Materials Issues in Art and Archaeology III
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Preface

This symposium, Materials Issues in Art and Archaeology, is the third in a series in which the goal is to present recent work on (1) ancient materials, (2) the technologies of selection, production and usage by which they are transformed into the objects and artifacts we find today, (3) the science underlying their deterioration, preservation and conservation, and hopefully, although this goal is achieved infrequently, (4) socio-cultural interpretation based on an empirical methodology of observation and measurement.

Our call for papers read: "This symposium will provide a multidisciplinary forum for reporting and interpreting new developments in technical studies of material culture and in the conservation science required to preserve that heritage. In order to promote a dialogue among empiricists who examine the materials science and cognitive and cultural behavior underlying art, archaeology and technology, those who develop the materials science and technology underlying modern artifacts, and those who attempt to elucidate the underlying mechanisms of deterioration and means of stabilization, we solicit contributions in the following areas:

THE ROLE OF TECHNOLOGY IN MATERIAL CULTURE:
- Processing evidence from workshops and industrial debris.
- Bone, ivory and stone technologies.
- Lead-based processes, arsenical copper, wootz.
- Innovation and technology transfer vs. conservatism and craft tradition in ceramics.
- Analysis of properties to interpret function.
- Cultural, historical and technological reconstruction through artifact analysis.

CONSERVATION SCIENCE:
- Mechanisms of deterioration.
- Assessment and monitoring of condition.
- Evaluation of methods of cleaning and consolidation.
- Model tests of accelerated aging procedures.

CHARACTERIZATION THROUGH COMPOSITIONAL AND STRUCTURAL ANALYSIS:
- New methods and applications including case studies using surface and/or bulk analysis, isotope analysis, nondestructive evaluation or techniques applicable in archaeological fieldwork.
- Comparison of empirical data with textual or ethnographic accounts.

MECHANICAL AND PHYSICAL PROPERTIES OF MATERIALS AND/OR ARTIFACTS:
- Optical properties and visual appearance.
- Strength, wear and fracture.
- Interfacial phenomena in composites, especially treated objects.
- Replication studies.

Papers should report completed case studies and new applications, rather than potentially useful methods or work in progress. Our intent is to promote research in ancient technology, archaeology, art and conservation which shares the knowledge, methods and tools of materials science and engineering."
Each of the papers was reviewed by three peers, some by more, according to the following criteria.

**Significance:** The research should be of strong interest to those interested in ancient materials, reconstruction of their technologies, and conservation of artifacts made from them.

**Originality:** Results reported should stem from a new line of research or a new approach or present original results and should not be merely an extension of previously published material. What original thought does this paper contribute, or how does this paper extend current knowledge in the fields of conservation science, ancient materials analysis or interpretation of material culture?

**Technical Validity:** Data and analytical methods should clearly support the conclusions drawn. Does the paper "over-interpret" the results? Is there a clear separation between strict interpretation of experimental data and results and the more conjectural, less substantive interpretation? Are there flaws in the experimental part of the paper?

**Conciseness:** Invited papers are supposed to be 14 pages; contributed papers are to be about seven. If the authors have expanded their papers in order to explain results, rather than just announce them, is the length justified? If the paper exceeds the limits, what in your opinion might be shortened or cut?

We wish to thank the conveners of the sessions for their contributions, especially E.V. Sayre, Charles Selwitz and J. Peter Northover. The Materials Research Society staff and the organizers of this conference are also thanked for making the symposium and proceedings volume possible. We gratefully acknowledge the assistance of the many unnamed reviewers who gave their time and invested this manuscript with their energy and expertise. Our special thanks to members of each of our several labs who served as reviewers; we are sure they are glad this proceedings is finally complete. Lastly, since volume II was published Cyril Smith has passed away; we here include further information on his accomplishments.

We welcome the participation of each of you who reads this book or part of it in planning for and attending the next conference, which will be held in San Francisco in April of 1994. Most especially we welcome people who would be interested in organizing a session of this symposium which would focus on a particular topic.

Pamela B. Vandiver
James R. Druzik
George S. Wheeler
Ian C. Freestone

September 1992
INTRODUCTION

by Pamela Vandiver

That the purpose of this symposium is more than anything an interdisciplinary dialogue has been stated, but the work of organizing this symposium has been rewarded amply by recent reviews of the previous proceedings. Four reviews were published in three separate fields: conservation, archaeology and history of science—they are proof that we are earning an interdisciplinary label for our intentions and activities. They each point out the shortcomings of the proceedings, but also the potential of using the methodology and instrumentation of modern materials science to investigate questions of materials, technology, preservation and conservation by observing, measuring and analyzing artifacts and their contexts. The paradigmatic example of results obtained by investigation of structure, processing, properties, performance and their interrelationships is shared by most of the eighty-one papers in this proceedings which represent the efforts of 171 authors. The four reviews of the previous proceedings are reprinted below with the permission of the journals in which they appeared and in the spirit of hope that we may learn and grow from such criticism.

A CONSERVATION PERSPECTIVE


A new trend of looking at ancient objects in the context of materials science has developed among American scientists, probably having its roots more than 10 years ago but becoming visible over the past five years. The publication of the journal Archeomaterials in 1986 may be taken as a symbolic event in this development. Such a trend will, I expect, give a new perspective on interdisciplinary study between natural sciences and art history/archaeology, just as Archaeometry, published from the Research Laboratory for Archaeology and this History of Art, Oxford University, gave rise to that new field some 30 years ago.

Materials Issues in Art and Archaeology is the 123rd volume of the Materials Research Society Symposium Proceedings. The symposium, which well reflects the above-mentioned new trend, was held on 6-8 April 1988 in Reno, Nevada, USA. Forty-one articles were presented, of which 39 were published in this volume. The editors set up three main sections each divided into two subgroups:

Part I. Structural and Compositional Analyses
A. Studies of Structure
B. Compositional Analyses

Part II. Ancient Materials Technology
A. Technology of Silicates
B. Technology of Ancient Metals

Part III. Processes of Deterioration and Conservation
A. Glasses: Natural, Ancient and Modern Replicas
B. Evaluation of Processes in Art and Architecture

In the paper entitled "Tapping the Memory in Archaeological Materials" (Part IIb), Michael R. Notis el al. mention that "In the areas of archaeology, archaeometry, museum management and conservation science conflict often exists between the desire
to preserve, and the desire to understand an artifact." From the content of this volume, it can be said that the organizers (editors) of the symposium intended to reconcile such a conflict on the ground of materials science. I feel personally that the study to understand an artifact is as important for conservators as the study of deterioration, since both approaches are closely related and information from academic curiosity might be fed back to the studies for conservation and enrich the scope of conservation science. Notis et al. are quite right to mention that "conservation can best be done when the materials and techniques that were used for making the object originally are understood."

In this sense, most of the papers included in this volume are useful for conservators and conservation scientists. Particularly instructive are those review papers which are generally put at the head of each section.

Pieter Meyers surveys the various methods which may make clear, mainly through images, the macro- and microstructures of works of art and historic artifacts, while Edward V. Sayre discusses compositional analyses, both elemental and isotopic, as applied to glass, pottery, bronze, human bones, cloth, pigments and manuscripts. On reading these papers, one understands how structural and compositional analyses can be carried out in more or less nondestructive ways as well as why the two kinds of analyses have to go hand in hand.

Pamela B. Vandiver's paper "Reconstructing and Interpreting the Technologies of Ancient Ceramics" is a unique presentation of the author's philosophy and strategy to make a breakthrough into archaeology from the side of materials science, with examples ranging from the neolithic potteries up to modern high-tech ceramics. W. David Kingery's paper, "A Role for Ceramic Materials Science in Art, History and Archaeology," treats the subject in nearly the same spirit as Vandiver but in a more pedagogic way, stressing plaster technology in the pre-pottery neolithic Near East.

R. Maddin's paper "Technical Studies—Early Use of Metals" reviews many of the methods which provided insight into early metallurgical technology. However, the uninitiated may regret the lack of a table of technological development and a map showing the important sites, like those which appear in Vandiver's and Kingery's papers, in order to understand the historical background of this interesting paper.

Apart from the review papers and other contributions dealing with methodology, there are several papers in Part I and Part II which report experimental studies of various artifacts from regional cultures: Greek marble sculpture by Stanley V. Margolis et al., Roman ceramics in Britain by Ian C. Freestone and Val Rigby, Greek roof tiles by Vassilis Kilikoglou et al., Maya blue pigment by Luis M. Torres, terracotta warriors of the Qin dynasty by Hans G. Wiedemann et al., early Christian Irish glass and second millennium B.C. glass beads from Britain by Julian Henderson, and medieval window-glass by Helen I. Alten. It is interesting to read these papers as topics, but for the conservation scientist the greatest interest would lie in knowing whether or not the apparent conflict about the firing temperature of the Qin terracotta between the present authors (who concluded that they had not been fired) and Chinese scientists (who said that they had been fired at 800-1000°C) came from improper sampling of a degraded part in the case of the former.

Six papers out of eight grouped in Part IIIA concern obsidian hydration dating. This already classic method, first proposed by Friedman and Smith in 1960, aims at dating implements from the stone age. Since the hydration rate is dependent on environmental variables, the method requires various kinds of theoretical and experimental investigations, as explained in two review papers by Jonathon E. Ericson and William B. White. Here conservation scientists will find a field in common with archaeological scientists in studying the causes and processes of deterioration.

Part IIIB is, notwithstanding its attractive heading, rather miscellaneous, with such articles as "The Fading of Some Traditional Pigments," "Recent Salinization of Ancient
Egyptian Temples” and “Physicochemistry of the Tomb of Nefertari.” Conservators will find more of interest in the last two papers, by Mary W. Colby et al., on “Protective Coating for Stained Glass” and J.P. Jackson et al. on “A New Tool for Cellulose Degradation Studies”.

In future, not only conservators but restorers will become more and more involved in materials science, because they are in a field where “archaeomaterials” and new materials overlap. This book is an attempt to introduce a new area of materials science.

Unfortunately there are technical drawbacks, due to the photo-offset printing of the authors’ manuscripts, that make it difficult to read and understand very interesting academic papers. First, several misspelled words and incorrect figures were found in some papers, mistakes which could have been prevented by a careful rereading. Second, use of color photographs would have allowed a better understanding of such papers as that by Wiedemann et al., since the authors specifically discuss differences in color. Third, the proceedings as a whole would have been much easier to read if some of the papers had been typographically less crowded.

AN ARCHAEOLOGICAL PERSPECTIVE


This leviathan among symposium proceedings (70 papers, 853 pages) is the product of a meeting held in April 1990 on the application of materials science to the interpretation and conservation of prehistoric and historic artifacts. The editors and publisher of this volume are to be congratulated for bringing the product to market so promptly from camera-ready copy, although at some cost of editorial control. The type in some chapters is tiny, others are in barely legible dot-matrix, and several are much too long (37 pages in one case) or have errors such as a missing page, figures without scales, or unformatted tables.

The papers in this volume range over a very wide field indeed. Twenty-six of these report research on the conservation of masonry, adobe, glass, oil paintings, paper and metals. Since most readers of this review will be archaeologists, I will not consider these papers further except to note that the scientific standards on display are consistently high. An excellent section on the conservation of stone and adobe should, however, be read by any archaeologist who is charged with the stabilization of standing structures.

The remaining papers fall into several loose groups. There is a short section on new techniques, two of which promise to be exceptionally useful. These are the industrial CAT scanner, which can provide digital radiographs and computed tomographic sections of metal, wooden and ceramic artifacts. This technique will become indispensable for the study of complex objects that cannot be disassembled or physically sectioned. There are also two papers on the environmental scanning electron microscope (ESEM). This modification of the conventional SEM dispenses with high vacuum in the sample chamber; samples need not be dried or coated. It should therefore prove particularly useful for examination of botanical and zoological specimens.

Most of the papers in this volume are case studies of metals, ceramics or glasses. There are also three papers on textiles and one wildly speculative essay on the
environmental effects of lime plaster production in the Neolithic of Jordan. Interspersed among these are five papers on provenience analysis (one each on bricks, copper alloys, obsidian, marble and pottery), and two papers on the detection of fake ceramics and jades by analysis of the surface patina. Finally, all of this heavy but nourishing technical matter is leavened by several non-technical chapters. These include a short but incisive review of the history of archaeometallurgy, a summary of the early development of systems of weights and measures, and a delightful essay on ceramics as metaphor in the literatures of the ancient Near East.

The case studies in this volume range from the pedestrian to the truly remarkable. The best provide a clear demonstration of the ability of materials science, when closely integrated with history and archaeology, to reveal aspects of past social knowledge and behavior. The study of single objects brings to light the technical knowledge and the level of skill of its maker—the artisan behind the artifact. When studies of many artifacts and their manufacturing debris are combined with field studies of workshops, kilns, quarries, mines and other such loci, a great deal may be inferred about the organization of production. When many such studies have been done, it becomes possible to detect regional technological traditions and their mutual interaction. This volume contains some excellent papers at each of the hierarchical levels of analysis, but there is unfortunately not space to list them here.

The range of institutions represented at this symposium indicates that there is now widespread appreciation among archaeologists of the value of materials analysis. What is equally clear from this volume is that only a fortunate few have access to appropriate technical expertise and advanced analytical equipment. The dominant players in this field are the well-funded public and private research laboratories, such as the Conservation Analytical Laboratory of the Smithsonian Institution, the British Museum Research Laboratory, and the Getty Conservation Institute. Archaeologists who can arrange collaborative projects with these centers reap the benefits of a wide range of specialist expertise and equipment, often at highly subsidized rates. Other archaeologists are blessed with sympathetic colleagues in science or engineering, who are willing not only to undertake the analyses but also (to judge from the acknowledgments) to absorb the cost as well. These saintly individuals are still rare, though their numbers are increasing.

These formal and informal arrangements fall a long way short of meeting the rising demand for materials analysis of archaeological materials. Many other archaeologists lack access to appropriate expertise and equipment and do not have adequate funding to contract out the work. Under these adverse circumstances they do the best they can with whatever they have at hand. There are several such studies in this volume. Rather than criticizing these papers for their relative lack of sophistication, it is more appropriate to view them as symptomatic of a major problem in American archaeology today. Enormous advances have been made in archaeometry in the last fifteen years while research funding in archaeology has remained essentially flat. Thus while most archaeologists are aware of the potential benefits of new archaeometric techniques, few can afford to use them in their own research. Unless there is marked improvement in the funding of archaeology in the U.S.A., many of the valuable but expensive techniques exhibited in this volume will never be widely used in archaeological interpretation.

A PERSPECTIVE FROM THE HISTORY OF TECHNOLOGY

A review by Robert B. Gordon, professor of geophysics and applied mechanics at Yale University, who is well-known for his study of colonial American iron technology, of Materials Issues in Art and Archaeology II, which appeared in Technology and Culture, Vol. 33, No. 3 (July 1992), pp. 602-603.
Archaeologists and museum conservators are enthusiastically using new instruments for microscopy and chemical analysis that have been developed by applied physicists for materials scientists to probe and measure artifacts. For several decades now, archaeometric methods, such as radiometric dating, dendrochronology, and microprobe analyses, have given archaeologists information to use in revising older interpretations of, for example, the peopling of the American continents, the development of copper metallurgy in southeastern Europe, or the technological capabilities of ancient South Americans. Art historians have also found archaeometric methods useful in discovering aspects of the techniques used by individual artists, in detecting fakes, and establishing dates. Many practitioners of archaeometry attended a symposium at a meeting of the Materials Research Society in 1990 to present the results of their instrumental examinations of stones, ceramics, alloys, paints, and fibers in prehistoric, ancient, and a few historical artifacts. The editors of the symposium proceedings managed the remarkable feat of publishing sixty-nine of the articles within a year of the meeting. They are a guide to current research in archaeometric materials analysis, and they demonstrate the range of techniques that can be brought to bear in the study of material evidence from the past.

The articles in this volume (with only a few exceptions) are four pages long, stand alone, and report work in progress. Many of the authors have emphasized the sophisticated instrumentation and methods they used; the introductory comments for the different sections of the proceedings bristle with adjectives like stunning, advanced, cutting edge, high-tech, tour de force modern technology, or high-tech understanding. The stated objective of the conference was assessment of premodern behavior and cognition based on technical studies. In their summary of the proceedings, the editors describe some of the problems that arise in interpreting archaeometric data this way. In the brief space allotted them, however, most authors were unable to go beyond the presentation of their observations. There are some exceptions. Karen Foster's extended essay on ceramic imagery in ancient Near Eastern literature makes no use of archaeometry. Jack Ogden's article questioning the commonly held view that ancient gold jewelry was cast rather than hand-wrought shows that important research can still be done with the aid of a hand lens alone. Nevertheless, a nonspecialist reader of this volume may gain the impression that the capacity of modern analytical technologists to produce data is outrunning the capacity of scholars to use and digest the results. In part this is because of the increasingly common preference of funding agency and museum administrators in the United States for novelty over reflection. It is a paradox, then, that this volume is dedicated to Cyril S. Smith, the scholar who has done so much to interpret the wider context of materials in art and technology.

Most historians of technology have used material evidence sparingly, while curators at museums of technology often display items in their collections to illustrate conclusions drawn from documents rather than as sources of information. In the culture of archaeometry, artifacts identified as 'ancient' or 'fine art' are accorded higher status than recent or vernacular ones; something that is 'earliest' or 'first' commands the highest respect. Only one of the sixty-nine articles in this proceedings volume deals with a North American industrial material. There are opportunities for a convergence of interest between historians of technology and practitioners of archaeometry that could be mutually beneficial.

A SECOND CONSERVATION PERSPECTIVE


A book review may be associated with the homely atmosphere of long winter evenings, a fireplace, a pot of tea, a warm sweater and a nicely laid out and illustrated book that grips the reviewer from the first page to the last. The reviewing of Materials Issues in Art and Archaeology II was in sharp contrast with this scenario, because its
perusal began in a copy shop. Here the reviewer tried to enlarge individual articles whose deciphered titles showed promise. Without this, the tiny print of most parts of the book would have made reading a real torture. First point: I do not think that a copy shop is the right introduction to a book.

Browsing through the thick volume, all sorts of fonts, font sizes, formatting and layout can be found, as well as handwritten alterations and even subsequent editorial changes in fonts other than that of the original paper. This may reflect the colourful variety of our world or the simple fact that many different printers are on the market and the editors have given no guidelines to establish uniformity. Second point: Nothing has been done to make Materials Issues in Art and Archaeology II easy to read. This is not a new observation; these technical drawbacks were reported by Hisao Mabuchi in respect of the first volume of Materials Issues in Art and Archaeology [Studies in Conservation 36 (1991) 122-124].

An introductory note by Pamela Vandiver and George Wheeler presents the goals of the symposium, held on 17-21 April 1990 in San Francisco. The symposium asked for contributions related to ancient technology, materials degradation and conservation science, characterization through compositional and structural analysis, and physical properties of art materials. The note mentions “communication” problems between people around the world and among the disciplines involved in the investigation, preservation and conservation of works of art. The object is seen to be surrounded by archaeologists, art historians, materials and conservation scientists and conservators. They all speak different languages, their mother-tongues as well as the languages of their disciplines, and unfortunately only a few of them have received an interdisciplinary education. Therefore they all have different ways of approaching the object. This is not a new observation, and has led in the past to the staking of various claims such as "archaeometry" and "conservation science". Both areas have their own journals, symposia, heroes, gurus and fan clubs, as well as their characteristic topics with, unfortunately, little overlap. Third point: It is a good thing to overcome this division between our curiosity about ancient materials on the one hand and our task of preserving or conserving objects of cultural importance on the other. Symposia and publications such as Materials Issues in Art and Archaeology II aim to bring these two artificially separated areas together again. Unfortunately a number of authors did not follow this wise philosophy. They have produced papers with (sometimes) good scientific results which have lost any relationship they may once have had to the objects under discussion.

To review symposia proceedings of this kind is unpleasant because of the wide range of topics, including those with which the reviewer is unfamiliar. Thus this review cannot hope to cover all the more than 800 pages. In practice, the enlarged and deciphered contributions were skimmed through and some were finally studied in detail. In other words, I decided to skip many, many pages and I how have to live with the knowledge that most authors who contributed to this volume may say that I skipped the wrong pages. Sorry for this! The decision will be more comprehensible if one recognizes that Materials Issues in Art and Archaeology II covers New Methods and New Applications of Technical Analyses, Painting, A Problem in Composite Materials, Substrates, Binding Media and Pigments; New Approaches from the Mechanics of Materials; New Methods of Non-Destructive Analysis Compared with Analyses of Microsamples; Stone, Adobe and Architectural Glass: Monitoring and Stabilization; Characterization of Stone Sculpture and Stone Tools; The Role of Technical Studies in Establishing Cultural Functions of Ceramics; The Cultural Uses of Ceramics; Ceramics as Cultural Indicators which Reveal Exchange Patterns of Goods and Technologies; Reconstruction of Ceramic Technology; Alteration during Use, Burial and Testing of Treatment in the Field; Refractories and Glasses: Materials Choices, Workshops and Industrial Debris; Metals: The Unnatural Indicators of Cultural Differences; Innovation,
Cultural Differentiation and Properties; Theoretical and Practical Approaches to the Study of Metals; Textiles, Paper and Polymers; Characterization, Technology, Conservation and Maintenance of Fragile Materials, a summary, an author index and (very useful) a subject index. Phew! Each of the parts is introduced by a short and well-written overview of the papers within the section. This is particularly useful because it guides one through the jungle of these thousands of papers and it allows the editors (mainly Pamela Vandiver) to explain their philosophy; to link areas so far separated, such as conservation science, ancient materials science and engineering. Luckily, the unfortunate term "archaeometry" is exorcised!

In Part I on new methods and new applications of technical analysis F.H. Seguin gives an excellent introduction to the disadvantages and benefits of classic and digital X-ray imaging techniques. The paper is followed by a short section on applications. One would have enjoyed seeing more relevant applications to works of art, which would have forced a critical evaluation of image processing techniques applied in the field of X-ray techniques.

Two of the most fascinating papers deal with the use of environmental electron microscopy, a new technique presented by D. Stuik et al. and applied to actual conservation problems such as dissolution and crystallization processes in stone and other porous materials; this technique is also applied by E. Doehne et al. to humidity cycling in adobe and dynamic lead corrosion. The outstanding advantage over conventional SEM is that wet or outgassing samples can be observed directly under very high magnification, without the limiting sample preparation procedure necessary for SEM where such samples cannot be investigated at all. However, the method is limited to liquids with low volatility because there is still a partial vacuum. The new technique opens the large "dark" area of liquid-solid or gaseous-solid interactions for future "close" observation by conservation scientists. Congratulations!

It is not easy to see why a paper on cation-selective reagents is included in part I. These molecules are indeed a fascinating topic and it can certainly be expected that some of these compounds will one day serve in conservation campaigns. Thus far one fully agrees with the author, who gives a review of the former use of chelating agents (such as EDTA) as well as an introduction (or rather, a compendium of facts which can be found in any university textbook), the paper lacks any practical case histories of cleaning or solid experimental results (what about residues left on the surface?). The paper simply seeps away. This type of preliminary contribution can have disastrous results when used by fascinated but inexperienced readers. Fifth point: Today, why do we read more preliminary than final papers?

Another maddening example: in a paper on "Ion beam analysis of pigments" conducted with proton-induced X-ray emission (PIXE), one might expect results based on the investigation of at least two pigments. One might even expect a few critical comments about the benefits or disadvantages of the method, based on applications to real works of art. Something like "there are not too many sites where you may find PIXE but, in any case, you have to bring your object to the equipment." No, the paper reports the investigation of a single pigment, cadmium red. "mixed with lithopone (BaS\textsubscript{2}O\textsubscript{4})". Do the authors mean baryte (BaS\textsubscript{2}O\textsubscript{4}) or lithopone (BaS\textsubscript{2}O\textsubscript{4} + ZnS)? Sixth point: this type of limited paper based on a dummy sample or samples considerably inflates the number of pages in the volume and suggests the timid question whether everything written is worth printing.

In Part II the valuable input from materials science to all the dynamic processes to be observed on paintings is obvious. This is true of the work of Gustav A. Berger, well known to readers of this journal, as well as the contributions of Marion F. Mecklenburg. Mecklenburg's computer-aided application of engineering principles to paintings yields surprising results which contribute definitive new aspects to the problem of art transit. One of the conclusions is that "vibration may not be a serious problem for
stretched canvas paintings” and vibration is therefore not seen to be a major cause of cracking. This solid paper, with its language of materials science and its cool objectivity, does not, however, banish my personal concern that scientific approaches like this will one day be abused to increase the number of paintings and objects that go whoring around the world from one exhibition to another.

The luminescence of painting materials, most of them used as media, has again attracted the scientist’s attention. With the kind of laser spectroscopy presented by Londa J. Larson et al., very small samples can be investigated. The authors describe the method as being “nondestructive for the sample”, which is not what we mean by non-destructive testing in our field. It is, however, an advantage to have a method that is non-destructive of the sample since the sample may then be reused for further investigations. The emission spectra shown do not fully convince me that laser spectroscopy may serve one day to identify, or even differentiate, organic mixtures of varying composition which, in addition, are altered by aging. Any of the very sensitive separation techniques available nowadays will finally yield more reliable results. As long as the study includes only a few samples, as in this case, the conclusion that the *emission peak maxima and shape can be used to differentiate between samples* may be correct. But as soon as more and aged samples of this complexity are investigated, or simply those (mis)treated by several cleaning cycles, reliable differentiation will become extremely difficult. A second paper by A. Larson and I. Zink, has obviously been submitted to the wrong publication. This contribution does not show the slightest effort on the part of the authors to make a connection between their work on the *Luminescence of alizarin and its metal complexes* and Materials Issues in Art and Archaeology II. One can only hope that this paper will one day serve as one of the seeds mentioned above (my fourth point).

The paper by D. Scott on two silver plates in the collection of the J. Paul Getty Museum impressed by the way in which the analytical work is integrated into the information about other Byzantine silver objects so far investigated (and by the choice of a readable font size). The discussion shows how valuable scientific results can be, but also that they can never provide absolute proof of the authenticity of an object.

H.G. Wiedemann et al. journey into the world of forgotten weights and money, and make the reader feel like one small part in an endless series of human generations. The authors point out that they are using thermoanalysis as an important experimental technique. However, it is not made all that clear what this technique has been used for or what the experimental results have been. The only application described is the identification of PbCO₃ as a corrosion product on a Roman lead ounce. X-ray diffraction has also been used, and this, in fact, is the only method of choice.

Prudent closing remarks by Pamela Vandiver and George Wheeler summarize Materials Issues in Art and Archaeology II. To learn from the past and to prevent a further loss of cultural heritage and technological knowledge is a key task for scientists. It is unimportant whether they are materials or conservation scientists. In their neglect of traditional boundaries, books like Materials Issues in Art and Archaeology II, which are based on very recent results and on the philosophy expressed by the editors throughout this thick volume, are valuable tools for the fulfillment of our daily obligations. Bearing this in mind, the very heterogeneous quality of the papers and the maddening make-up of the book are of minor relevance.

A VIEWPOINT OF THIS PROCEEDINGS

The editors thank these reviewers for their incisive comments and their thoroughness. Our response is to endeavor to do a better job with this volume and the next one, and we have made several changes. In an effort to focus on larger issues of cultural significance which pose both physical and philosophical problems, Druzik assembled data on management of buildings and collections during times of risk due to armed
conflict. From presentations in the session, Cultural Heritage in Conflict, we learned of the necessity of detailed planning and preparedness. With the hope that more planning will take place, we reproduce a model publication from the British Museum, Air Raid Precautions in Museums, Picture Galleries and Libraries. The overwhelming conclusion is that behavior based on strong emotional dislike will cause the most damage to cultural heritage because that heritage is symbolic of the control of the "other side." Such destructive behavior can come from raiding by the "authoritarian" side in a conflict or looting by the "weaker" side. Protection afforded by the Hague Convention seems to be minimal.

Some of the problem may reside in the five-sided figure on a white background which is supposed to be a protective insignia. The green color is difficult to read from a distance. The figure which consists of a square motif with a point on the lower is perhaps not as effective a shape as might have been designed. The lower side seems to be pointing downward, almost as if to point to the structure like an arrow to a target. In a test which asked 50 high school juniors to associate seven symbols (cross, star with 5 points, hexagon, octagon, circle, pointed square, arrow) with protection or direction to a target and to order them from one extreme to the other, 88% of the students placed the Hague pentagon next to the arrow as indicating direction to a target.

We would like to present more interpretive and reflective articles on the wider context of materials issues in art and archaeology. While this proceedings is not as successful as we would wish, there are several other recent attempts which should be cited to provide a wider context for this proceedings. The January issue of the MRS Bulletin concentrated on the theme of "Art and Technology" with articles spanning modern technologies for art production by Otto Piene of M.I.T. to Northern and Southern European styles of painting during the Renaissance, Old World and New World styles of majolica production, the connection between the metallurgy of harpsichord wire and Columb’s pendulum, new approaches to silk preservation, to production of Neolithic period plaster sculpture from Jericho, and to refinements in the interpretation of paintings which accelerator radiocarbon dating of very small samples will make possible. Steven Lubar and W. David Kingery are publishing a proceedings of a conference held at the Smithsonian Institution, entitled Learning from History (Smithsonian Institution Press, Washington, D.C., expected 1993) in which interpretation of the social context of technology is stressed. Another such conference is to be held next spring. David Scott of the Getty Conservation Institute is editing the symposium on New World archaeometry as presented at the 1992 Archaeometry Conference in Los Angeles. The American Ceramics Society will continue its biennial symposia on the history of ceramics next April and the publications in the series entitled Ceramics and Civilization (American Ceramics Society, Westerville, OH) which now numbers six. Archeomaterials, under the new management of Robert M. Ehrenreich and J. Emlen Myers, will continue publication of articles of both a technical and interpretive nature which are too long for many other archeometric or conservation science journals. The same excellent quality of illustration will continue. The new editors welcome submissions (P.O. Box 4190, Rockville, MD 20849, Tel. (301) 294-3430).

In the second part of this proceedings, "Examination, Technical Analyses and Discovery," we have grouped papers into three sections: (1) the geological and geochemical context in which materials are found, manipulated and degrade, (2) the characterization of composition and structure of art objects and archaeological artifacts, and (3) properties of materials used by the artist, artisan and conservator. We hope that the section on geological context will grow in future volumes, as we become more aware of the environmental constraints on production and use. A recent book, Life as a Geological Force: Dynamics of the Earth by Peter Westbroek (Norton, New York, 1991) sets forth the perspective of biogeochemistry in a popular style.
With time, fewer studies of artifacts can be divided purely into either a compositional or a structural category, as many questions depend on combining analytical techniques of both types, so we have discontinued this division, perhaps ill-advisedly. However, one special book on compositional analysis will undoubtedly be acknowledged in future contributions to this symposium as promoting both accuracy and precision of measurement as well as interpretation. Chemical Characterization of Ceramic Pastes in Archaeology, edited by Hector Neff (Prehistory Press, Madison, WI, 1992). Another volume has been published which may further similar studies of stone, Ancient Stones: Quarrying, Trade and Provenance, edited by M. Waelkens, N. Herz and L. Moens (Leuven University Press, Leuven, Belgium, 1992). Another book on structural analysis should have a similar effect in its particular area of specialty, Phytolith Systematics: Emerging Issues, edited by George Rapp, Jr. and Susan C. Mullolland (Plenum, New York, 1992). This effort is the first publication in a new series promoted by the Society of Archaeological Sciences.

A relatively new area in museum studies which is yielding significant results is the measurement of mechanical properties. This area has grown considerably with each symposium, as participants have investigated more varied materials. The presentations in this proceedings are just a part of the increase in recent studies of the mechanical properties of art objects and archaeological artifacts. Another conference proceedings has added to the growing literature, Art in Transit, edited by Marion Mecklenburg (National Gallery of Washington, 1991).

In the third part, "Ancient Technology and Craft: The Role of Technology in Material Culture," we group studies according to object reconstruction from evidence provided by workshops, industrial debris or the artifacts themselves. Production events, tools and techniques, production processes and sites, or styles of production and use are three areas where most papers are individual case studies. This is the first time that we have not had to group papers in the style of objects studied in the last century, that is by material. Instead there are themes of inquiry clearly independent of material. Most of these papers depend on "deconstruction" of particular artifacts into minute observations and data, and then arguments are made on the basis of "structuralism" to compare and contrast particular artifacts or groups of artifacts within an all-important historical or archaeological context.

Another group of papers expresses a range of perspectives on the interaction among technical analyses, ethnographic evidence and the written record. This is an old query and theme in the study of artifacts, but one which is being revitalized by books such as Ceramic Ethnoarchaeology, edited by William A. Longacre (University of Arizona Press, Tucson, 1992), The Ceramic Legacy of Anna O. Shepard, edited by Ronald L. Bishop and Frederick W. Lange (University Press of Colorado, Niwot, CO, 1991), and The Historic City of Nara: An Archaeological Approach by Tsuhei Kiyotani and Tanaka Migaku and translated into English by David Hughes and Gina Barnes (The Center for East Asian Cultural Studies, Tokyo, and U.N.E.S.C.O., Paris, 1991). Another group of papers question limits to technological change provided by constraints of raw materials and past ways of working with materials. One symposium dedicated to Donald Harden (Roman Glass: Two Centuries of Art and Invention), edited by M. Newby and K. Painter, Society on Antiquaries of London, 1991) has this same theme implicit in many of the papers. Other papers in this volume investigate the use of artifacts as objects of display or as tools, and in so doing discuss cross-cultural interactions and cultural diversity which is reflected in the making and use of artifacts. One study by Lechevallier, Inuzan and Plumet postulates cultural contact and communication based on similarities and differences in technology and technological style, or patterns of activities recognizable by study of residual material culture.

The fourth part of the proceedings consists of "Conservation Science and Preservation," and is divided into three parts. The identification and physical chemistry of post-depositional processes is the foundation upon which conservation treatment
Identification of weathered and degraded products is also necessary before any studies of technology or materials identification can take place. Treatment, deterioration and structure in architectural and building materials is a concern which has been a focus of many participants, particularly during the second meeting. Corrosion of metals and ceramics and their protection is also featured as a section. One of the participants, David E. Clark, with his colleague, Bruce K. Zoitos, has edited a significant contribution to the conservation science literature. *Corrosion of Glass, Ceramics and Ceramic Superconductors: Principles, Testing, Characterization and Applications* (Noyes Publications, Park Ridge, NJ, 1992). In the interest of promoting further understanding among scientists of the field of conservation, a book which presents case studies and is edited by Andrew Oddy, keeper of conservation at the British Museum, is recommended (*The Art of the Conservator*, Smithsonian Institution Press, Washington, D.C., 1992).

The last section, "Experiments in Education and Artifact Study," is new this year. Several researchers see the study of artifacts as a way to promote interdisciplinary education or as a means of intriguing more students with materials science and other science and engineering disciplines as careers or simply for their knowledge and enjoyment. In addition, replications of artifacts are a way of understanding the process of making objects and gaining firsthand knowledge of craft processes as well as making study copies widely available.

The quality of this book still is somewhat lacking, but again it is being published in a timely fashion being available within months of the conference. The articles may not be as deep, or as wide, or as long, or as tall as the possible dimensions of our field which many can envision, but this is the best the editors and participants can do. As you, the readers, criticize this proceedings, as you try to find something of use in it, please consider the possibility of contributing to the next proceedings for which the meeting will be held in April-May of 1994.