in museums were treated with pesticides including heavy metals such as arsenic, mercury, lead and zinc (Goldberg 1996; Nason 2001; Seifert et al. 2000; Hawks 2001). Sirois (2001) described the use of a portable XRD developed at the Canadian Conservation Institute to analyze a representative selection of natural history specimens and First Nations masks, and confirmed the incidence of arsenic and/or mercury in the study of artifacts analyzed to date at 23 percent.

Recent research conducted by Boyer, Odegaard and Smith (2001) for the Hopi Tribe in Arizona utilized a Niton portable XRF unit and demonstrated the potential application of this commercially available technology to the assessment of pesticide residues on cultural objects.

We have found it to been very useful in non-destructive identification, both quantitative and qualitative, of heavy metals that may be present in pigments or pesticide residues that were applied to the surface of objects. Our current research with the Niton XRF [2] proposes to:

- Determine efficiency and non-destructive nature of the instrument for use on museum collections, particularly painted objects of all kinds, and organic-based objects (with or without paint) with possible pesticide residues.
- Develop appropriate protocols for the transfer of environmental technology to museum applications, and a correlation of the readings with human toxicity levels.
- Discern potential relationships between known painted objects and their composition, sources of raw pigment material and the traditional artistic practices of the American Indians in the Southwest, including use of materials, trade and exchange.
- Disseminate findings to colleagues representing diverse fields.

A case study with Brazilian objects was conducted. A small group of featherwork items were selected for the XRF pesticide study. They were not subject to NAGPRA but did represent objects made of organic materials that if worn would touch the skin directly, and had parts that would move slightly above the eyes, nose, and mouth of the wearer during dance.

In 1956 the Arizona State Museum received a donation of 103 ethnographic items collected by Lt. Col. Norwood J. Eggleling while he was stationed in Brazil as a military medical officer. The objects collected included numerous items reflecting the featherwork traditions of the Tupi people of the Brazilian coast at the time of European contact (Pró-Memória National Foundation 1980:40). Of the featherwork items only two tested positive for heavy metals (arsenic). According to an article in the Tucson Daily Citizen newspaper, some of the collection was displayed in 1955-6 and although there are no records, we suspect that these items may have been treated at that time. Although the donor could have treated these items, it seems likely that all would have been treated rather than just the two.

A feather diadem (catalog # E-3132) had a very visible deposit of white powder between the feather layers (Fig. 4). The diadem is said to be worn by men during ceremonies as a visor across the forehead. Recto and verso digital photographs were taken of the object, and numbers from the XRF readings were indicated on the photos at the corresponding test locations (Figs. 5, 6). A table indicates the concentration levels of arsenic (ppm) in one column and the confidence or error value in the other column for each of the test readings (Fig. 7).

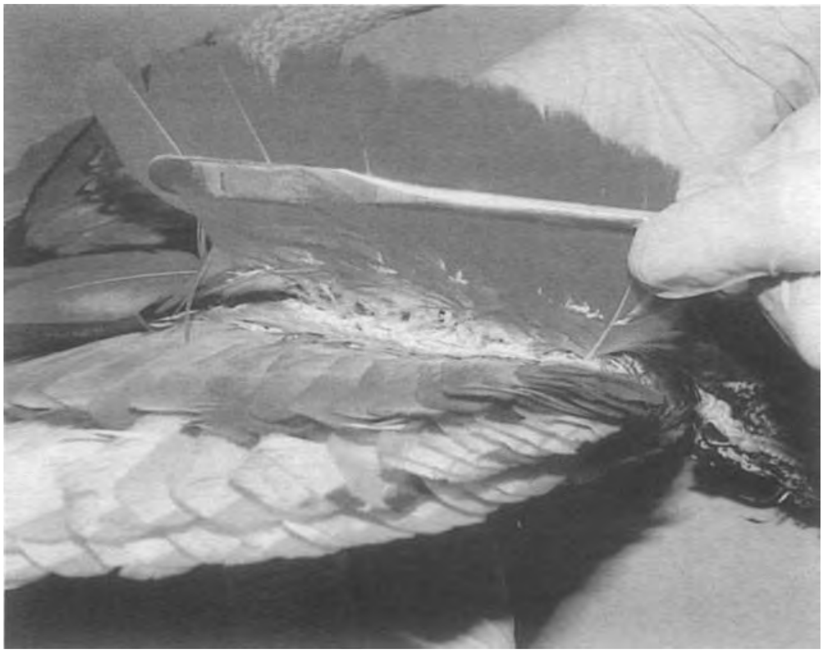
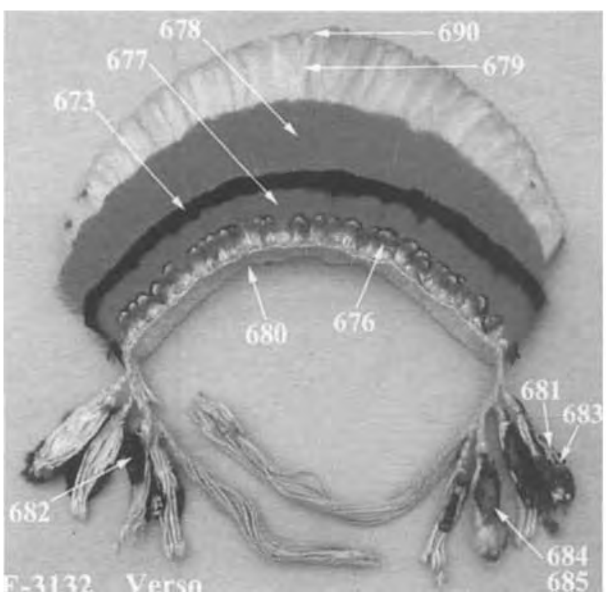


Figure 4. In some cases powders, such as arsenic or DDT, were applied directly to artifacts and remain intact and visible on interior surfaces.



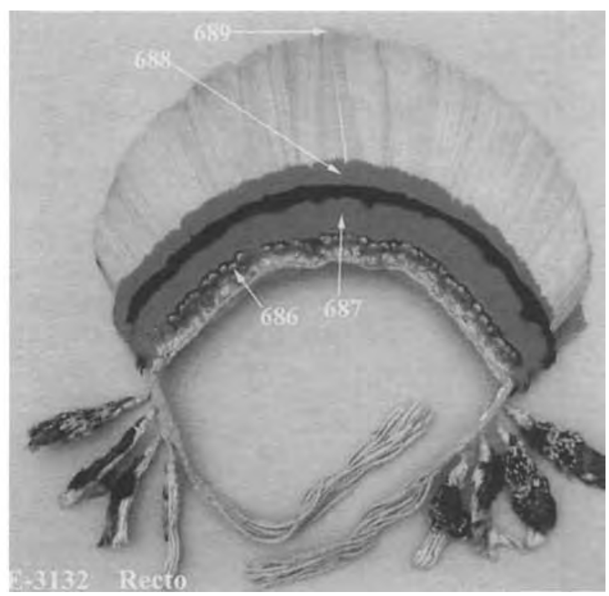


Figure 5. (Verso) and Figure 6. (Recto). Digital photographs were taken of the study object, and the XRF reading numbers were indicated on the photos at the corresponding test locations.

Reading No.	Location Description	As	As error
673	Verso, Inside between red and blue	2280	19
676	Verso, Top of brown feather	1810	16
677	Verso, Top of red feather	1467	15
678	Verso, Middle of red feather	438	7.9
679	Verso, Middle of yellow feather	70.56	3.33
680	Verso, Underside of headband	1031	12
681	Verso, Turquoise feather on tassel	1798	16
682	Verso, Blue feather on tassel	791.9	10.8
683	Verso, Turquoise feather on tassel	1666	16
684	Verso, Blue feather on tassel	322.8	6.9
685	Verso, Blue feather on tassel	262.7	6.2
686	Recto, Small brown feather	3132	22
687	Recto, Middle of red feather	2490	19
688	Recto, Middle of red feather	747.2	10.3
689	Recto, Tip of yellow feather	3.17	1.21
690	Verso, Tip of yellow feather	38.17	2.54

Figure 7. An Excel table indicates the concentration levels of arsenic (ppm) in one column and the confidence or error value in the other column for each of the test readings.

The toxicological assessment of the object was based on the amount of arsenic estimated to be on the object. This estimate of quantity was determined by multiplying the total area (1092 cm^2) by the total of the XRF readings (1147/$\mu g/cm^2$). The estimate amount of arsenic on the diadem was 1.2 grams. Leslie Boyer, MD, concluded that the object is dangerous and may pose a significant health risk through handling, storage and use. She estimates an acute oral dose of arsenic compounds to range from 1 mg to 10 g, with chronic effects occurring from exposure to as little as 3 to 4 mg a day.

The second object is also a headpiece (# E-3124) that is worn like a visor in ceremonials but unlike the first example, this item did not have any visible white powder (Fig. 8).

Figure 8. This visor did not have visible white powder but was suspected to be cross-contaminated through adjacent storage with the diadem.

It is suspected that it became contaminated through adjacent storage with the diadem. After testing with the XRF, the object was vacuumed with a soft blender brush and a dental vacuum (Fig. 9). XRF readings were then taken again (Fig. 10).

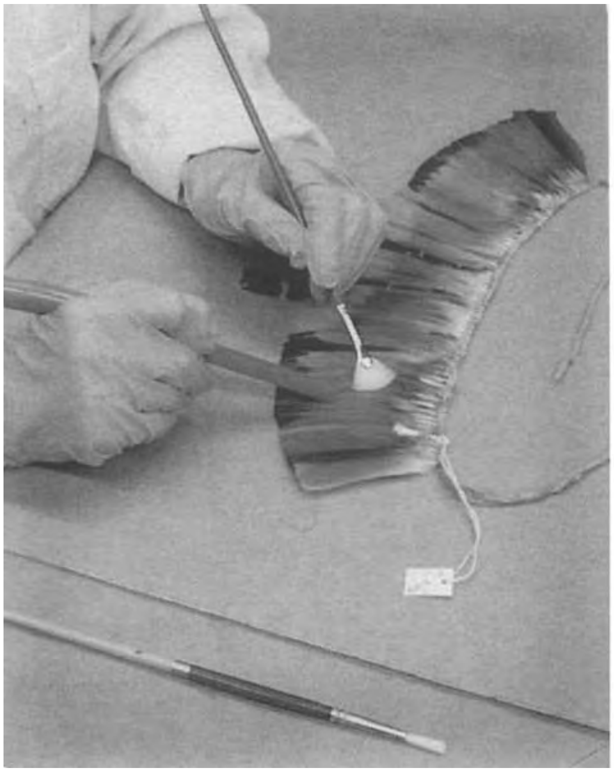


Figure 9. After initial testing with XRF indicated the presence of arsenic, the visor was surface cleaned using a soft blender brush and dental vacuum.

Figure 10. The visor is tested again using the Niton XLi 723 handheld XRF spectrum analyzer.

Results indicated that the vacuum cleaning did not remove the arsenic (Fig. 11, 12).

All of the flat featherwork items from this accession were rehoused in order to provide a protective barrier for curatorial handling, to isolate them from one another, and to provide greater visibility. The simple rehousing consisted of small sheet of Plexiglas cut to an appropriate size and polished on the edges, a zip-lock polyethylene bag cut and resealed to the size of the Plexiglas platform, and identification labels to alert those viewing or handling the objects to the arsenic contamination present (Fig. 13).

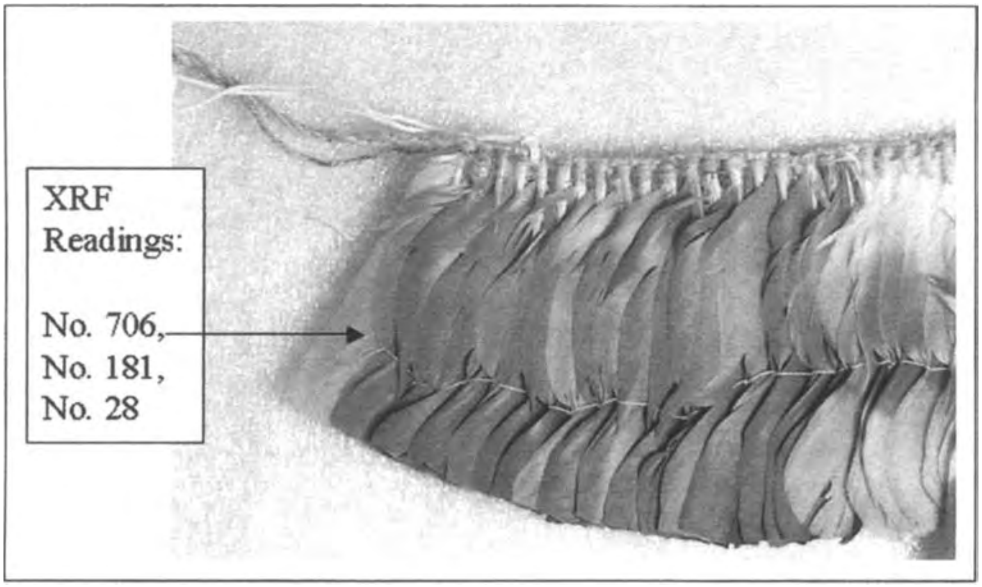


Figure 11. One area in which XRF readings were taken. The results are graphed in Fig. 12.

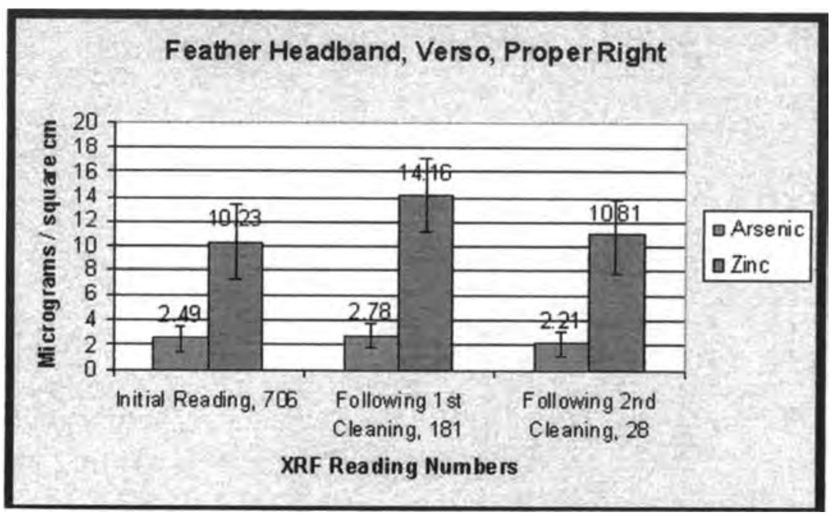


Figure 12. The graphed results corresponding to the tested areas indicate that vacuum cleaning did not remove the arsenic.

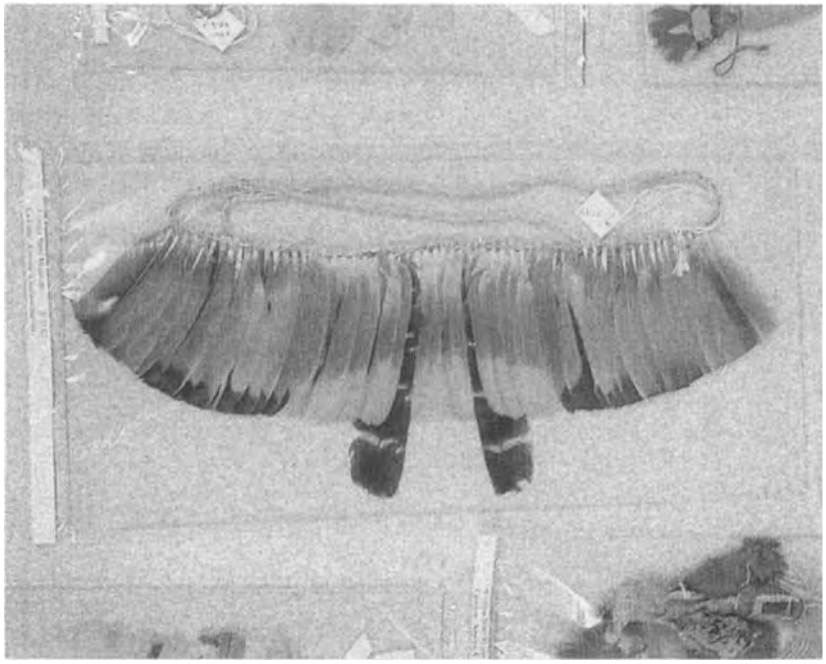


Figure 13. All of the flat featherwork items from this accession were rehoused to provide a protective barrier for curatorial handling, to isolate them from one another, and to provide greater visibility.

This method leaves the object visible on both sides, and provides a lightweight support with a barrier to prevent direct contact. The custom fit of the bag and slight charge of the Plexiglas hold the featherwork in place.

Museum workers, tribal members, artisans, and visitors to collections have benefitted from the knowledge gained through our research efforts. Further research with XRF and FTIR technologies is presently underway to study potentially toxic pesticide contaminants as well as heavy metal pigments that may have been used to create objects. With the ultimate goal of removing poisonous pesticide contaminants from the surface of cultural objects so that they are not a human health risk, the challenge is three-fold: 1) how do we sample the surface of artifact objects without damaging them, 2) how do we assess the health risk of the contaminants, and 3) if present, can a method of removal be developed that remains compatible with the physical and cultural aspects of the objects.

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2. Niton XLi 723 handheld XRF spectrum analyzer. Niton Corporation. 900 Middlesex Turnpike, Building 8, Billerica, MA 01821-3926. (800) 875-1578 (www.niton.com)

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