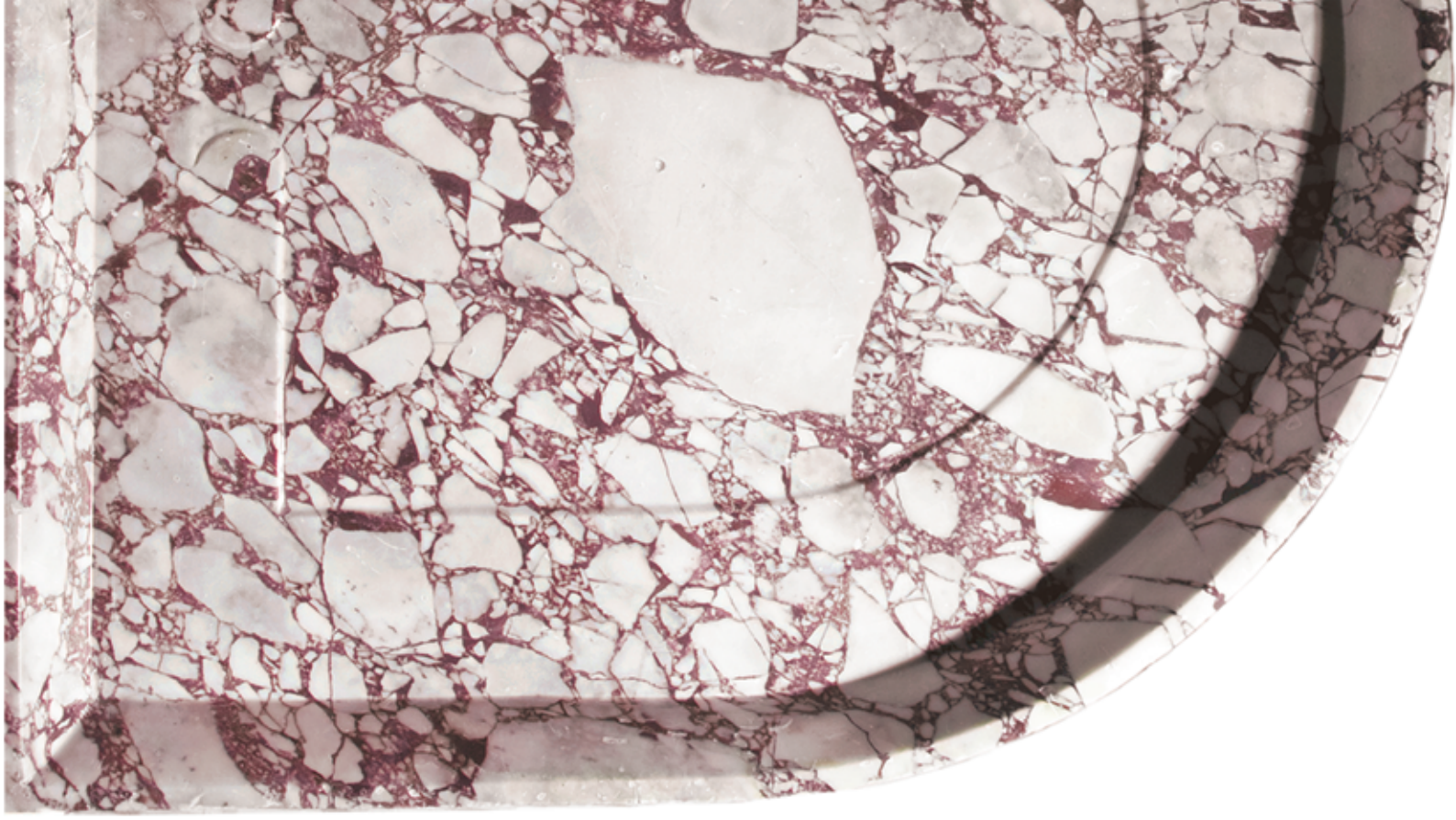
A Review of Copying Techniques in Greco-Roman Sculpture

Moureaud, Séverine



ASMOSIA XI

Interdisciplinary Studies on Ancient Stone

PROCEEDINGS

of the XI ASMOSIA Conference, Split 2015

Edited by Daniela Matetić Poljak and Katja Marasović

ARTS ACADEMY IN SPLIT

UNIVERSITY OF SPLIT,
FACULTY OF CIVIL ENGINEERING,
ARCHITECTURE AND GEODESY

Interdisciplinary Studies on Ancient Stone

Proceedings of the XI ASMOSIA Conference (Split 2015)

Publishers:

ARTS ACADEMY IN SPLIT
UNIVERSITY OF SPLIT

and

UNIVERSITY OF SPLIT
FACULTY OF CIVIL ENGINEERING,
ARCHITECTURE AND GEODESY

Technical editor:
Kate Bošković

English language editor:
Graham McMaster

Computer pre-press:
Nikola Križanac

Cover design:
Mladen Čulić

Cover page:
Sigma shaped *mensa* of *pavonazzetto* marble from Diocletian's palace in Split

ISBN 978-953-6617-49-4 (Arts Academy in Split)
ISBN 978-953-6116-75-1 (Faculty of Civil Engineering, Architecture and Geodesy)

e-ISBN 978-953-6617-51-7 (Arts Academy in Split)
e-ISBN 978-953-6116-79-9 (Faculty of Civil Engineering, Architecture and Geodesy)

CIP available at the digital catalogue of the University Library in Split, no 170529005

Association for the Study of Marble & Other Stones in Antiquity

ASMOSIA XI

Interdisciplinary Studies of Ancient Stone

Proceedings of the Eleventh International Conference of ASMOSIA,
Split, 18–22 May 2015

Edited by
Daniela Matetić Poljak
Katja Marasović

Split, 2018

Nota bene
All papers are subjected to an international review.
The quality of the images relies on the quality of the originals provided by the authors.

CONTENT

PRESENTATION 15

NECROLOGY: NORMAN HERZ (1923-2013) *by Susan Kane* 17

1. APPLICATIONS TO SPECIFIC ARCHEOLOGICAL QUESTIONS – USE OF MARBLE

Hermaphrodites and Sleeping or Reclining Maenads: Production Centres and Quarry Marks
Patrizio Pensabene 25

First Remarks about the Pavement of the Newly Discovered Mithraeum of the Colored Marbles at Ostia and New Investigations on Roman and Late Roman White and Colored Marbles from Insula IV, IX
Massimiliano David, Stefano Succi and Marcello Turci 33

Alabaster. Quarrying and Trade in the Roman World: Evidence from Pompeii and Herculaneum
Simon J. Barker and Simona Perna 45

Recent Work on the Stone at the Villa Arianna and the Villa San Marco (Castellammare di Stabia) and Their Context within the Vesuvian Area
Simon J. Barker and J. Clayton Fant 65

Marble Wall Decorations from the Imperial Mausoleum (4th C.) and the Basilica of San Lorenzo (5th C.) in Milan: an Update on Colored Marbles in Late Antique Milan
Elisabetta Neri, Roberto Bugini and Silvia Gazzoli 79

Sarcophagus Lids Sawn from their Chests
Dorothy H. Abramitis and John J. Herrmann 89

The Re-Use of Monolithic Columns in the Invention and Persistence of Roman Architecture
Peter D. De Staebler 95

The Trade in Small-Size Statues in the Roman Mediterranean: a Case Study from Alexandria
Patrizio Pensabene and Eleonora Gasparini 101

The Marble Dedication of Komon, Son of Asklepiades, from Egypt: Material, Provenance, and Reinforcement of Meaning
Patricia A. Butz 109

Multiple Reuse of Imported Marble Pedestals at Caesarea Maritima in Israel
Barbara Burrell 117

Iasos and Iasian Marble between the Late Antique and Early Byzantine Eras
Diego Peirano 123

Thassos, Known Inscriptions with New Data
Tony Kozelj and Manuela Wurch-Kozelj 131

The Value of Marble in Roman *Hispalis*: Contextual, Typological and Lithological Analysis of an Assemblage of Large Architectural Elements Recovered at Nº 17 Goyeneta Street (Seville, Spain)
Ruth Taylor, Oliva Rodríguez, Esther Ontiveros, María Luisa Loza, José Beltrán and Araceli Rodríguez 143

Giallo Antico in Context. Distribution, Use and Commercial Actors According to New Stratigraphic Data from the Western Mediterranean (2nd C. Bc – Late 1st C. Ad)
Stefan Ardeleanu 155

Amethystus: Ancient Properties and Iconographic Selection
Luigi Pedroni 167

2. PROVENANCE IDENTIFICATION I: (MARBLE)

Unraveling the Carrara – Göktepe Entanglement
Walter Prochaska, Donato Attanasio and Matthias Bruno 175

The Marble of Roman Imperial Portraits
Donato Attanasio, Matthias Bruno, Walter Prochaska and Ali Bahadir Yavuz 185

Tracing Alabaster (Gypsum or Anhydrite) Artwork Using Trace Element Analysis and a Multi-Isotope Approach (Sr, S, O)
Lise Leroux, Wolfram Kloppmann, Philippe Bromblet, Catherine Guerrot, Anthony H. Cooper, Pierre-Yves Le Pogam, Dominique Vingtain and Noel Worley 195

Roman Monolithic Fountains and Thasian Marble
Annewies van den Hoek, Donato Attanasio and John J. Herrmann 207

Archaeometric Analysis of the Alabaster Thresholds of Villa A, Oplontis (Torre Annunziata, Italy) and New Sr and Pb Isotopic Data for *Alabastro Ghiaccione del Circeo*
Simon J. Barker, Simona Perna, J. Clayton Fant, Lorenzo Lazzarini and Igor M. Villa 215

Roman Villas of Lake Garda and the Occurrence of Coloured Marbles in the Western Part of "Regio X Venetia et Histria" (Northern Italy)
Roberto Bugini, Luisa Folli and Elisabetta Roffia 231

Calcitic Marble from Thasos in the North Adriatic Basin: Ravenna, Aquileia, and Milan
John J. Herrmann, Robert H. Tykot and Annewies van den Hoek 239

Characterisation of White Marble Objects from the Temple of Apollo and the House of Augustus (Palatine Hill, Rome)
Francesca Giustini, Mauro Brilli, Enrico Gallocchio and Patrizio Pensabene 247

Study and Archeometric Analysis of the Marble Elements Found in the Roman Theater at Aeclanum (Mirabella Eclano, Avellino - Italy)
Antonio Mesisca, Lorenzo Lazzarini, Stefano Cancelliere and Monica Salvadori 255

Two Imperial Monuments in Puteoli:
Use of Proconnesian Marble in the Domitianic and Trajanic Periods in Campania
Irene Bald Romano, Hans Rupprecht Goette, Donato Attanasio and Walter Prochaska 267

Coloured Marbles in the Neapolitan Pavements (16th And 17th Centuries):
the Church of *Santi Severino e Sossio*
Roberto Bugini, Luisa Folli and Martino Solito 275

Roman and Early Byzantine Sarcophagi of Calcitic Marble from Thasos in Italy:
Ostia and Siracusa
Donato Attanasio, John J. Herrmann, Robert H. Tykot and Annewies van den Hoek 281

Revisiting the Origin and Destination of the Late Antique Marzamemi
'Church Wreck' Cargo
Justin Leidwanger, Scott H. Pike and Andrew Donnelly 291

The Marbles of the Sculptures of Felix Romuliana in Serbia
Walter Prochaska and Maja Živić 301

Calcitic Marble from Thasos and Proconnesos in Nea Anchialos (Thessaly)
and Thessaloniki (Macedonia)
Vincent Barbin, John J. Herrmann, Aristotle Mentzos and Annewies van den Hoek 311

Architectural Decoration of the Imperial Agora's Porticoes at Iasos
Fulvia Bianchi, Donato Attanasio and Walter Prochaska 321

The Winged Victory of Samothrace - New Data on the Different Marbles
Used for the Monument from the Sanctuary of the Great Gods
Annie Blanc, Philippe Blanc and Ludovic Laugier 331

Polychrome Marbles from the Theatre of the Sanctuary of Apollo Pythios
in Gortyna (Crete)
Jacopo Bonetto, Nicolò Mareso and Michele Bueno 337

Paul the Silentiary, Hagia Sophia, Onyx, Lydia, and Breccia Corallina
John J. Herrmann and Annewies van den Hoek 345

Incrustations from Colonia Ulpia Traiana (Near Modern Xanten, Germany)
Vilma Ruppienė and Ulrich Schüssler 351

Stone Objects from Vindobona (Austria) – Petrological Characterization
and Provenance of Local Stone in a Historico-Economical Setting
Andreas Rohatsch, Michaela Kronberger, Sophie Insulander,
Martin Mosser and Barbara Hodits 363

Marbles Discovered on the Site of the Forum of Vaison-la-Romaine (Vaucluse, France):
Preliminary Results
Elsa Roux, Jean-Marc Mignon, Philippe Blanc and Annie Blanc 373

Updated Characterisation of White Saint-Béat Marble. Discrimination Parameters
from Classical Marbles
Hernando Royo Plumed, Pilar Lapeunte, José Antonio Cuchí,
Mauro Brilli and Marie-Claire Savin 379

Grey and Greyish Banded Marbles from the Estremoz Anticline in Lusitania
Pilar Lapuente, Trinidad Nogales-Basarrate, Hernando Royo Plumed, Mauro Brilli and Marie-Claire Savin 391

New Data on Spanish Marbles: the Case of *Gallaecia* (NW Spain)
Anna Gutiérrez Garcia-M., Hernando Royo Plumed and Silvia González Soutelo 401

A New Roman Imperial Relief Said to Be from Southern Spain:
Problems of Style, Iconography, and Marble Type in Determining Provenance
John Pollini, Pilar Lapuente, Trinidad Nogales-Basarrate and Jerry Podany 413

Reuse of the *Marmora* from the Late Roman Palatial Building at Carranque
(Toledo, Spain) in the Visigothic Necropolis
Virginia García-Entero, Anna Gutiérrez Garcia-M. and Sergio Vidal Álvarez 427

Imperial Porphyry in Roman Britain
David F. Williams 435

Recycling of Marble: Apollonia/Sozousa/Arsuf (Israel) as a Case Study
Moshe Fischer, Dimitris Tambakopoulos and Yannis Maniatis 443

Thasian Connections Overseas: Sculpture in the Cyrene Museum (Libya)
Made of Dolomitic Marble from Thasos
John J. Herrmann and Donato Attanasio 457

Marble on Rome's Southwestern Frontier: Thamugadi and Lambaesis
Robert H. Tykot, Ouahiba Bouzidi, John J. Herrmann and Annewies van den Hoek 467

Marble and Sculpture at Lepcis Magna (Tripolitania, Libya):
a Preliminary Study Concerning Origin and Workshops
Luisa Musso, Laura Buccino, Matthias Bruno, Donato Attanasio and Walter Prochaska 481

The Pentelic Marble in the Carnegie Museum of Art Hall of Sculpture,
Pittsburgh, Pennsylvania
Albert D. Kollar 491

Analysis of Classical Marble Sculptures in the Michael C. Carlos Museum,
Emory University, Atlanta
Robert H. Tykot, John J. Herrmann, Renée Stein, Jasper Gaunt, Susan Blevins and Anne R. Skinner 501

3. PROVENANCE IDENTIFICATION II: (OTHER STONES)

Aphrodisias and the Regional Marble Trade. The *Scaenae Frons* of the Theatre at Nysa
Natalia Toma 513

The Stones of Felix Romuliana (Gamzigrad, Serbia)
Bojan Djurić, Divna Jovanović, Stefan Pop Lazić and Walter Prochaska 523

Aspects of Characterisation of Stone Monuments from Southern Pannonia
Branka Migotti 537

The Budakalász Travertine Production
Bojan Djurić, Sándor Kele and Igor Rižnar 545

Stone Monuments from Carnuntum and Surrounding Areas (Austria) –
Petrological Characterization and Quarry Location in a Historical Context
Gabrielle Kremer, Isabella Kitz, Beatrix Moshammer, Maria Heinrich and Erich Draganits 557

Espejón Limestone and Conglomerate (Soria, Spain):
Archaeometric Characterization, Quarrying and Use in Roman Times
*Virginia García-Entero, Anna Gutiérrez Garcia-M, Sergio Vidal Álvarez,
María J. Peréx Agorreta and Eva Zarco Martínez* 567

The Use of Alcover Stone in Roman Times (*Tarraco, Hispania Citeri*or).
Contributions to the *Officina Lapidaria Tarraconensis*
Diana Gorostidi Pi, Jordi López Vilar and Anna Gutiérrez Garcia-M. 577

4. ADVANCES IN PROVENANCE TECHNIQUES, METHODOLOGIES AND DATABASES

Grainautline – a Supervised Grain Boundary Extraction Tool
Supported by Image Processing and Pattern Recognition
Kristóf Csorba, Lilla Barancsuk, Balázs Székely and Judit Zöldföldi 587

A Database and GIS Project about Quarrying, Circulation and Use of Stone
During the Roman Age in *Regio X - Venetia et Histria*.
The Case Study of the Euganean Trachyte
Caterine Previato and Arturo Zara 597

5. QUARRIES AND GEOLOGY

The Distribution of Troad Granite Columns as Evidence for Reconstructing
the Management of Their Production
Patrizio Pensabene, Javier Á. Domingo and Isabel Rodà 613

Ancient Quarries and Stonemasonry in Northern Choria Considiana
Hale Güney 621

Polychromy in Larisaean Quarries and its Relation to Architectural Conception
Gizem Mater and Ertunç Denktaş 633

Euromos of Caria: the Origin of an Hitherto Unknown Grey Veined Stepped Marble
of Roman Antiquity
Matthias Bruno, Donato Attanasio, Walter Prochaska and Ali Bahadir Yavuz 639

Unknown Painted Quarry Inscriptions from Bacakale at *Docimium* (Turkey)
Matthias Bruno 651

The Green Schist Marble Stone of Jebel El Hairech (North West of Tunisia):
a Multi-Analytical Approach and its Uses in Antiquity
Ameur Younès, Mohamed Gaied and Wissem Gallala 659

Building Materials and the Ancient Quarries at *Thamugadi* (East of Algeria),
Case Study: Sandstone and Limestone
Younès Rezkallah and Ramdane Marmi 673

The Local Quarries of the Ancient Roman City of *Valeria* (Cuenca, Spain)
Javier Atienza Fuente 683

The Stone and Ancient Quarries of Montjuïc Mountain (Barcelona, Spain)
Aureli Álvarez 693

Notae Lapicidinarum: Preliminary Considerations about the Quarry Marks from the Provincial Forum of *Tarraco*
Maria Serena Vinci 699

The Different Steps of the Rough-Hewing on a Monumental Sculpture at the Greek Archaic Period: the Unfinished Kouros of Thasos
Danièle Braunstein 711

A Review of Copying Techniques in Greco-Roman Sculpture
Séverine Moureaud 717

Labour Forces at Imperial Quarries
Ben Russell 733

Social Position of Craftsmen inside the Stone and Marble Processing Trades in the Light of Diocletian's Edict on Prices
Krešimir Bosnić and Branko Matulić 741

6. STONE PROPERTIES, WEATHERING EFFECTS AND RESTORATION, AS RELATED TO DIAGNOSIS PROBLEMS, MATCHING OF STONE FRAGMENTS AND AUTHENTICITY

Methods of Consolidation and Protection of Pentelic Marble
Maria Apostolopoulou, Elissavet Drakopoulou, Maria Karoglou and Asterios Bakolas 749

7. PIGMENTS AND PAINTINGS ON MARBLE

Painting and Sculpture Conservation in Two Gallo-Roman Temples in Picardy (France): Champlieu and Pont-Sainte-Maxence
Véronique Brunet-Gaston and Christophe Gaston 763

The Use of Colour on Roman Marble Sarcophagi
Eliana Siotto 773

New Evidence for Ancient Gilding and Historic Restorations on a Portrait of Antinous in the San Antonio Museum of Art
Jessica Powers, Mark Abbe, Michelle Bushey and Scott H. Pike 783

Schists and Pigments from Ancient Swat (Khyber Pukhtunkhwa, Pakistan)
Francesco Mariottini, Gianluca Vignaroli, Maurizio Mariottini and Mauro Roma 793

8. SPECIAL THEME SESSION: „THE USE OF MARBLE AND LIMESTONE IN THE ADRIATIC BASIN IN ANTIQUITY"

Marble Sarcophagi of Roman Dalmatia Material – Provenance – Workmanship
Guntram Koch 809

Funerary Monuments and Quarry Management in Middle Dalmatia
Nenad Cambi 827

Marble Revetments of Diocletian's Palace
Katja Marasović and Vinka Marinković 839

The Use of Limestones as Construction Materials for the Mosaics of Diocletian's Palace
Branko Matulić, Domagoj Mudronja and Krešimir Bosnić 855

Restoration of the Peristyle of Diocletian's Palace in Split
Goran Nikšić 863

Marble Slabs Used at the Archaeological Site of Sorna near Poreč Istria – Croatia
Đeni Gobić-Bravar 871

Ancient Marbles from the Villa in Verige Bay, Brijuni Island, Croatia
Mira Pavletić and Đeni Gobić-Bravar 879

Notes on Early Christian Ambos and Altars in the Light of some Fragments
from the Islands of Pag and Rab
Mirja Jarak 887

The Marbles in the Chapel of the Blessed John of Trogir
in the Cathedral of St. Lawrence at Trogir
Đeni Gobić-Bravar and Daniela Matetić Poljak 899

The Use of Limestone in the Roman Province of Dalmatia
Edisa Lozić and Igor Rižnar 915

The Extraction and Use of Limestone in Istria in Antiquity
Klara Buršić-Matijašić and Robert Matijašić 925

Aurisina Limestone in the Roman Age:
from Karst Quarries to the Cities of the Adriatic Basin
Caterina Previato 933

The Remains of Infrastructural Facilities
of the Ancient Quarries on Zadar Islands (Croatia)
Mate Parica 941

The Impact of Local Geomorphological and Geological Features
of the Area for the Construction of the Burnum Amphitheatre
Miroslav Glavičić and Uroš Stepišnik 951

Roman Quarry Klis Kosa near Salona
Ivan Alduk 957

Marmore Lavdata Brattia
Miona Miliša and Vinka Marinković 963

Quarries of the Lumbarda Archipelago
Ivka Lipanović and Vinka Marinković 979

Island of Korčula – Importer and Exporter of Stone in Antiquity
Mate Parica and Igor Borzić 985

Faux Marbling Motifs in Early Christian Frescoes
in Central and South Dalmatia: Preliminary Report
Tonči Borovac, Antonija Gluhan and Nikola Radošević 995

INDEX OF AUTHORS 1009

DOI: https://doi.org/10.31534/XI.asmosia.2015/05.12

A REVIEW OF COPYING TECHNIQUES IN GRECO-ROMAN SCULPTURE

Séverine Moureaud
Centre Camille Jullian, Aix-en-Provence, France (sevemoureaud@hotmail.com)

Abstract

This paper deals with the different techniques of copying or reproduction used or probably used in Greco-Roman marble sculpture. It appears that these techniques changed during the course of time. It would be interesting to make an inventory of all possibilities, by taking a historical point, interpreting the analysis of traces on unfinished and on finished statues, placing these techniques in historical and geographical contexts. It will be also necessary to propose new hypotheses with the help of new methodological approaches.
What can we say about the reproduction of models or statues in marble during the Archaic, Classical, Hellenistic and Roman periods? This article first presents the use of modules (drawn or mathematical) during the Archaic period and the different clues to the use of reproduction during that time. Then, it considers the different hypotheses which were proposed for the Classical period and the clues visible on archaeological pieces will be considered. Experimental research of a copying technique observed at Delos and used in the Hellenistic period during the 2nd century BC will be presented. My experimental research at Delos shows the necessity for statuary production to be adapted to a new context of the consumption of statues. We also look at the Roman techniques, the clues and the hypotheses proposed. Consideration of the tools would also be interesting, but the focus here will be on the archaeological objects and their traces. For this purpose, I put store by a methodological analysis of material in the manner of scholars of prehistory. It would be also interesting to try to propose some way to progress on these questions: methodological and comparative analysis, ethno-archaeology, interdisciplinary collaborations.

Keywords
copy, sculpture, technique

It seems interesting to focus on copying techniques during Antiquity. Since there are so few archaeological research works concerning copying, the subject requires new approaches and the progress of interdisciplinary research can perhaps open new issues. I would like to propose methodological points concerning vocabulary, traces and copying techniques and to introduce some new recent research at the same time.

Vocabulary

There exist many ways to reproduce a model. Three main ways could be proposed and we will see changes in each one of them. First, direct carving uses visual perception and drawing in the reproduction activity. Second, the copy uses only a few main points which are reported from the model to the copy. Third, an exact copy uses many different points which are reported from the model to the copy. Based on all the works of specialized researchers[1] I suggest the following summary of definition for each way/approach of copying:

Direct carving	- Carving *de visu*, without models or just a mental idea tracing or drawing on the block or no.	
	- Carving with a model, without reported points or simply outlining on the block (bi- or tridimensional model, reduced or not, in any kind of material)	Umbildung / "Approached idea"
Indirect carving	- Carving with a model with main reported points (basically a tridimensional model, reduced or not)	Approached copy
	- Carving with a model with all points reported in detail (tridimensional model, reduced or not)	Exact copy

1 ASHMOLE, YALOURIS 1967, 10; BAUDRY 2000; BLÜMEL 1969, 48-61; JOCKEY 1993, 371-373; PALAGIA 2006; ROCKWELL 1993; an important historiography about technics of roman copies in TOUCHLETTE 2000, 351.

Fig. 1.
Statues of Cleobis and Biton by Polymedes of Argos (Archaeological Museum, Delphi, Greece), view from behind (photo: Lauraki)

Fig. 2.
Unfinished statuettes from Kyme in marble, 2nd century BC (461T and 462T, Archaeological Museum, Istanbul, Turkey) view of the right side (photo: S. Moureaud)

Fig. 3. A series of statuettes of Ganesh in soap skin (workshop in Mahabalipuram, India) (photo: S. Moureaud)

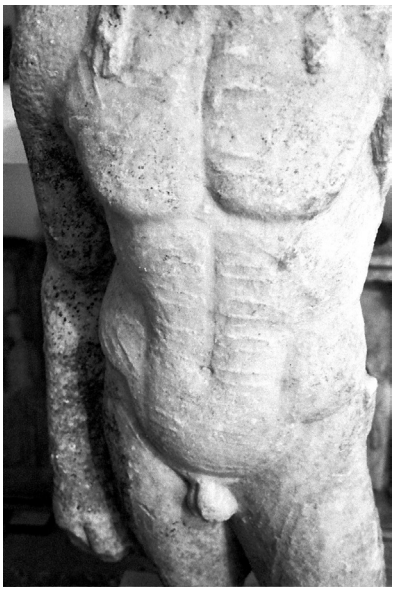


Fig. 4.
Unfinished statue of a man in marble, Roman times (inv. 1664, National Museum, Athens, Greece), detail of traces on torso (photo: S. Moureaud)

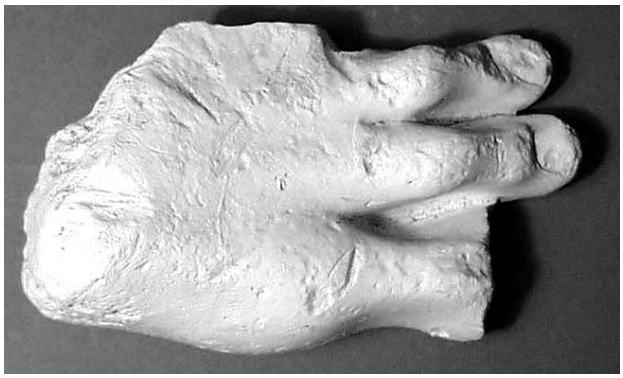


Fig. 5. Plaster cast of a hand, Roman (Museo Archeologico dei Campi Flegrei, Napoli, Italia) (photo: Classical Art Research Centre, Oxford)

Using techniques for reproduction…but what for?

The several goals behind the use of copies can be observed during Antiquity. First, it was a necessity to represent an ideal canon. Certainly that was the case in the Archaic period, to comply with some ideal proportions[2] (Fig. 1). Then, a new *proplasma*, which means what is shaped before, could be created by masters and reproduced by some technicians or some other sculptors. Certainly that was the case of the Archaic *kouros* of Paros[3] and these uses were more evident again during Classical[4] and early Hellenistic times. Finally, during the late Hellenistic

2 PROST 2008.

3 See after and other paper in progress about this unfinished kouros.

4 About the use of copy at Olympia: ASHMOLE, YALOURIS 1967, 10; BLÜMEL 1969, 48-61; PALAGIA 2006, 264.

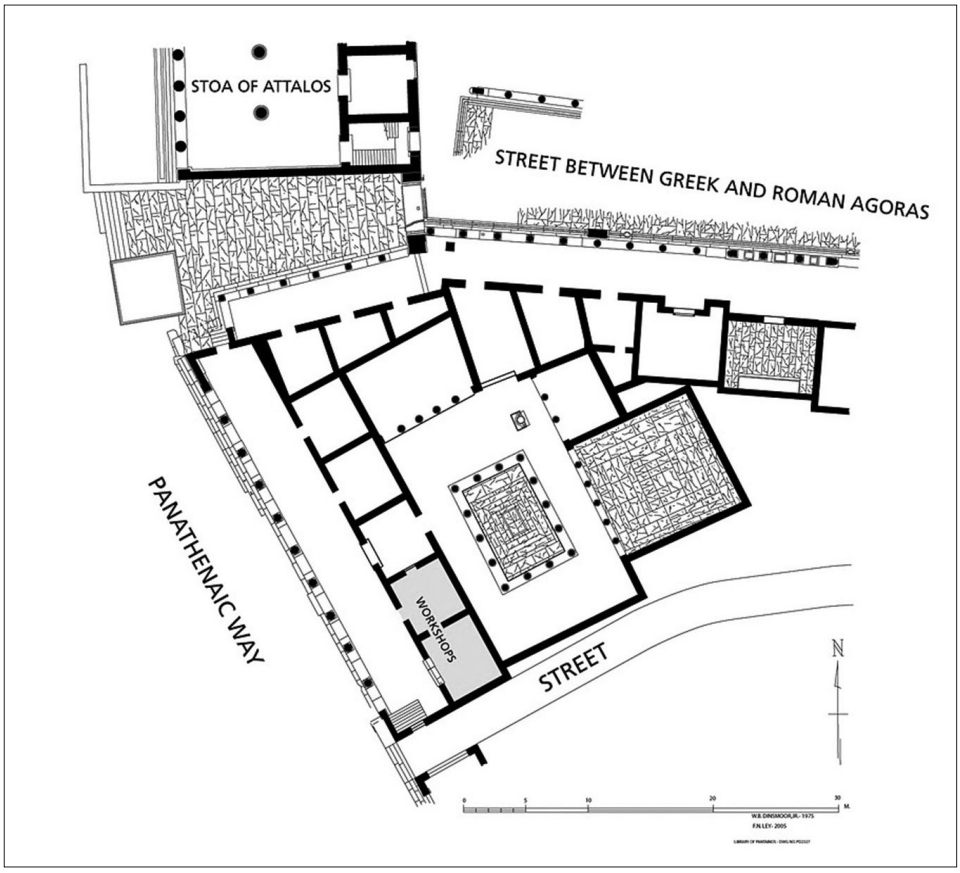


Fig. 6.
Plan of the Library of Pantainos, with sculptor's workshop in two of its rooms, 2nd-3rd century AD (Image: http://agora.ascsa.net/id/agora/image/2009.05.0097)

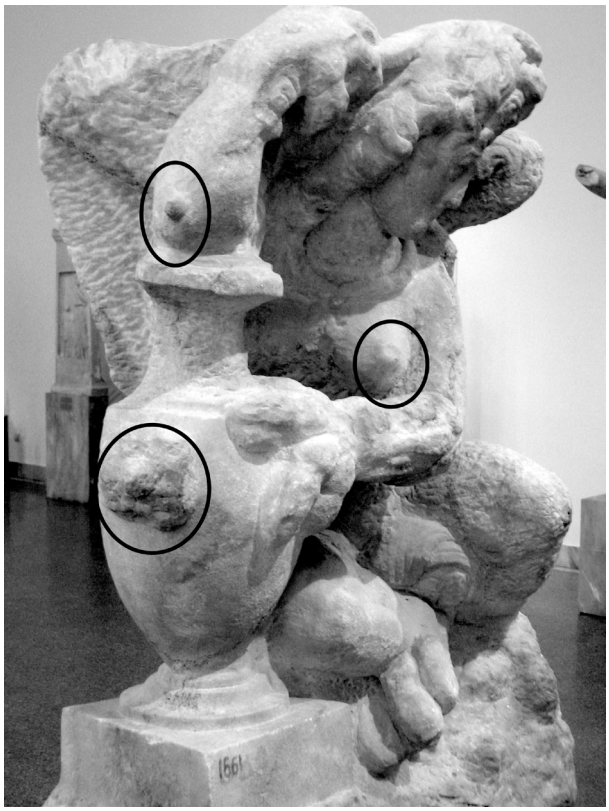


Fig. 7. Funerary Female Sphinx of Rheneia, 2nd BC, hump on protruding part (inv. 1661, National Museum, Athens, Greece), three-quarter view (photo: S. Moureaud)

and Roman periods, the production of statues for domestic use and for the imperial cult increased. In those circumstances, the copy was not only used to "create", but to produce faster[5] (Fig. 2).

Archaeological artefacts and traces

What sorts of artefacts can be used to understand the copy in Antiquity? First, a series of statues can be compared to each other by visual observation and by taking measurements (Fig. 3). Though rare, unfinished sculptures are direct witnesses of techniques with different traces of reproduction and even more rare are unfinished sculptures showing reproduction traces. Most are familiar like pieces from Athens, Fig. 4, from Delos or Rome. Some are less exceptional, from a stylistic point of view, but it is really interesting to deal with some new issues such as innovation centers and means of circulation. We are also interested in plaster models the best examples of which were discovered in the workshop of Baiae (Fig. 5)[6]. Finally, different workshops excavated have let

5 MOUREAUD 2015.

6 http://www.beazley.ox.ac.uk/CGPrograms/Cast/ASP/Cast.asp?CastNo=B217. LANDWEHR 1982 and LANDWEHR 1985.

Fig. 8. Unfinished statue of Aphrodite, Hump with drill hole, probably from Rheneia, probably 2nd BC (inv. 3188, National Museum, Athens, Greece), detail of the face (photo: S. Moureaud)

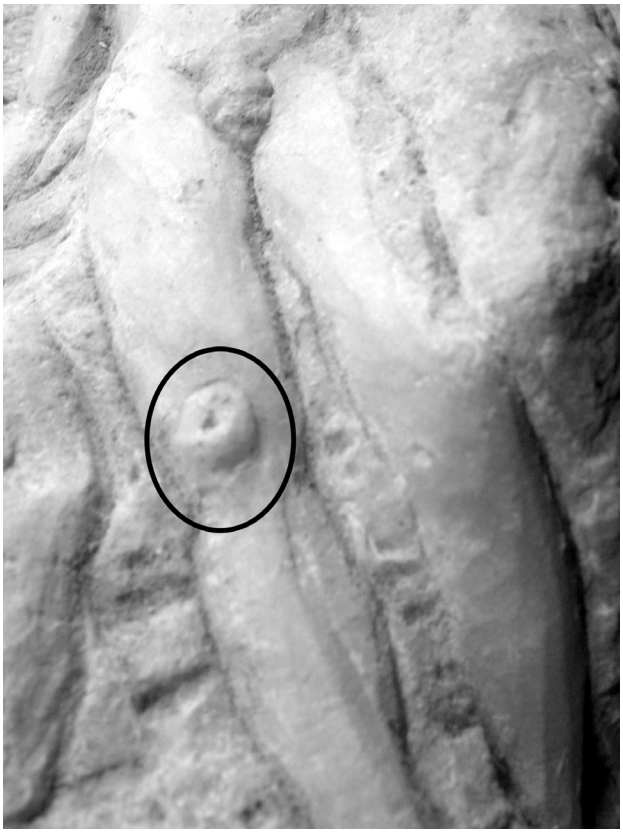


Fig. 9. Unfinished statuette of a young man, hump with hole, Agora of Athens, Roman period (inv. S 918, Agora Museum, Athens, Greece), detail of legs (photo: S. Moureaud)

Fig. 10. Unfinished statuette of Hermes, Hump with hole, 2nd century AD (inv. 2883, National Museum, Athens, Greece), detail of the back of the head (photo: S. Moureaud)

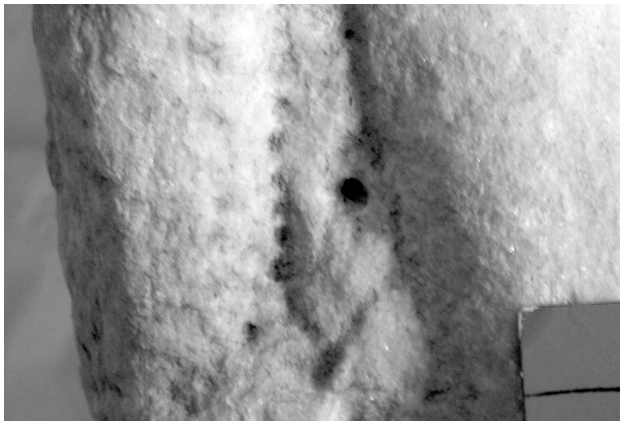


Fig. 11. Unfinished statuette of Dionysus and Satyr, simple hole (inv. 5662, National Museum, Athens, Greece), detail between legs of Dionysus (photo: S. Moureaud)

us understand the organization, as in Athens, Fig. 6[7], Paros, Delos, Aphrodisias and Pouzzoli from within.

Traces of reproduction on unfinished statues could appear in many ways

Different kinds of traces can be observed on unfinished statues. They can be prominent and look like little humps. Most often, the hump is located on a protruding part of the unfinished statue[8] (Fig. 7)[9]. Some other

7 http://agora.ascsa.net/id/agora/image/2009.05.0097.

8 A statuette of Aphrodite from Delos presents, Delos Museum, A 3825, Hellenistic times, found south gymnasium, GD 76. MARCADÉ 1996, 148, n° 64.

9 Funerary Female Sphinx of Rheneia, National museum, Athens, 1661, 2nd BC, PALAGIA 2006, 269, fig. 77, n. 6.

Fig. 12. Unfinished statuette from Kyme in marble, round diggings on the surface scraped by a round chisel, 2nd century BC (461T, Archaeological Museum, Istanbul, Turkey), detail of the body (photo: S. Moureaud)

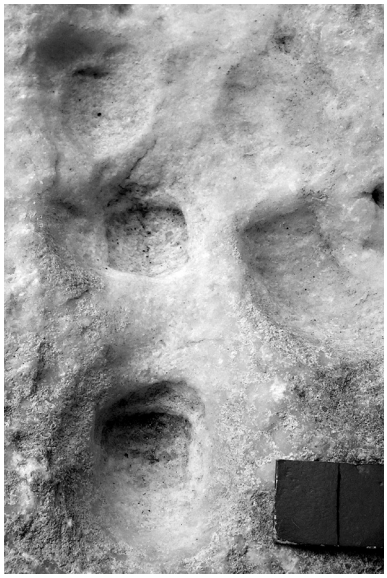


Fig. 13. Unfinished statue of a young man from Rheneia, surface gouged with a round chisel, Hellenistic period (inv. 1660, National Museum, Athens, Greece), detail of traces on the torso (photo: S. Moureaud)

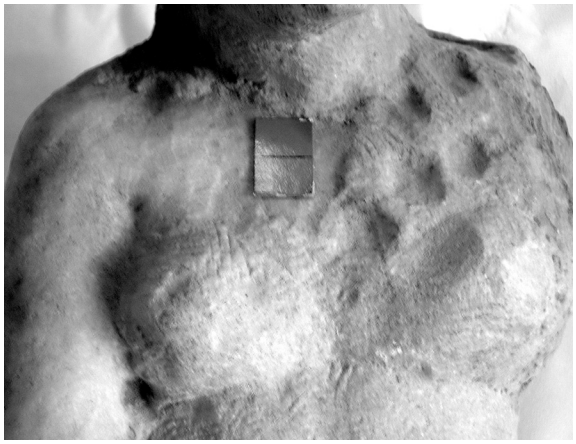


Fig. 14. Unfinished statue of Aphrodite, surface gouged with a a round chisel, probably from Rheneia, probably 2nd century BC (inv. 3188, National museum, Athens, Greece), detail torso (photo: S. Moureaud)

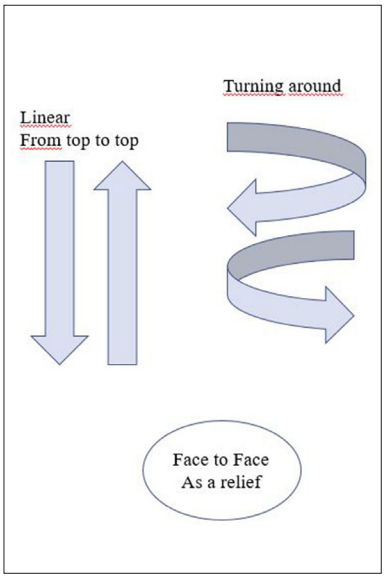


Fig. 15. Different progression of carving observed on unfinished statues

Fig. 16. Unfinished kouros in Naxian marble, homogeneous progression, 6th century BC (inv. 14, National Museum, Athens, Greece), detail of the body (photo: S. Moureaud)

Fig. 17. Unfinished kouros of Paros, non-homogeneous progression, 530 BC (inv. 1377, Paros Museum, Greece), detail of the body (photo: S. Moureaud)

Fig. 18. Unfinished statue of a young man from Rheneia, progression from top to top, Hellenistic period (inv. 1660, National Museum, Athens, Greece), part of the body (photo: S. Moureaud)

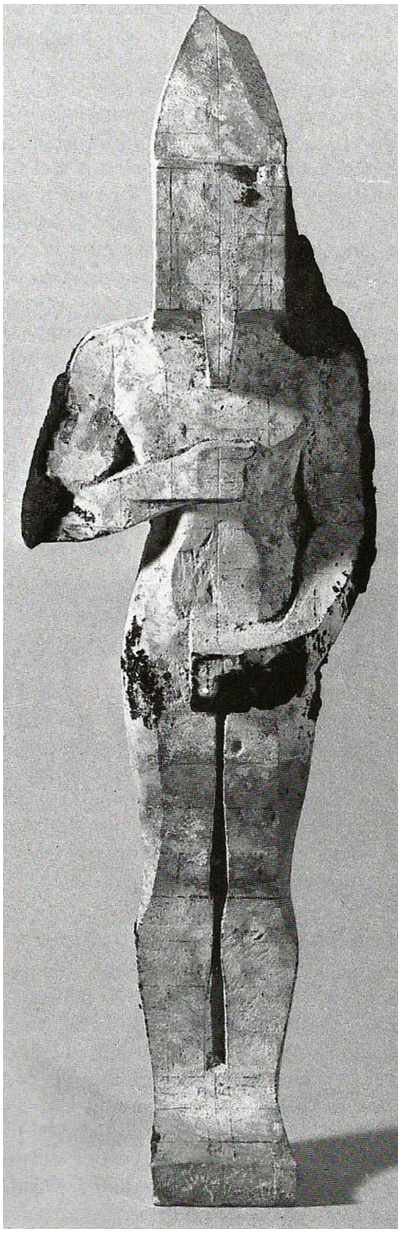


Fig. 19. Preliminary draft of a statuette of Osiris in limestone with a bitumen coating, Grid-pattern with 21 squares 1/4, Khenti Imentet, 664 -332 BC (inv. E 27140, Louvre Museum, Paris, France) (photo: BAUDRY 2000, fig. 73 p. 399)

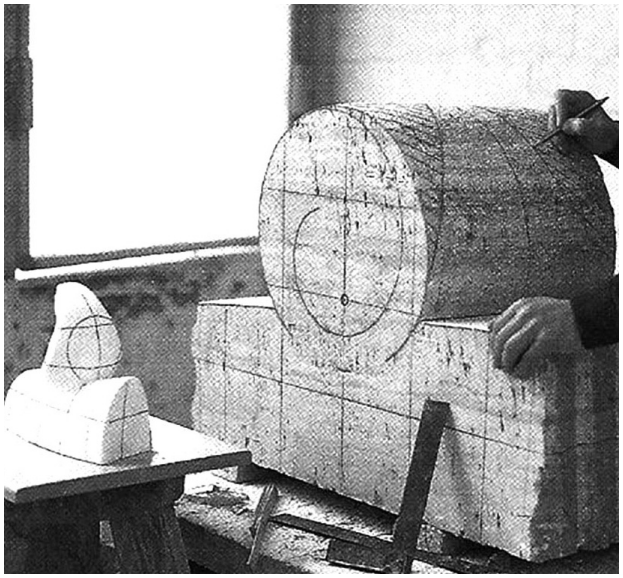


Fig. 20. Use of a cubit to reproduce a sculpture (photo: J. C. Santamera)

types of humps can have a small drill hole[10] in the center in which to place the point of the calipers or to drive in a nail (Figs. 8, 9, 10). In that case, they are also called *puntelli*. Reproduction traces can also appear as a more or less deep and large simple hole, Fig. 11. It could be made by a drill or by a point chisel. Some kinds of round concavities on the surface scraped by a round chisel can be observed. The diameter of these concavities is never more than 2 or 3 cm (Fig. 12, 13, 14). Finally, no traces on the object have proved whether the sculptor used a scale module There are no drawings to be observed for the Greek period, as there were in Egyptian times[11].

Progression of carving

When a sculpture is unfinished, it is necessary to observe how the carving progresses in the stone. The piece can be rotated or progress can be made as if it were a relief (one face after the other) or linearl (Fig. 15). Progression could also be homogeneous (Fig. 16) or inhomogeneous (Fig. 17). Most of the time, we observed an inhomogeneous progression for sculptures made by reproduction. Indeed, the technician was only interested in "measuring points". So he did not use global progression to clarify the surface. Many states of carving and many different traces are observed on the surfaces. We observed them only for some Hellenistic sculptures from

10 Most of the time it's a drill hole but it happens sometimes to recognize just a fine point hole trace.

11 PROST 2008, 386-387. Also a point on Samian cubit, echo to royal Egyptian cubit, p. 385-386. SPIVEY 1996, 69.

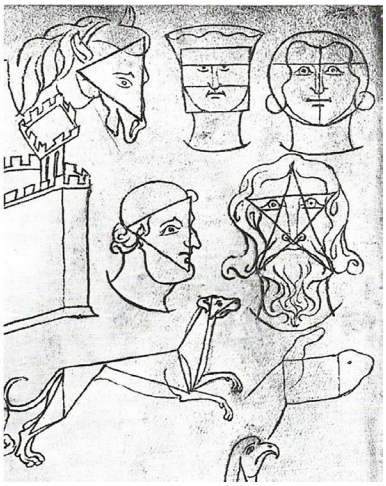


Fig. 21. Construction of volume by using geometrical forms or cubit rods, Drawing of Villard de Honnecourt, pl. XXXVI

Fig. 22. Unfinished kouros of Paros, use of a technique of reproduction, 530 BC (inv. 1377, Paros Museum, Greece) (photo: S. Moureaud)

Delos which present concavities and drill holes, a linear progression from top to top (Fig. 18), otherwise an inhomogeneous progression is observed for indirect carving.

Methods

A methodological approach in understanding techniques of copying must have several focuses and implies an interdisciplinary study. First a technical approach to the object is essential. To be a complete analysis, it needs to be looked at and discussed by stone technicians and experts in antique sculpture. I also expect a lot from the methodology of prehistorians in the study of stone materials. To define and use a specific vocabulary that describes every step of a "chaîne opératoire" [operational chain] and to apply this method of technical analysis for all the pieces concerned in order to compare them is necessary. According to P. the experimental way could help the analysis by either confirming or invalidating the hypothesis. I am also really interested in the ethno-archaeological approach. With the help of an interdisciplinary study, I have researched into some traditional workshops in India and in Tinos[12]. Even if it is necessary to be cautious when comparing traditional contemporary and ancient craftsmanship, we made some really interesting observations on techniques, the workshop's organization and the craftsmen. These observations give us new ways to approach antique sculptural craftsmanship.

Techniques

Many different techniques seem to have been used throughout the different periods of Antiquity. I briefly present you some of these techniques, even if some are not really clarified[13].

- Cubit and module

First, during the Archaic period, the sculptors used the cubit to create their statues like the Egyptians (Fig. 19)[14]. It is also possible to reduce or enlarge a statue with this method[15] (Fig. 20). The medieval use of geometrical forms and a module is also known from drawings[16] (Fig. 21). This is empirical, but accurate; the system of reproduction could have been used to duplicate – for example the twins Kleobis and Biton from Delphi – to reduce and to enlarge a model. Isaac Newton in his "Dissertation of Cubits" demonstrated that the cubit from Samos was nearly the same as the cubit of Memphis[17]. We can refer to the works about the Samian *korai* of Cheramyès[18] and

12 Public Project (ANR) 2010, *ToucherCréer*, http://www.agence-nationale-recherche.fr/?Project=ANR-10-CREA-0014, director Hara Procopiou. Professor University Paris I Panthéon Sorbonne.

13 For a complementary historiography of different techniques used in the Renaissance, we can refer to the publication of Olga Palagia, "Did the Greeks use a pointing machine?" and to the works of Mickael Pfanner, Carl Blümel and Peter Rockwell for some technical analysis.

14 Preliminary draft of a statuette of Osiris with traces o fbitumen (mummy) BAUDRY 2000, 398-399 and Christiane Desroches-Noblecourt, in Revue du Louvre et des Musées de France, number 4, 1975, Paris, 251-254 and http://cartelfr.louvre.fr/cartelfr/visite?srv=-car_not_frame&idNotice=19133&langue=fr.

15 SANTAMERA CAMI 2001, 97.

16 Villard de Honnecourt 13th AD, Sketchbook, Bibliothèque nationale, Paris, pl. XXXVI. BAUDRY 2000, 401.

17 http://www.newtonproject.sussex.ac.uk/view/texts/normalized/THEM00276.

18 ROLLEY 1994, 262-263; KARAKASI 2001. http://www.louvre.fr/oeuvre-notices/core-du-groupe-de-cheramyes.

Fig. 23. Caliper and triangulation process in a workshop of Mahabalipuram, India (photo: S. Moureaud)

about a Samian *kouros*[19]. Also, Francis Prost proposes ecognizing the use of an empirical reproduction system in a workshop of Naxian *kouroi* in Delos[20]. He supposes the use of a changing system of proportions in order to modify scales. The results of the technique appear to be eapproximate copies rather than exact ones. Indeed, just the most important volumes seem to have been reproduced, and the details change from a statue to another.

The Archaic period shows an interesting example the study of which is in progress. Indeed, we hypothesize the use of a technique of reproduction for the unfinished *kouros* of Paros (Fig. 22). In addition to Francis Croissant's study that considers this sculpture as a new original stylistic creation from Paros[21], we propose recognizing

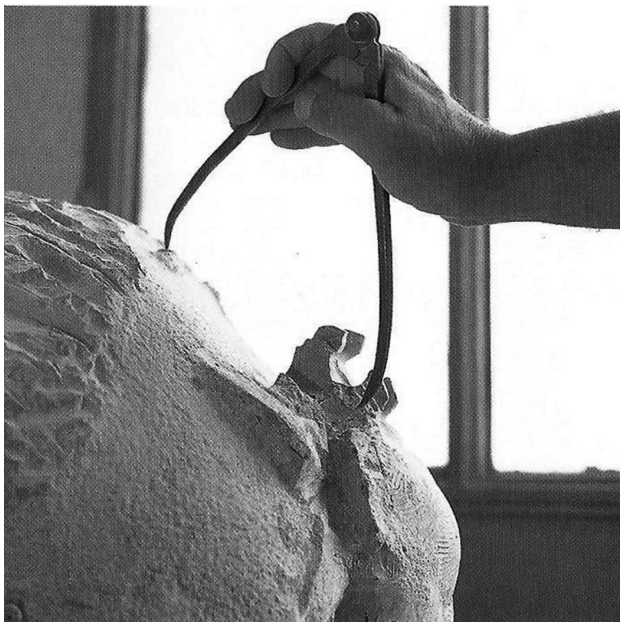


Fig. 24. Use of callipers for triangulation process (photo: J. C. Santamera)

the use of a new reproduction process in it. It left traces of a very specific inhomogeneous progression of carving. All steps of implementation can be observed all around the surface of the *kouros*. This is really unusual for unfinished Archaic statues which present most of the time an homogeneous surface testifying to a linear progression[22].

- Sight-size process[23]

Elements of these methods were used since Leon Battista Alberti in the fifteenth century. By positioning a small-scale clay model at a specific distance between the life model and the observation point on both, the work and the model are visually the same size, and a 'side by side' comparison can be made to check accuracy and proportion. This process is being practiced again in art schools in Italy or in France. I learned this method during my training as a sculptor.

- The three-caliper process or triangulation process

This method using a triangulation pointing process is the best-known process. It was explained by many researchers, particularly by Marie-Thérèse Baudry [24] on general sculpture. This process was recognized by Peter

19 KYRIELEIS 1996, 30-44, fig. 7 and fig. 8. Vitruvius, book III, 1, about rationality. *Cf.* also MENARD 1882, 493-497: he quotes a commentary of scientists of the expedition of Bonaparte, about Karnak's monuments: "L'examen attentif de ces sculptures nous a donné lieu de remarquer que l'artiste, dans leur exécution, ne s'est pas toujours astreint à suivre le trait primitif, qui était ordinairement tracé à l'encre rouge [il fait référence à des œuvres ébauchées de Médinet-Abou, présentant des tracés] ; mais que, le modifiant à son gré, sans s'écarter toutefois des règles reçues, il se laissait, en quelques sortes, guider par les effets qu'il voyait naître sous ses mains. Le mur de la salle hypostyle présente particulièrement la preuve de ce que nous avançons : on y remarque de très grandes sculptures, dans lesquelles le trait du ciseau s'éloigne plus ou moins de l'esquisse. Il résulte de cette observation que les sculpteurs égyptiens ne se servaient point de patrons dans l'exécution de leurs dessins, qui n'étaient pas tous parfaitement conformes, ainsi qu'un examen superficiel pourrait le faire croire.", 495-496.

20 PROST 2008.

21 CROISSANT 2008-2009.

22 This work is in progress and the details will be published shortly.

23 ARKLES 2007.

24 BAUDRY, 2000, 172-174.

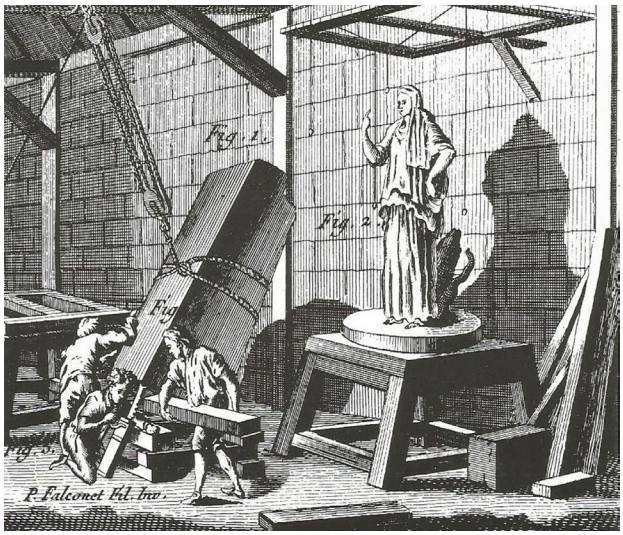


Fig. 25. Use of a frame and plumb lines for reproduction purposes (drawing of Encyclopédie de Daremberg et Saglio)

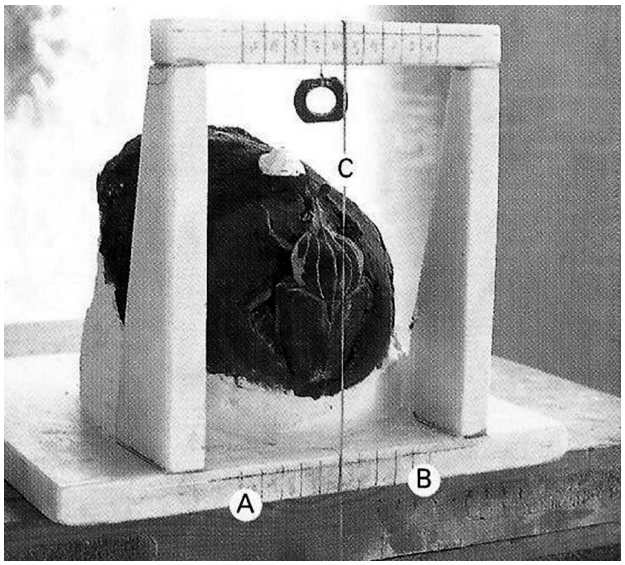


Fig. 26. Use of a graduated frame and plumb lines for reproduction purposes (photo: J. C. Santamera)

Rockwell for reliefs of the Pediment of Aphaïa temple[25] and by Olga Palagia for reliefs of the temple of Olympia[26]. Some calipers were discovered in Delos[27]. As we can see in India, this process is still used to copy in stone the clay model created by the master (Fig. 23); also used in Carrara (Fig. 24).

Fig. 27. Pointing machine in the workshop of a portraitist, Tinos, Greece (photo: S. Moureaud)

Fig. 28. Pointing machine in the Museum of Marble Craft, Tinos, Greece (photo: S. Moureaud)

25 ROCKWELL 1993, 117.

26 PALAGIA 2006.

27 South Agora of the Italians (GD 52) in backfill of Antigone's Portico (GD 29), W. Deonna, "Le mobilier délien", EAD XVIII, Paris, 1938, 214, fig. 246 and pl. 578.

- The stick process

Proposed by Leonardo da Vinci, this process consists in placing the model in a box, taking measures with sticks. After that, you have to place the block in the same box and to report the different points traced on batons[28].

- The chassis (frame) and plumb-line process

A frame is placed above the model, where plumb-lines are suspended[29]. This process also needs the use of calipers and some kind of set squares (Figs. 25 and 26)[30].

- Profile process

This process was proposed by Mickael Pfanner[31] to understand mass production of imperial portraits. It is an intermediate process between an exact and an approximate copy. For him, only the profile is copied exactly with calipers and the rest is made by free interpretation.

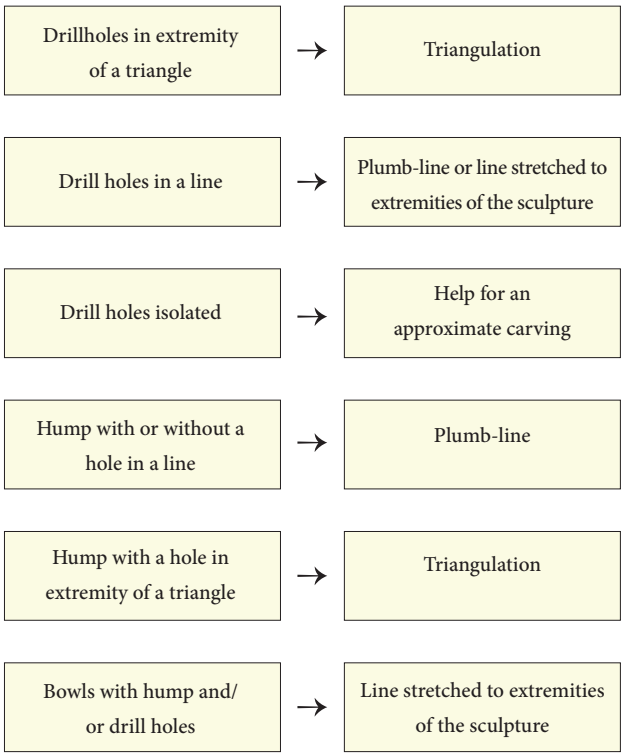
- Some other propositions[32]

A line stretched between the two extremities of the statue of a young man of Rheneia was suggested by Carl Blumel[33]. The use of a simple plumb line or an axis of symmetry and a caliper was also proposed for different pieces[34].

- The pointing machine

An early device of the pointing machine was published by Nicolas Gatteaux in the beginning of the 19th century (Figs. 27 and 28). We all agreed that even if the Greeks and Romans did develop different ways to reproduce statues, traces and unfinished statues do not give us evidence about the use of them[35]. Hence, the following questions are raised: do we know exact series of copies for those periods? Did the Hellenistic and Roman sculptors need an exact pointing process when we know how often they adapt the copies? Even molds of plaster and copies discovered at Baiae show us that they did not mold the copy exactly[36].

The following diagram matches the traces and the processes mentioned above:



28 BAUDRY 2000, 175.

29 BAUDRY 2000, 176.

30 SANTAMERA CAMI 2001, 99.

31 PFANNER 1989, 204-222.

32 Different methods observed and proposed for the reproduction of sculpture must prompt reflection about a period of experimentations. Some methods were tried, compared and abandoned, PFANNER 1989, 187-190. I will talk about a period of experimentation than I observed in Delos during the end of the Hellenistic times.

33 PALAGIA, 2006, 269; BLÜMEL 1969, 46, BLÜMEL 1927, 57.

34 ROCKWELL 1993, 118; BLÜMEL 1969, 53-54, fig. 42.

35 Difficult to recognize exact copies, but some researchers appear to believe in the use of a pointing machine during the Roman times: RICHTER 1965, 290, pl.LXII and CLARIDGE 1985.

36 LANDWEHR 1982, 23. For that matter, I reproduce here a short extract of a workshop concerning copies that took place in Oxford in October 2015, intitled Replicas in Roman Art: Redeeming the Copy?: "It has become clear that the Romans who used 'copies' were not always -- indeed not normally -- motivated by the desire to reproduce famous works; the artists did not copy mechanically and their work was more creative and less concerned with accuracy than had been believed; replication in art was motivated by a range of factors besides mere art-appreciation, including notions of domestic decorum, religious sensibilities, and the practicalities of artists' workshops." http://www.beazley.ox.ac.uk/events/Replicas%20Workshop%20Abstract.pdf.

Fig. 29. First group from Delos presented a non-homogeneous progression with some variations from one piece to another. From left to right: Statuette of Aphrodite (inv. A 3825, Delos Museum, Greece), Female Sphinx of Rheneia (inv. 1661, National Museum, Athens, Greece), Bust of Serapis (inv. A 4023, Delos Museum, Greece), Relief of the Homeric Hymn of Demeter (inv. A 3194, Delos Museum, Greece) (photo S. Moureaud and P. Jockey)

Fig. 30. Second group from Delos presented a homogeneous progression, Statue of Aphrodite, probably from Rheneia, probably 2nd century BC (inv. 3188, National Museum, Athens, Greece) (photo: S. Moureaud)

Some analysis and new problematics

Experimental times

It appears that during the Antiquity, many kinds of processes could be used to copy a *proplasma* (what is shaped before) before the invention of the pointing machine. This appears to be even more true at the end of the Hellenistic times. Indeed, between the 2nd and the 1st century BC, many unfinished statues from Delos and Rheneia present a variety of traces of copying. It is possible to gather them in different groups according to the different traces and ways of making. A first group presents an inhomogeneous progression with also many variations from one piece to another, Fig. 29. A second group presents a uniform and linear progression, Figs. 30 and 18. There is no doubt that we have evidence of an experimental period during which workshops tried to develop their techniques to adapt their production to increasing demand. In fact, during that specific period in Delos[37], the production of sculpture increased due to a general domestic use.

37 MOUREAUD 2009 and 2015.

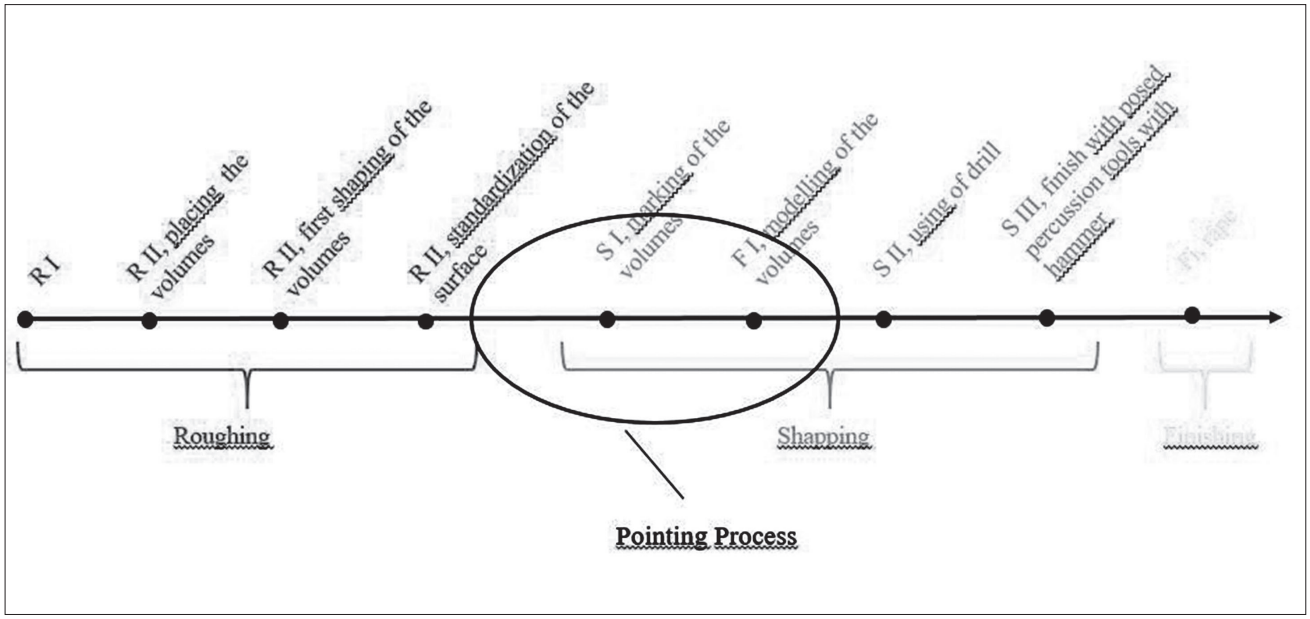


Fig. 31. Use of reproduction only after a first step of roughing out general forms in the "chaîne opératoire"

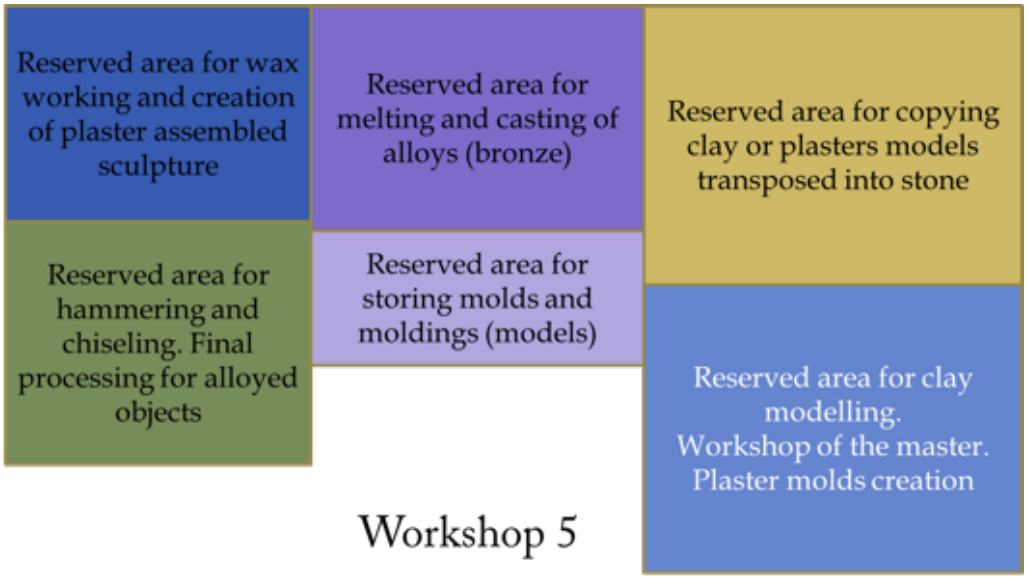


Fig. 32. Spatial organisation in the workshop of a craftsman in Mahabalipuram, India

Ways of diffusion

In three cases we notice the link between the technique of reproduction progress and the necessity to create a new type of production. That was the case concerning the Parian *kouros*, Fig. 22, which presents a different way of making than used for previous *kouroi* . Obviously, a new technique was employed to create a new type *kouros,* which was directly inspired by the type of Parian *korei*[38]. That was also the case for early Classical reliefs. On the pediment of Olympia, Peter Rockwell noticed a correction due to a mistake in reporting points[39]. He stated that it was obvious that the technique had not yet been mastered. Similarly, it was necessary for Delian sculptors to find new ways to produce more, by trying different copying processes. We can note that evolutions of the technique of copying are linked to some specific places for a specific goal. By these observations we can propose some places of innovation. The recognition of innovation places can also allow some ways of diffusion of a technique as we can see in a new example. Two unfinished statuettes

38 CROISSANT 2008-2009. An article is also in progress concerning a technical analysis of that *kouros*.

39 ROCKWELL 1993, 117, note 16.

Fig. 33. Wax working area in the workshop of a craftsman in Mahabalipuram, India (photo: S. Moureaud)

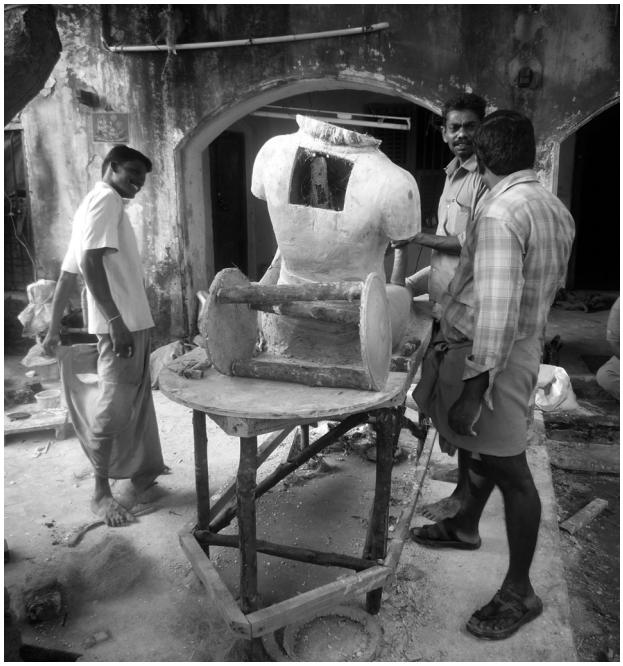


Fig. 34. Area for the creation of plaster-assembled sculpture in the workshop of a craftsman in Mahabalipuram, India (photo: S. Moureaud)

Fig. 35. Area for the melting and casting of alloys (bronze) in the workshop of a craftsman in Mahabalipuram, India (photo: S. Moureaud)

Fig. 36. Area for the modelling (master craftsman) and plastering of moulds creation in the workshop of a craftsman in Mahabalipuram, India (photo: S. Moureaud)

Fig. 37. Area for the storing of moulds and mouldings in the workshop of a craftsman in Mahabalipuram, India (photo: S. Moureaud)

Fig. 38. Hammering and chasing area in the workshop of a craftsman in Mahabalipuram, India (photo: S. Moureaud)

Fig. 39 Area for the copying of clay and the plastering of stone models in the workshop of a craftsman in Mahabalipuram, India (photo: S. Moureaud)

of Eros the archer from Kime (Fig. 2), presenting some similar traces of reproduction as observed in Delos (same use of the tooth chisel and same kind of concavities) could give us evidences of the diffusion of technique of copy invented on the island during the late Hellenistic times[40].

Comparative study of unfinished pieces

A systematic comparative study of unfinished pieces[41] showed that the technique of copying in sculpture was used only after a first step of roughing out general forms (Fig. 31).

Ethno-archaeological approach

Finally, I would like to briefly discuss the use of an ethno-archaeological approach in India and in Tinos, by showing their different traditional and contemporary styles of craftsmanship. This allows the observation of a hierarchical and spatial organization in workshops, the place of the master, the itinerant craftsmen, the social origins of the technicians and their tasks. For example, I have briefly presented the bronze and marble workshop of a famous Indian sculptor in India, Fig. 32. The master only made models using clay or wax. The remaining tasks were left to the specialized technicians in allocated areas (Fig. 33-39). Even if there are some cultural differences, that approach has given us some new ways to propose new problem areas or to find some parallels between ancient sources and traditional contemporary observations. This research is currently in progress.

To conclude, this brief overview about copy in Antiquity shows that we can propose new hypothesis with new interdisciplinary approaches. Even if sculptures with reproduction traces or ancient texts about technique are rare, it is possible to approach this subject by other ways.

40 MOUREAUD 2015.

41 MOUREAUD 2009, 228-234.

BIBLIOGRAPHY

ARKLES J. 2007: Sculpting From Life - A Studio Manual of the Sight-Size Method, Jason Arles ed.

ASHMOLE B., YALOURIS N. 1967: Olympia, The sculptures of the temple of Zeus, Phaidon Press, Londres.

BAUDRY M.-Th. 2000: Sculpture, méthodes et vocabulaire, Edition du patrimoine, Paris.

BLÜMEL C. 1927: Griechische Bildhauerarbeit. Jahrbuch des Deutschen Archäologischen Instituts 11, Druck und verlag von Walter de Gruyter, Berlin.

BLÜMEL C. 1969: Greek sculptors at work, Phaidon, London.

CLARIDGE A. 1985: "Sulla lavorazione dei Marmi bianchi della sculpture dell'eta Romana", in P. PENSABENE (ed.): Marmi antichi, Problemi d'impiego, di restauro e d'identificazione, Studi Miscellanei 26, Rome, 113-126, pl. 1-8.

CROISSANT Fr. 2008-2009: "Le premier kouros parien", Annali di Archeologia e Storia Antica Dipartimento di Studi del Mondo Classico e del Mediterraneo Antico, Nuova Serie N. 15-16, 155-166.

JOCKEY Ph. 1993: Techniques et ateliers de sculpture à Délos à l'époque hellénistique. Phd Thesis, Paris X Nanterre, B. Holtzmann dir., unpublished.

KARAKASI K. 2001: Archaische Koren. Hirmer, Munich.

KYRIELEIS H. 1996: Der grosse Kouros von Samos. Samos X, Habelt ed., Bonn.

LANDWEHR Ch. 1982: Griechische Meisterwerke in Römischen Abgüsse: Der Fund von Baïa, Liebieghaus Museum alter Plastik, Frankfurt.

LANDWEHR Ch. 1985: Die antiken Gipsabgüsse aus Baiae. Griechische Bronzestatuen in Abgüssen Römischer Zeit. Archäologische Forschungen 14, Berlin.

MARCADÉ J. 1996: Sculptures déliennes, École française d'Athènes, Ed. de Boccard, Paris.

MENARD R. 1882: La vie privé des anciens, le travail dans l'Antiquité. Ed. Morel et Cie, Paris.

MOUREAUD S. 2009: Pour une archéologie du geste en sculpture. Le travail du marbre des idoles cycladiques à l'époque romaine. Phd Thesis, Université Aix-Marseille, Jockey Ph. (dir.), unpublished.

MOUREAUD S. 2015: "Diffusion des techniques sculpturales dans l'espace hellénistique. Intérêt des appréciations techniques pour y répondre" in MONTEL S. (ed.): La sculpture gréco-romaine en Asie Mineure, Acte du colloque international de Besançon, 9 et 10 octobre 2014, Presses universitaires de Franche-Comté, Besançon.

PALAGIA O. 2006: "Marble carving techniques" in O. PALAGIA (ed.): Greek sculpture, function, materials, and techniques in the archaic and classical periods, University Press, Cambridge, 243-280.

PFANNER M. 1989: "Über das Herstellen von Porträts. Ein Beitrag zu Rationalierungsmassnahmen und Produktionsmechanismen von Massenware im spöten Hellenismus und in der römischen Kaiserzeit", Jahrbuch des deutschen archäologischen Instituts 104, 157-257.

PROST Fr. 2008: "Un atelier de Kouroi naxiens", in La sculpture des Cyclades à l'époque archaïque, supplément BCH 48, 381-399.

RICHTER G. M. A. 1965: "An Unfinished portrait herm of Sokrates", in Studi in onore di Luisa Banti, 289-291.

ROCKWELL P. 1993: The art of stoneworking, a reference guide. Cambridge University Press, New York.

ROLLEY Cl. 1994: La sculpture grecque, des origines au milieu du V^{ème} siècle, Ed. Picard, Paris.

SANTAMERA J. C., CAMI J. 2001: La sculpture sur pierre, Ed. Gründ, Paris.

SPIVEY N. 1996: Understanding Greek Sculpture, Ancient Meanings, Modern Readings, Thames and Hudson, London.

TOUCHLETTE L. 2000: "The mechanics of Roman copy production?", in TSETSKHLADZE G. R., PRAG A. J. N. W. and SNODGRASS A. M. (eds.), Periplous, Papers on Classical Art and Archaeology presented to Sir John Boardman, London.