


X-rays for Archaeology

Edited by
M. Uda,
G. Demortier
and I. Nakai



 Springer

X-rays for Archaeology

Edited by

M. UDA

Waseda University, Tokyo, Japan

G. DEMORTIER

Namur University, Namur, Belgium

and

I. NAKAI

University of Tokyo, Japan

 Springer

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN-10 1-4020-3580-2 (HB)
ISBN-13 978-1-4020-3580-7 (HB)
ISBN-10 1-4020-3581-0 (e-book)
ISBN-13 978-1-4020-3581-4 (e-book)

Published by Springer,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

www.springeronline.com

Cover shows an image of the tomb of Amenhotep III in Egypt.
Photo courtesy of Masayuki Uda.

Printed on acid-free paper

All Rights Reserved

© 2005 Springer

No part of this work may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording or otherwise, without written permission from the Publisher, with the exception of any material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work.

Printed in the Netherlands.

Table of contents

Foreword	ix
Part I <i>In-situ</i> Measurements	
<i>Chapter I-1</i> Characterization of Pigments Used in Ancient Egypt <i>M. Uda</i>	3
<i>Chapter I-2</i> Importance of <i>in-situ</i> EDXRF Measurements in the Preservation and Conservation of Material Culture <i>A.G. Karydas, X. Brecolaki, Th. Pantazis, E. Aloupi, V. Argyropoulos, D. Kotzamani, R. Bernard, Ch. Zarkadas and Th.Paradellis</i>	27
<i>Chapter I-3</i> Scientific Field Research in Egypt -Results from research undertaken by the Institute of Egyptology, Waseda University- <i>Sakuji Yoshimura</i>	55
Part II Use of Ion Beam	
<i>Chapter II-1</i> Ion Beam Techniques for the Non-destructive Analysis of Archaeological Materials <i>Guy Demortier</i>	67
<i>Chapter II-2</i> The Origin of Ancient Gemstones Unveiled by PIXE, PIGE and μ -Raman Spectrometry <i>T. Calligaro</i>	101
<i>Chapter II-3</i> Investigations of Medieval Glass by a Combined PIXE/PIGE Method Glassmaking à façon de Venise <i>Ž. Šmit and M. Kos</i>	113

<i>Chapter II-4</i>		
PIXE Analysis of pre-Hispanic Items from Ancient America		123
<i>J.L. Rivalcada Sil</i>		
<i>Chapter II-5</i>		
PIXE Study on Chinese Underglaze-Red Porcelain Made in Yuan Dynasty		151
<i>H.S.Cheng, Z.Q.Zhang, E.K.Lin, Y.P.Huang</i>		
<i>Chapter II-6</i>		
Glassmaking in the Venetian Manner		159
<i>Mateja Kos and Žiga Šmit</i>		
<i>Chapter II-7</i>		
Study on Pigments for Ceramics and Glass Using X-ray Methods		163
<i>B. Constantinescu, Roxana Bugoi, GH. Niculescu, D. Popovici, GH. Manucu-Adamesteanu</i>		
<i>Chapter II-8</i>		
Compositional Differences of Blue and White Porcelain Analyzed by External Beam PIXE		173
<i>Y. Sha, P.Q. Zhang, G.G. Wang, X.J. Zhang, X. Wang, J. Liu</i>		
Part III Use of Synchrotron Radiation		
<i>Chapter III-1</i>		
Synchrotron radiation X-ray fluorescence analysis of archaeological ceramics and glass		183
<i>Izumi Nakai</i>		
<i>Chapter III-2</i>		
Synchrotron Radiation in Archaeological and Cultural Heritage Science		199
<i>E. Pantos</i>		
<i>Chapter III-3</i>		
Study of the Elemental Distribution in Ancient Chinese Porcelain		

Using Synchrotron Radiation X-ray Fluorescence <i>Y. Y. Huang, P. L. Leung, W. He</i>	209
--	-----

<i>Chapter III-4</i> Study on the Compositional Differences among Different Kilns' Tang Sancai by SRXRF <i>Y. Lei, S. L. Feng, J. Jiang, Z. X. Zhuo, S. L. Zhang, Y. M. Liao</i>	217
---	-----

<i>Chapter III-5</i> Study of Chemical Composition in Ancient Celadon of Yue Kiln <i>Dongyu Fan, Songlin Feng, Qing Xu</i>	223
--	-----

Part IV Radiography

<i>Chapter IV-1</i> The Use of Medical Computed Tomography (CT) Imaging in the Study of Ceramic and Clay Archaeological Artifacts from the Ancient Near East <i>N. Applbaum and Y.H. Applbaum</i>	231
---	-----

<i>Chapter IV-2</i> The Radiographic Examinations of the "Guardian Statues" from the Tomb of Tutankhamen <i>Jiro Kondo</i>	247
---	-----

<i>Chapter IV-3</i> Analytical Study of Paintings by X-ray Radiography and Spectoroscopy <i>Kamba Nobuyuki</i>	253
---	-----

<i>Chapter IV-4</i> Radiographic Findings in Ancient Egyptian Mummies <i>Kazuaki Hirata</i>	259
---	-----

Part V Interdisciplinary Field between Art and Science

<i>Chapter V-1</i> X-ray Application on Post-Amarna Objects from Dahshur <i>S.Hasegawa, M.Uda, S.Yoshimura, J.Kondo, T.Nakagawa, S.Nishimoto</i>	265
--	-----

<i>Chapter V-2</i> Decorative Program at Malqata Palace, Egypt <i>Shin-Ichi Nishimoto</i>	271
<i>Chapter V-3</i> X-ray Archaeology in China <i>Changsui Wang</i>	275
<i>Chapter V-4</i> The Relationship between Arts and Sciences in the Field of Archaeology: From Cooperation to a Truly Equal Partnership <i>Sakuji Yoshimura</i>	291
Color Plates	295
Index	305

**Part V: Interdisciplinary Field
between Art and Science**

Chapter V-2

Decorative Program at Malqata Palace, Egypt

Shin-Ichi Nishimot

Department of Architecture, School of Science & Engineering, Waseda University, Japan, 3-4-1 Okubo, Shinjyuku-ku, Tokyo, 169-8555, Japan
nishimot@waseda.jp

Keywords: Amenhotep III, painting, decoration, bedroom, ceiling, building phases

A severely ruined palace-city founded by Amenhotep III (ca. 1390-1352 B.C.) is preserved at Malqata on the West Bank of the Thebes in Egypt. It consists of various structures in the desert: several residential palaces, the temple of Amen, a festival hall, houses and apartments for attendants, and a desert altar "Kom al-Samak", all of which were constructed from mud bricks and had decoratively painted walls and ceilings. In 1985, this area was placed under the auspices of the Waseda University Mission, and several rooms in the main palace have been excavated. A report on the excavation was published in 1993. Based on this publication, further detailed study of the site has been carried out by the author.

From Room H, the great columned hall located in the middle of the main palace, numerous painted mud fragments have been excavated as reported in the previous publication, and the painting that occupied the entire ceiling has been reconstructed. At the innermost room of the main palace is the king's bedchamber, from which a large numbers of fragments of the ceiling painting have also been recovered. As reported by a previous excavator, the Metropolitan Museum of Art, one of the most remarkable motifs is a series of great vultures representing the Goddess Nekhbet with outstretched wings, under each of which are inscribed the names and titles of Amenhotep III. The series of vultures is surrounded by geometrical patterns, such as rosettes and checkerboard patterns. The first attempt to reconstruct the whole ceiling painting was made in 1988, and a detailed study of images of each fragment and of attempts at re-assembly since 1989 has revealed that there were eight images of Nekhbet, not seven as was supposed at an earlier stage of reconstruction. All nine lines of inscription have also been reconstructed, based on the position in which fragments were found on the floor. The floor of the innermost part of the king's bedchamber, where the king's bed was located, is raised. It has emerged that the ceiling of this upper level was more elaborately painted than that of the lower level. The inscriptions are slightly longer, and the color of the center circle of the rosette pattern is red, rather than green.

The fragments of the northernmost ceiling suggest that the ceiling of this part would have been slightly curved down towards the north wall, which is reminiscent of the roof shape of "pr wr", a traditional shrine of Upper Egypt, with a roof sloping down from the front. A paneled pattern and a wavy line are painted on the lower part of the walls, but the rest of the interior decoration of this bedchamber is painted a glossy transparent yellow color, presumably imitating gold, very similar to the shrines of Tutankhamen.

However, there is another large bedroom for the king at the north of the main palace: Room B. From the fact that the inscriptions on the ceiling mention the king's name, it has been determined that this room was also a bedchamber of king Amenhotep III. Why two king's bedrooms are prepared for a sole king? The presence of the two bedrooms for the king in one palace is problematic, but a clue to resolve this question could be found in the traces of the enlargement of the main palace.

Concerning the building phases of the palace complex, R. Johnson already pointed out: "The palace of the king, west villas (the administrative area), and middle palace, oriented to Amenhotep's mortuary temple, were probably part of the original complex, while the north palace, audience pavilion, and Amen temple, all oriented to the enlarged harbor, date to the later jubilees."² Presumably the southern part of the main palace and the west village seem to have been constructed in the 30th regal year of Amenhotep III, and the northern part of the main palace is thought to have been added soon after that. The temple of Amen, the platform and the north palace were erected in the regal year 33-34. The causeway running to the west side of the main palace seems to have been constructed "when it (palace) had been abandoned."³

Appendix:

Chemical analysis on the pigments detected at the King's Bedroom and Room B in the palace of Malqata has been carried out by Masayuki Uda, Professor at Waseda University, and the result of the preliminary analysis is as follows.

White:	$3\text{MgCO}_3 \cdot \text{CaCO}_4$	huntite
Black:		probably carbon
Blue:	$\text{CaO} \cdot \text{CuO} \cdot 4\text{SiO}_2$	Egyptian blue
Green:	(not identified)	
Yellow:	$\alpha\text{FeO} \cdot \text{OH}$	goethite
Red:	$\alpha\text{Fe}_2\text{O}_3$	hematite

References

¹ Nakagawa, Takeshi and Nishimoto, Shin-ichi (eds.): *Studies on the Palace of Malqata: Investigations at the Palace of Malqata*, 1985-1988, Chuo Koron Bijutsu Shuppan Ltd, Tokyo, 1993.

² Johnson, R.: Monuments and Monumental Art under Amenhotep III: Evolution and Meaning, in O'Connor, D. and Cline, E. (eds.): *Amenhotep III; Perspective on His Reign*, The University of Michigan Press, Ann Arbor, 1998, 76.

³ Kemp, B. J.: A Building of Amenophis III at Kom el-'Abd, *Journal of Egyptian Archaeology* 63 (1977), 81.

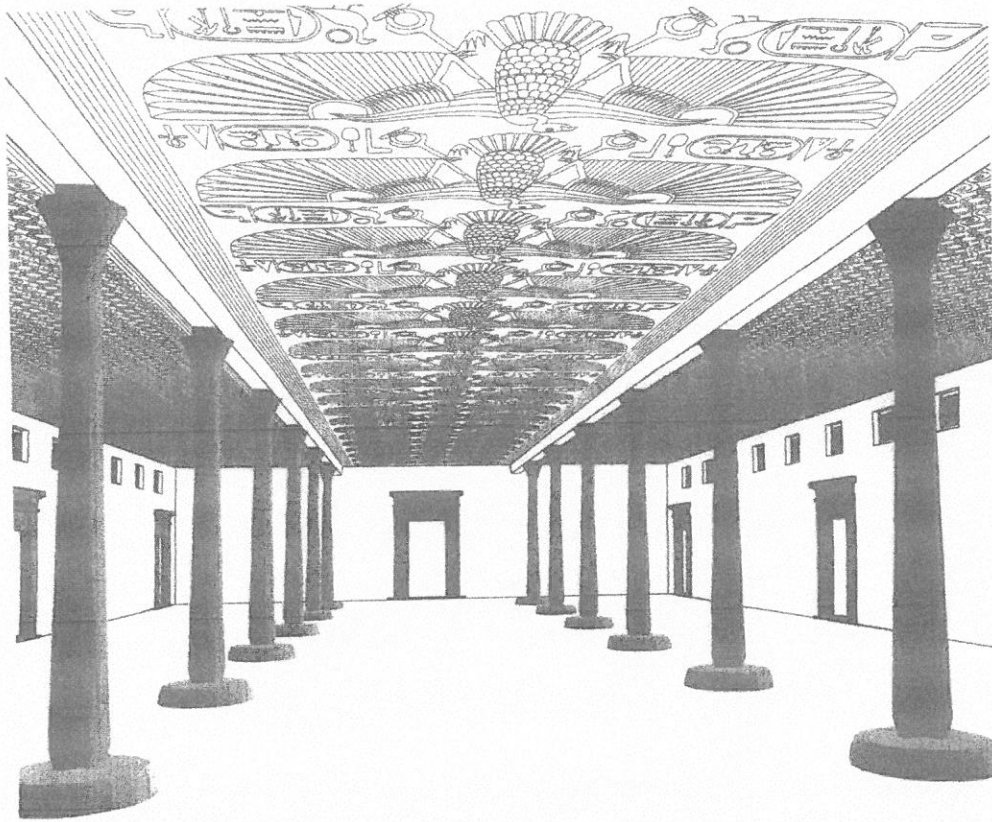


Figure V-2-1. Room H, reconstruction (by Takaharu Endo).

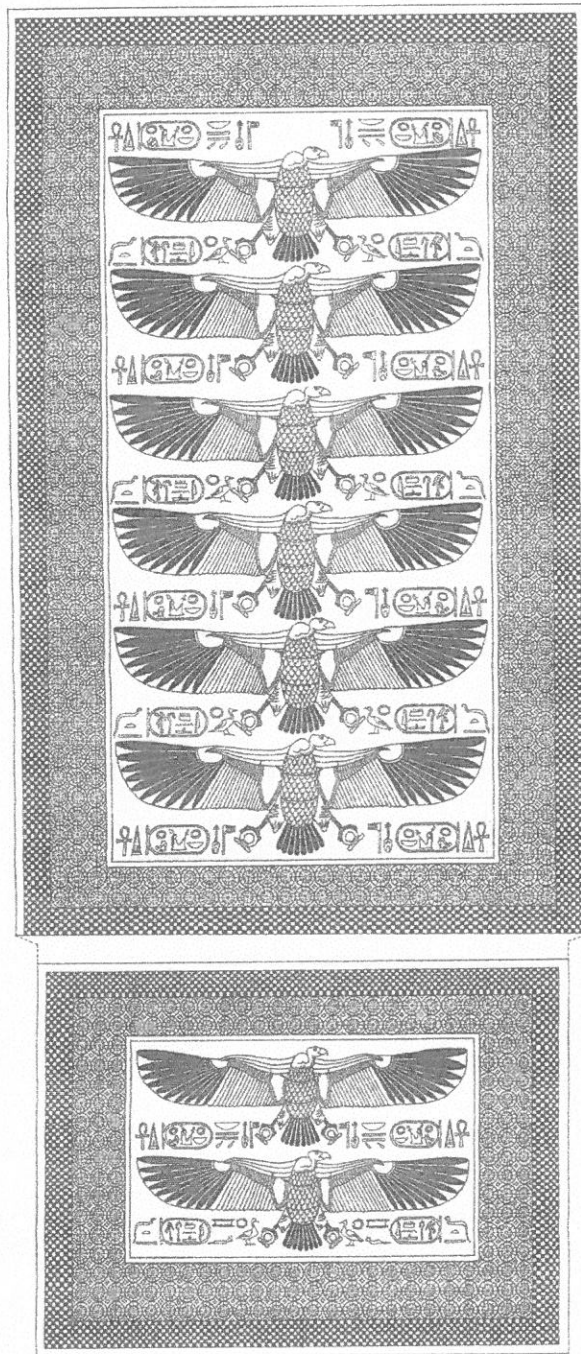


Figure V-2-2. Ceiling Painting of the king's bedroom (by the author).

X-rays for Archaeology

Edited by
M. Uda, G. Demortier and I. Nakai

The application of X-rays to archaeological objects with the goal of gaining insight into both their construction and chemical composition, in a non-destructive manner, dates back to the discovery of radiation. Nowadays, X-ray techniques, such as X-ray fluorescence and diffraction are standard tools. This book offers physicists, art historians, archaeologists, curators, and conservators a detailed overview via contributions written by leading scientists in the field. The book contains scientific data, i.e. *in situ* measurement data taken with portable XRF and XRD, and fine data taken with accelerating ion beams and synchrotron radiations, together with their explanations. Results obtained by traditional scientific methods are also reviewed. The broad data collection spans experimental data taken both from monuments in the field and exhibits in museums, for example:

- ancient Egyptian wall-painting pigments
- ancient Egyptian wooden statues and mummies
- ancient Greek funerary monuments
- Cypriot ceramics
- medieval, Lyubliana and Venetian glass
- Romanian ceramics
- ancient Near-Eastern clay
- old Japanese porcelain
- pre-Hispanic items from America
- ancient Chinese underglaze-red
- blue and white porcelain
- Chinese celadon
- Phoenician cosmetics

Also included are data from glazes, ancient gold and silver coins, gold jewellery, gold alloys, corroded metals, gemstones (ruby, emerald and garnet), painting pigments, pottery, bronze, obsidian, stucco, turquoise, and so on. The discussion fostered here between natural scientists and archaeologists anticipates the future direction of archaeology.

ISBN 1-4020-3580-2



9 781402 035807