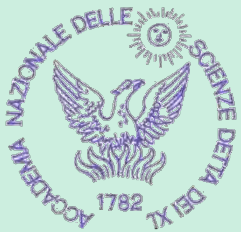
ACCADEMIA NAZIONALE DEI LINCEI

La mineralogia ed i beni culturali: attrazione fatale

Gilberto Artioli
Università di Padova

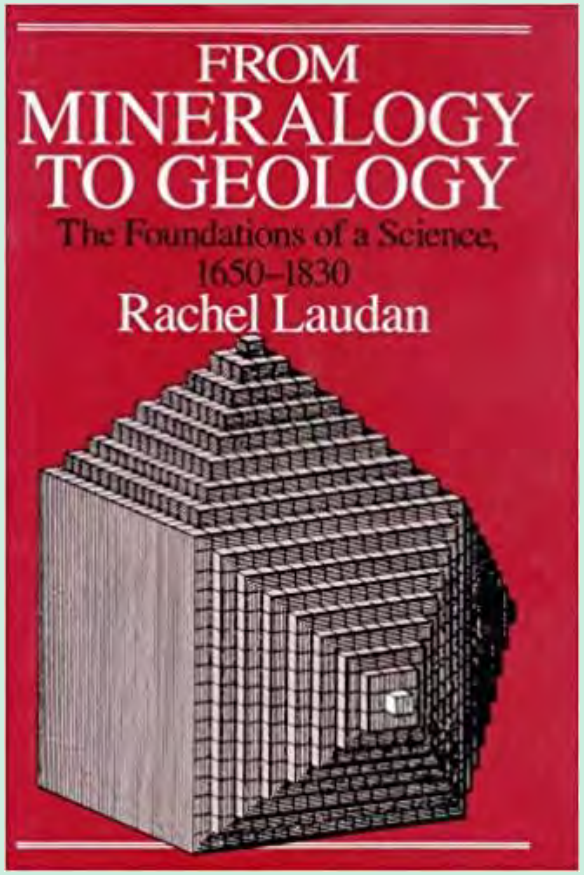


UNIVERSITÀ DEGLI STUDI DI PADOVA

CIRCe

Lo sviluppo storico della **cristallografia** e della **mineralogia** sono intimamente legate.

Abraham Gottlob Werner (1749-1817), uno dei padri della cronologia stratigrafica in geologia, ha definito la mineralogia "*as being made up of three major subdivisions that, taken together,* ***closely approximate the scope of modern geology****: oryctognosy (the identification and classification of minerals), mineral geography (the distribution of rocks and minerals), and geognosy (the formation and history of rocks and minerals)*"



La mineralogia e la cristallografia:

- **hanno solide radici nella fisico-chimica dello stato solido**
- **si occupano di tutti materiali rilevanti per i beni culturali**: dai minerali naturali ai prodotti delle trasformazioni causate dalle attività umane
- **hanno conoscenza della distribuzione degli elementi e delle associazioni minerali sulla crosta terrestre,** quindi della loro disponibilità come risorse
- **sono ben consapevole della complessità dei sistemi naturali,** e quindi adeguata al loro studio ed interpretazione
- **utilizzano un gran numero di tecniche sperimentali avanzate per lo studio dello stato solido.**

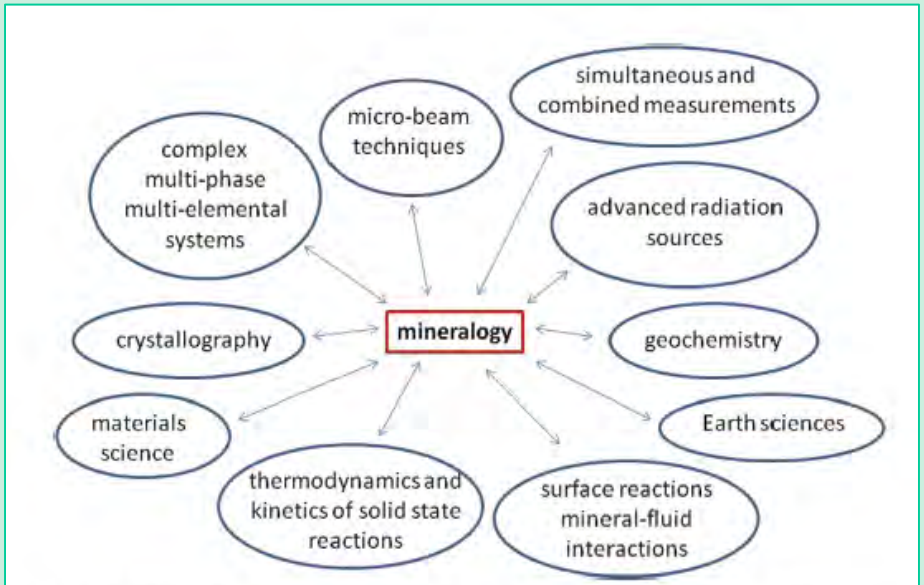
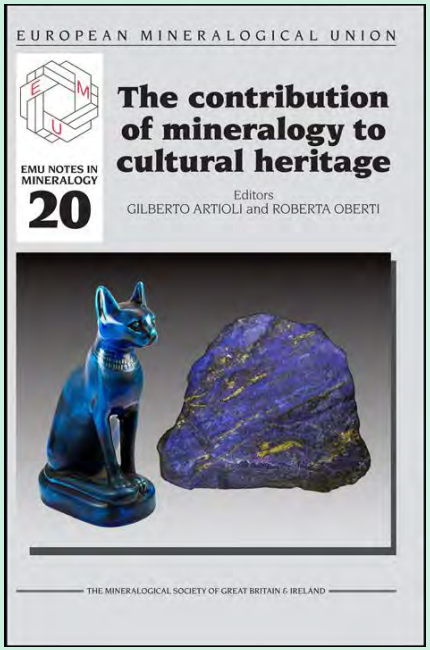
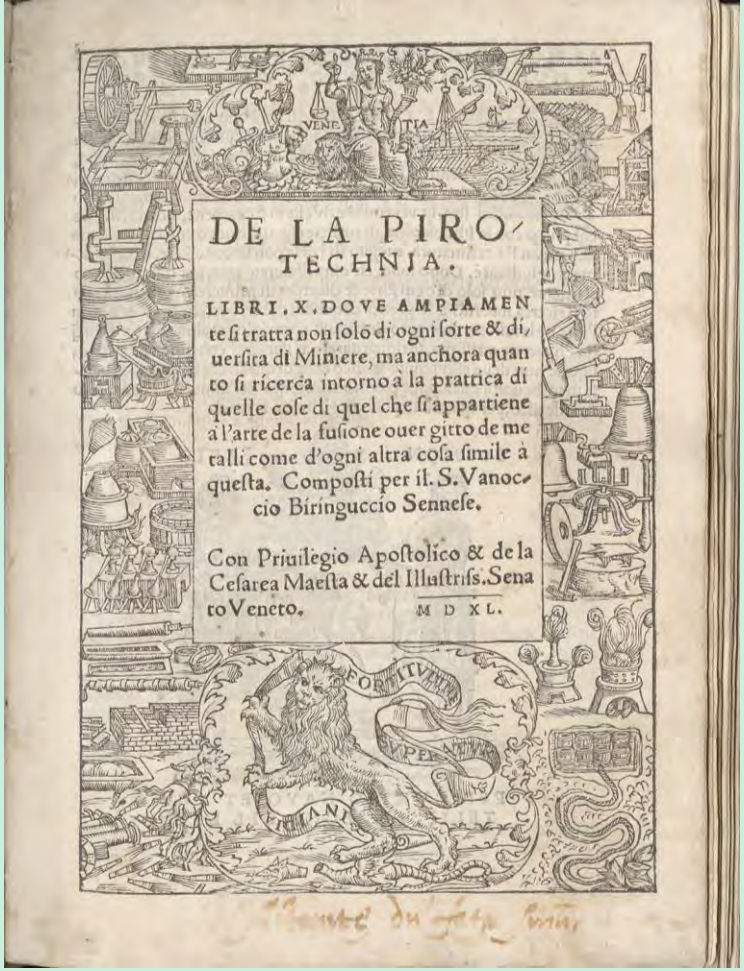


Fig. 2. The schematic diagram of some of the disciplines and know-how forming the backbone of modern mineralogy.




-Aquamarine Beryl -



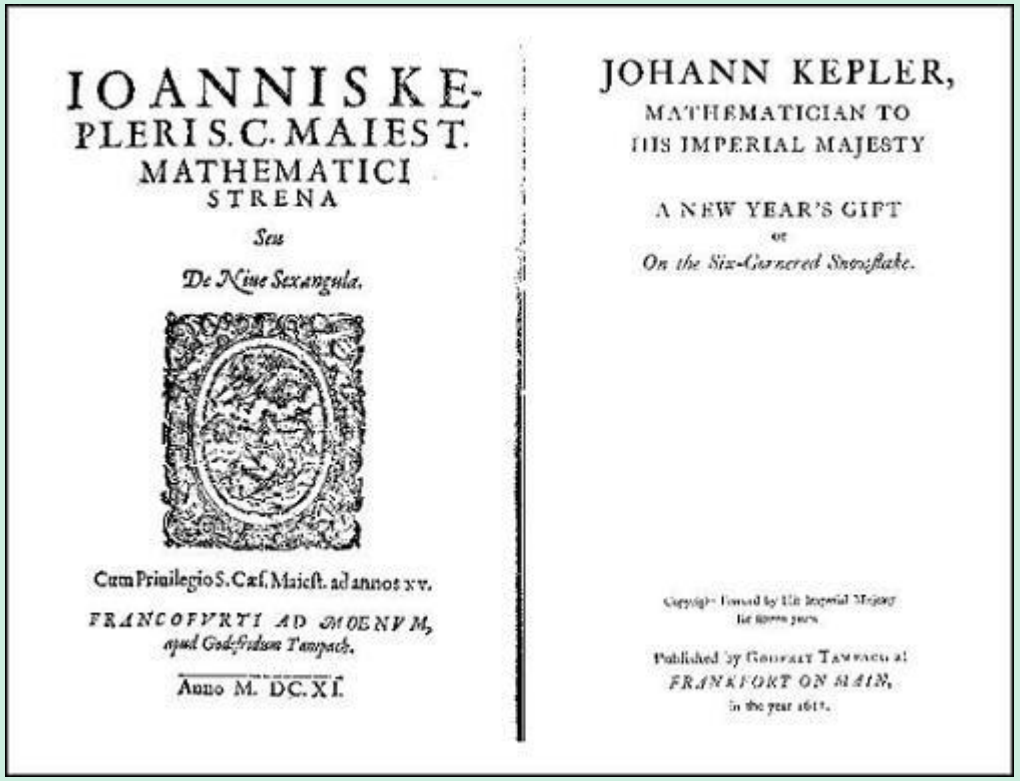
Vannoccio Biringuccio (1480–c. 1539)

«De La Pirotechnia» sulla pirite:

"a forma di certe grane, hor grosse et hor piccole, tutte cubiche a similitudine di dadi, over bisquadre tutte justamente squadrate"…

Johannes Kepler
(1571-1630)

De nive sexangula
Johannes Kepler
(*1611*)



IOANNIS KE-
PLERI S. C. MAIEST.
MATHEMATICI
STRENA
Seu
De Nive Sexangula.

Cum Priuilegio S. Cæs. Maiest. ad annos XV.

FRANCOFVRTI AD MOENVM,
apud Godefridum Tampach.

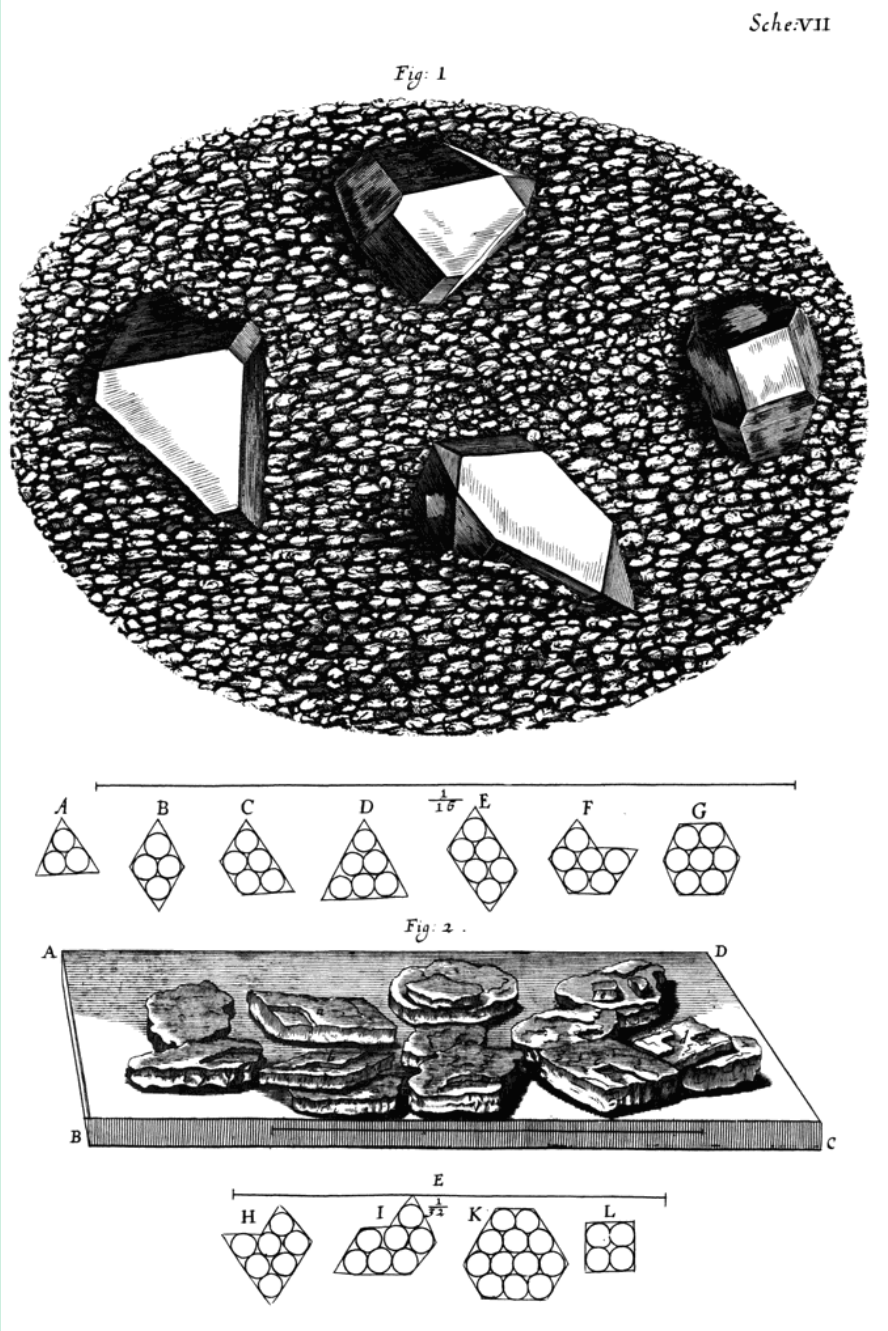
Anno M. DC. XI.

JOHANN KEPLER,
MATHEMATICIAN TO
HIS IMPERIAL MAJESTY

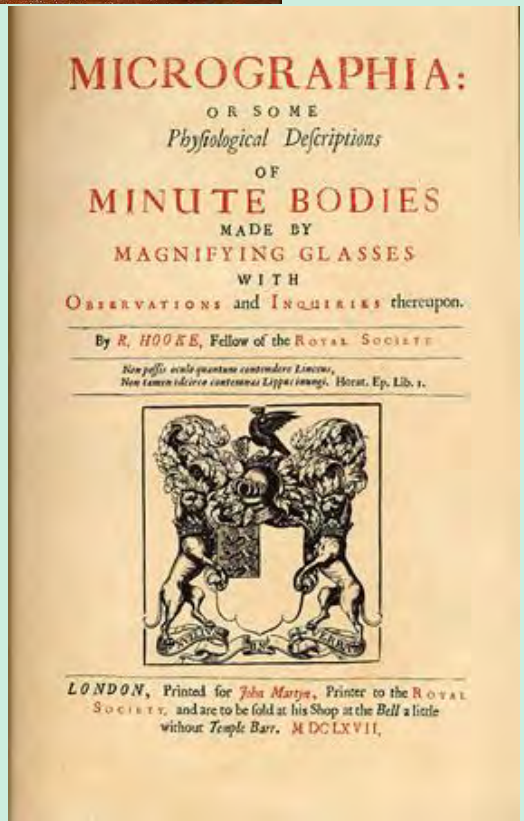
A NEW YEAR'S GIFT
OR
On the Six-Cornered Snowflake.

Copyright [illegible] by His Imperial Majesty
[illegible] years

Published by GODFREY TAMPACH at
FRANKFORT ON MAIN,
in the year 1611.



Robert Hooke (1635 – 1703)


MICROGRAPHIA:

OR SOME

Physiological Descriptions

OF

MINUTE BODIES

MADE BY

MAGNIFYING GLASSES

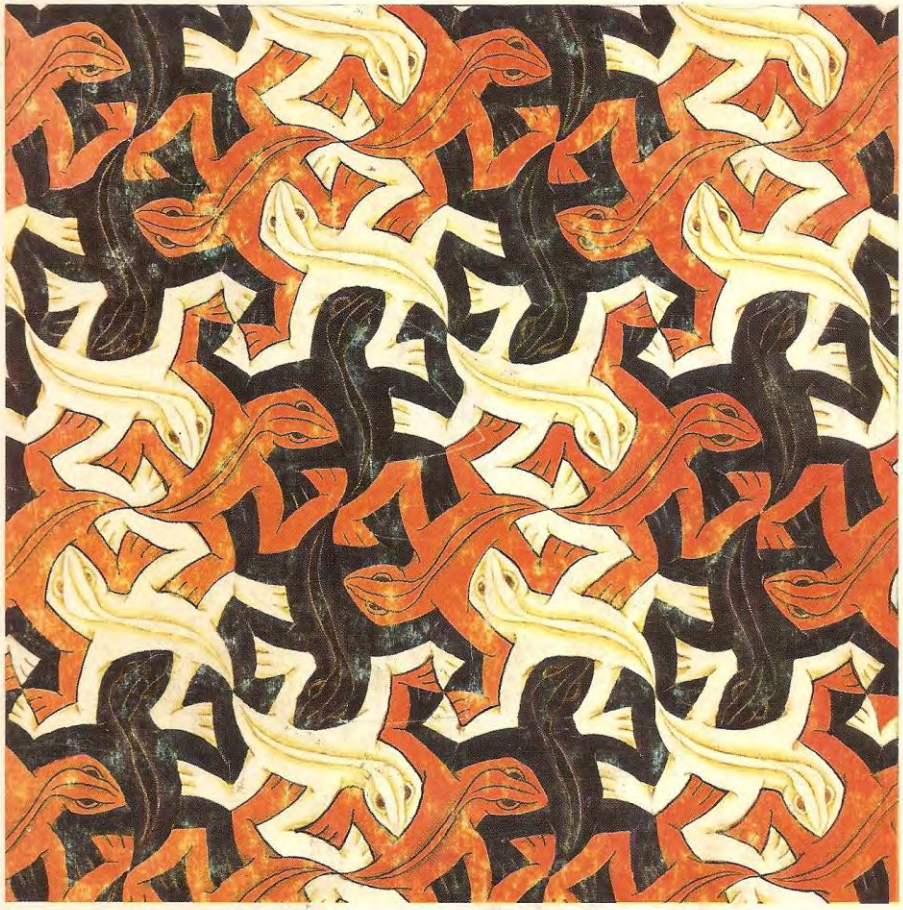
WITH

OBSERVATIONS and INQUIRIES thereupon.

By *R. HOOKE*, Fellow of the ROYAL SOCIETY.

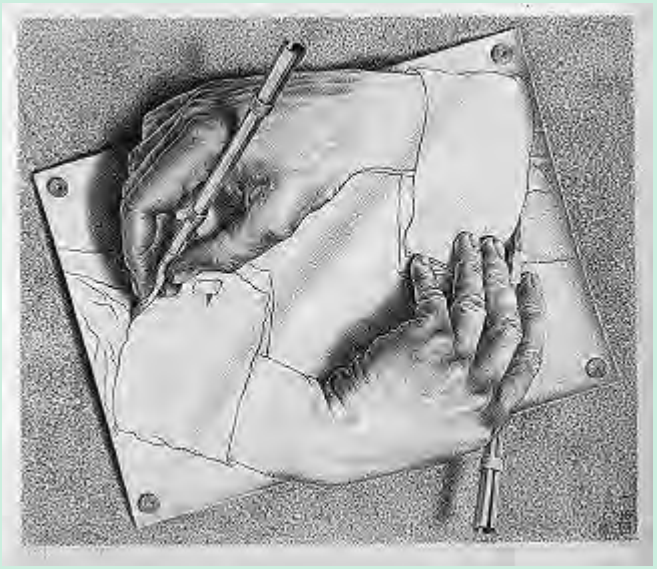
Non posse oculo quantum contendere Lynceus,
Non tamen idcirco contemnas Lippus inungi. Horat. Ep. Lib. 1.

LONDON, Printed for *John Martyn*, Printer to the ROYAL SOCIETY, and are to be sold at his Shop at the *Bell* a little without *Temple Barr*. MDCLXVII.

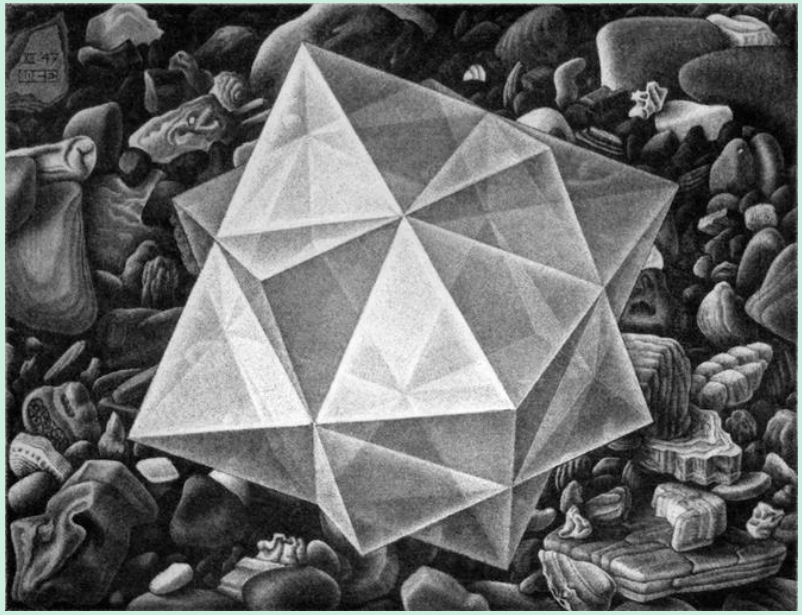


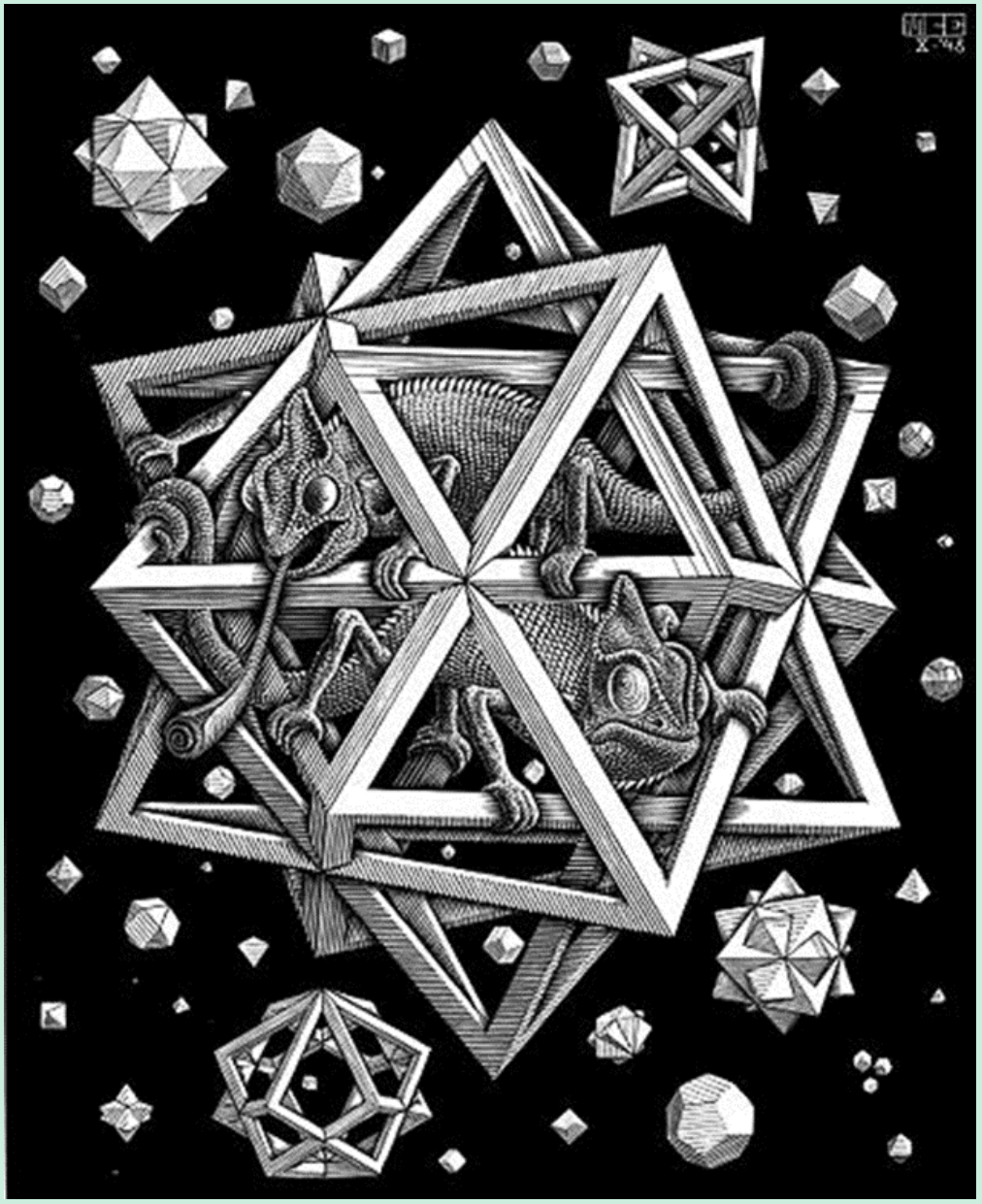
SYMMETRY ASPECTS OF M. C. ESCHER'S PERIODIC DRAWINGS

BY CAROLINE H. MACGILLAVRY

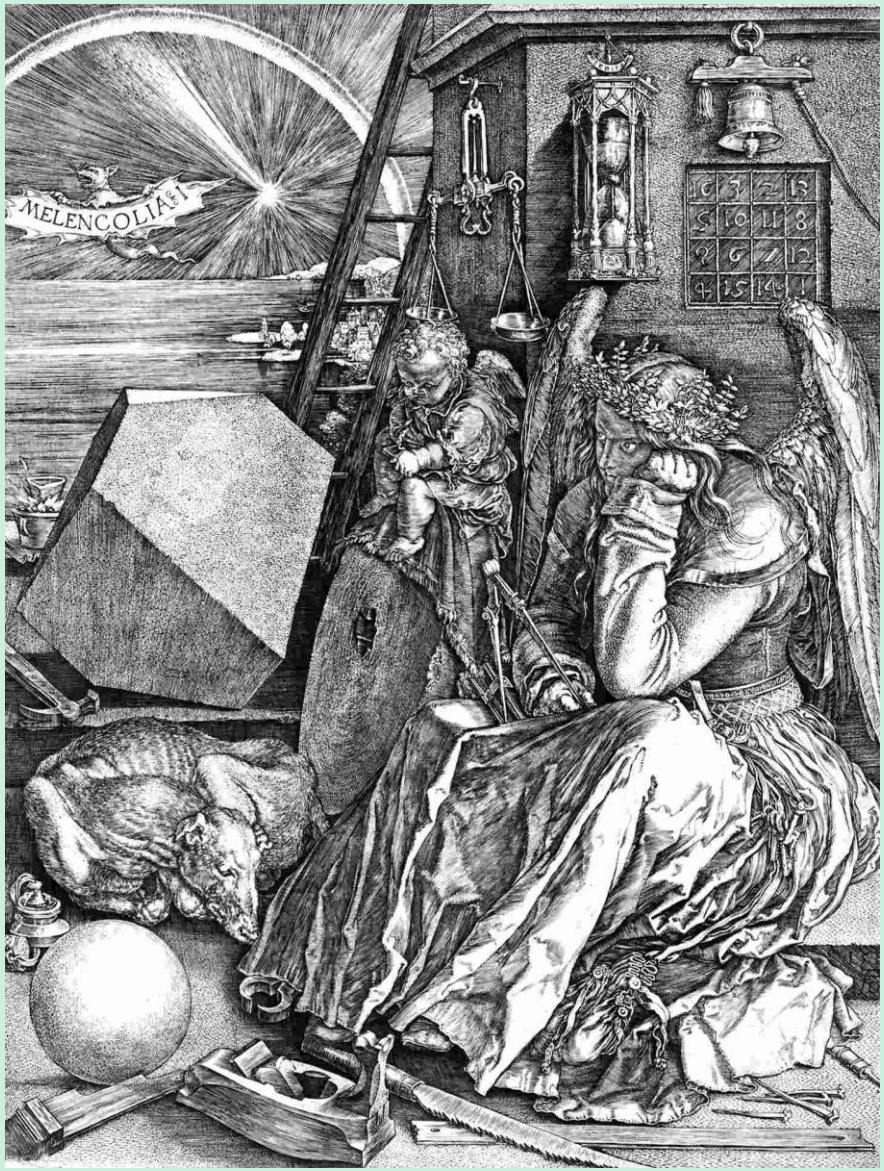


Maurits Cornelis Escher
1898 -1972





ritratto Fra Luca Pacioli -
Jacopo de' Barbari (attr.)



Dürer – Melancolia

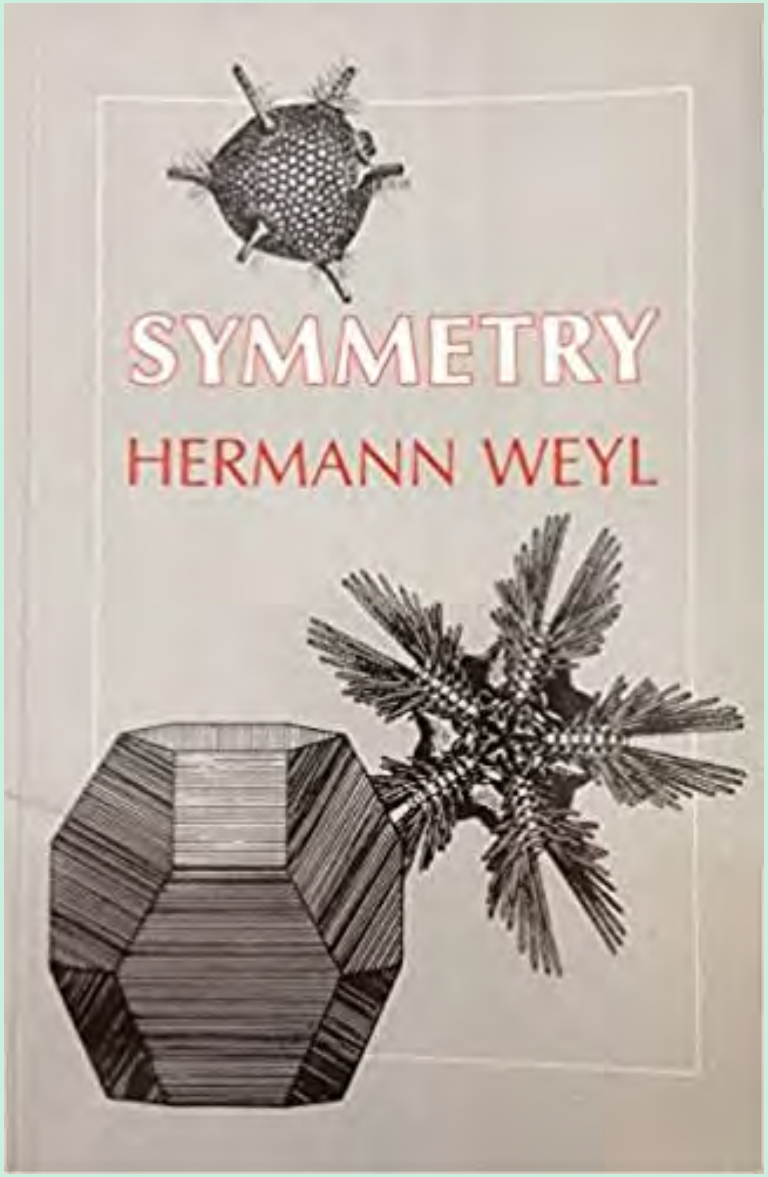
Crystals in Art

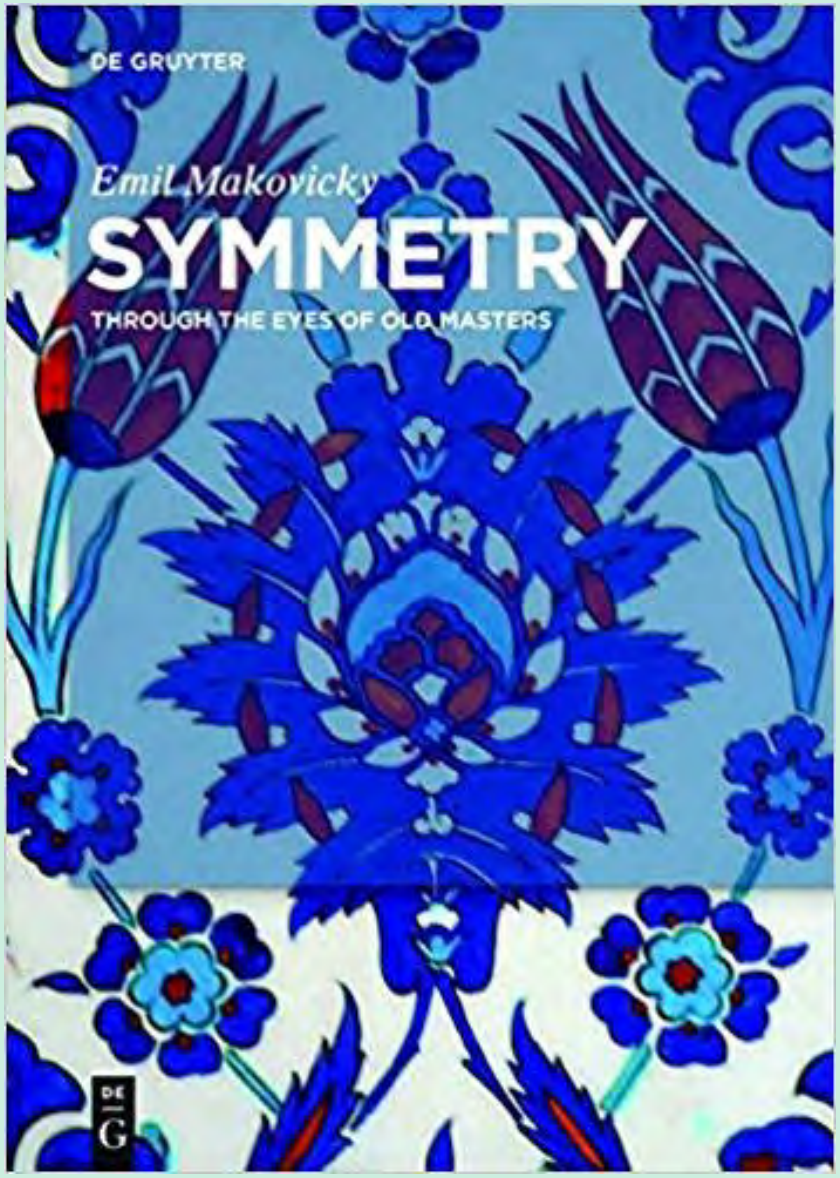
ANCIENT TO TODAY

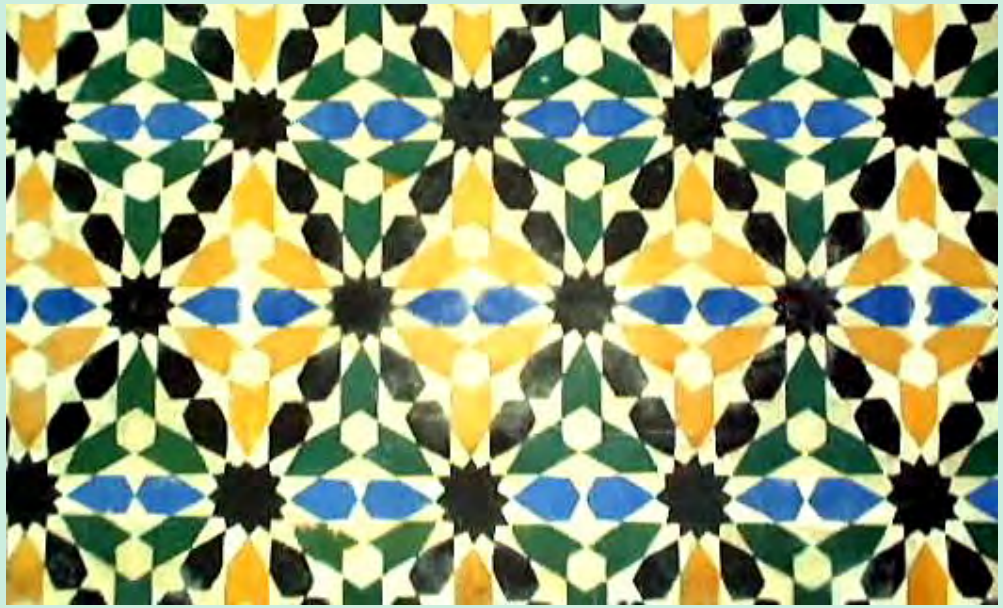
Marina Abramović

Lauren Haynes and

Alexis Arnold


SYMMETRY
HERMANN WEYL

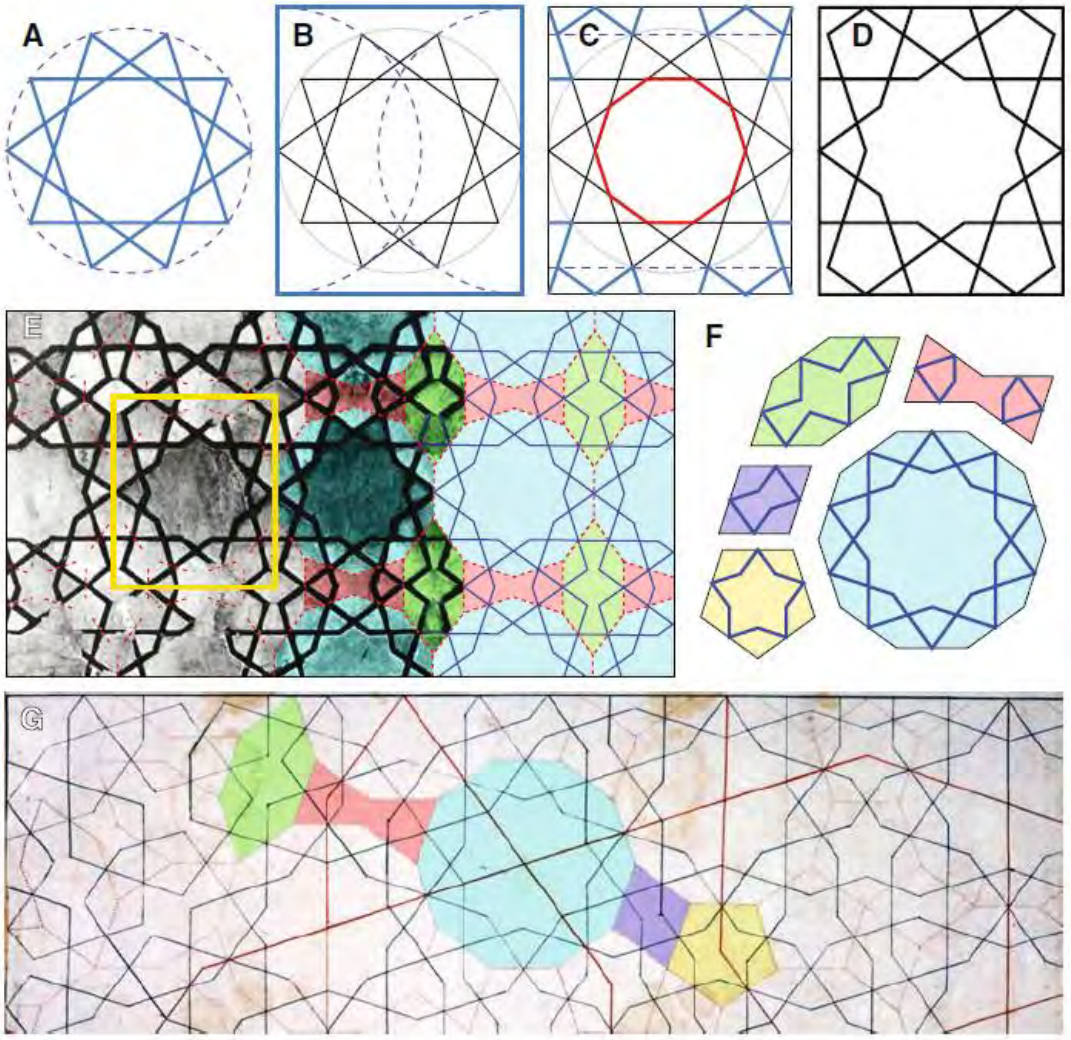

DE GRUYTER
Emil Makovicky
SYMMETRY
THROUGH THE EYES OF OLD MASTERS



Decagonal and Quasi-Crystalline Tilings in Medieval Islamic Architecture

Peter J. Lu[1]* and Paul J. Steinhardt[2]

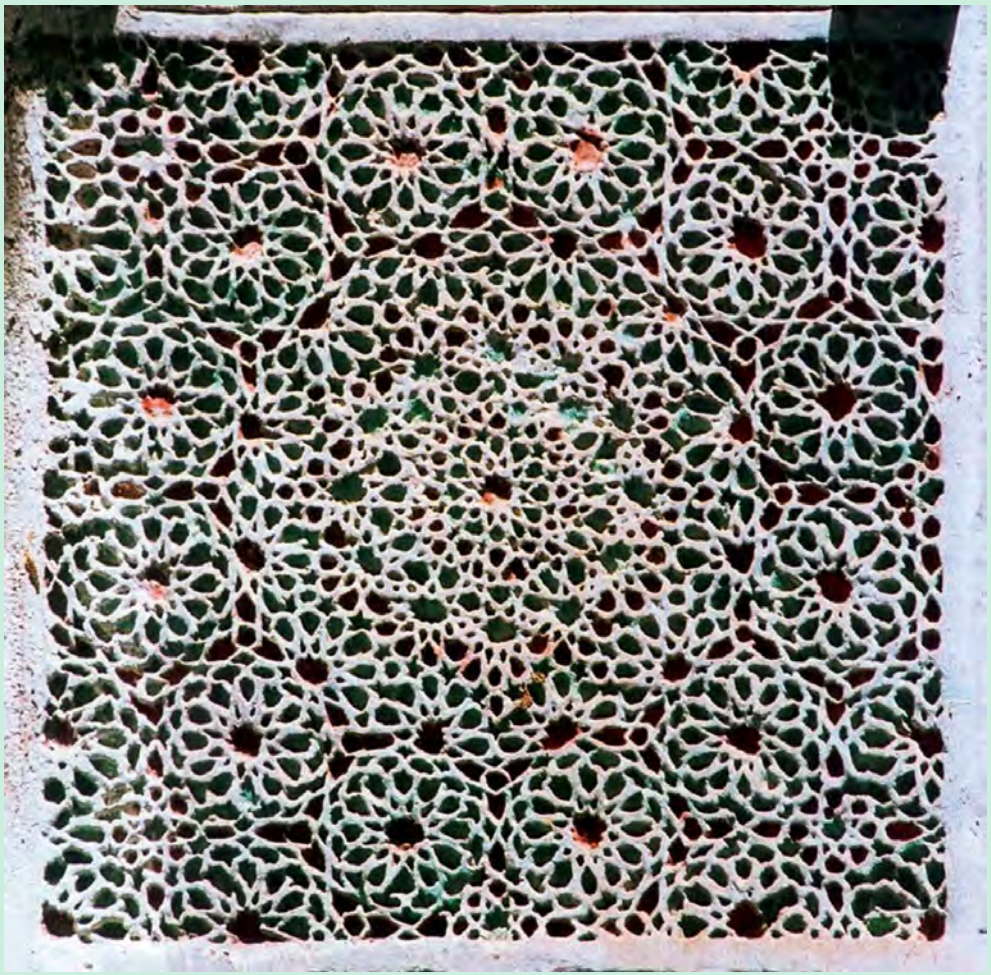
23 FEBRUARY 2007 VOL 315 SCIENCE

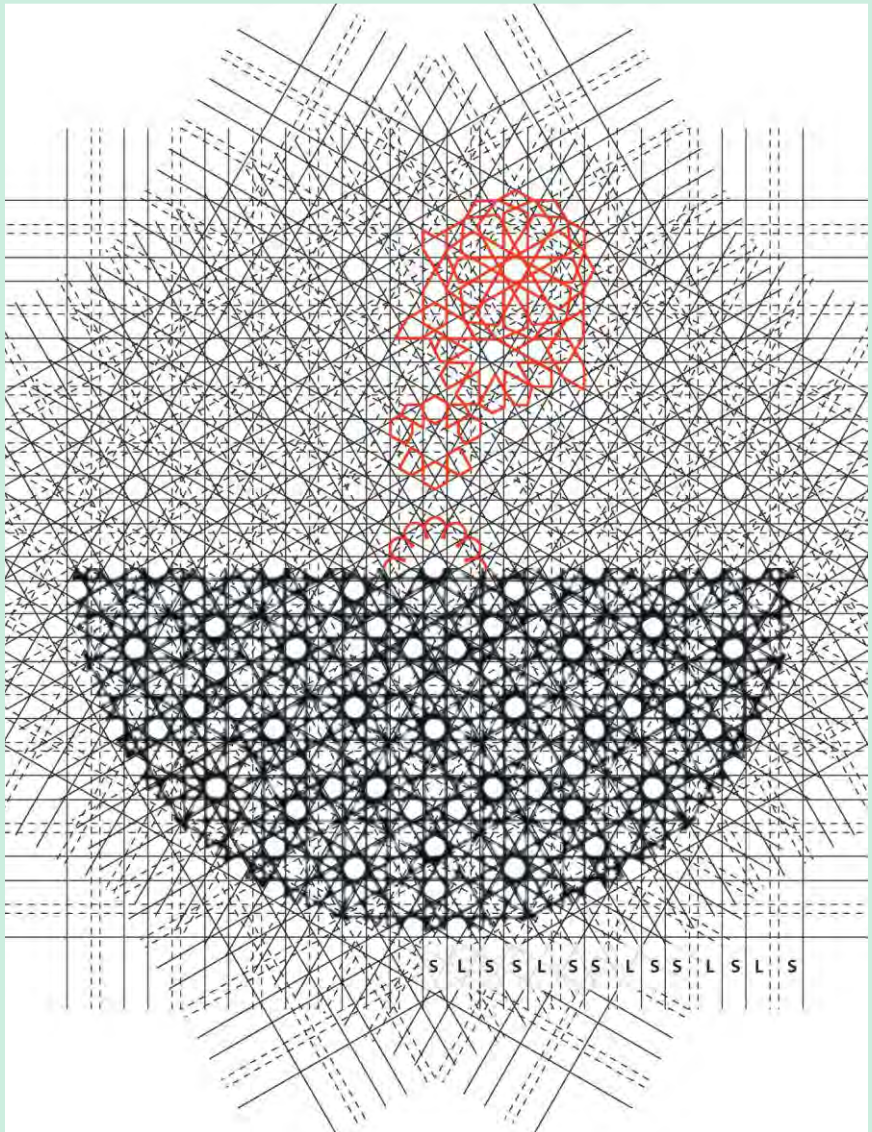


The first find of dodecagonal quasiperiodic tiling in historical Islamic architecture

J. Appl. Cryst. (2011). **44**, 569–573

Emil Makovicky[a]* and Nicolette M. Makovicky[b]





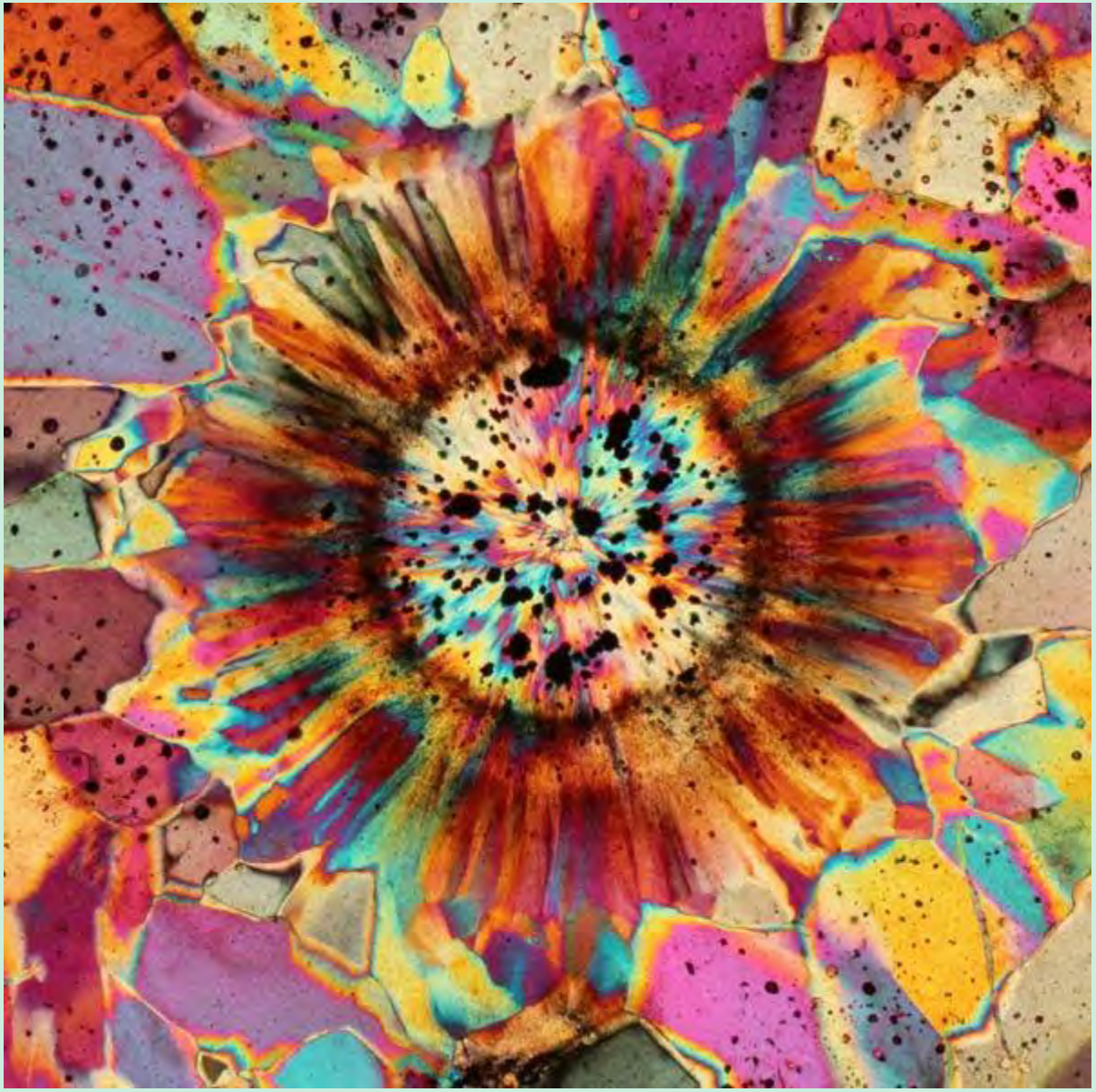
24th Congress and General Assembly
of the International Union of Crystallography

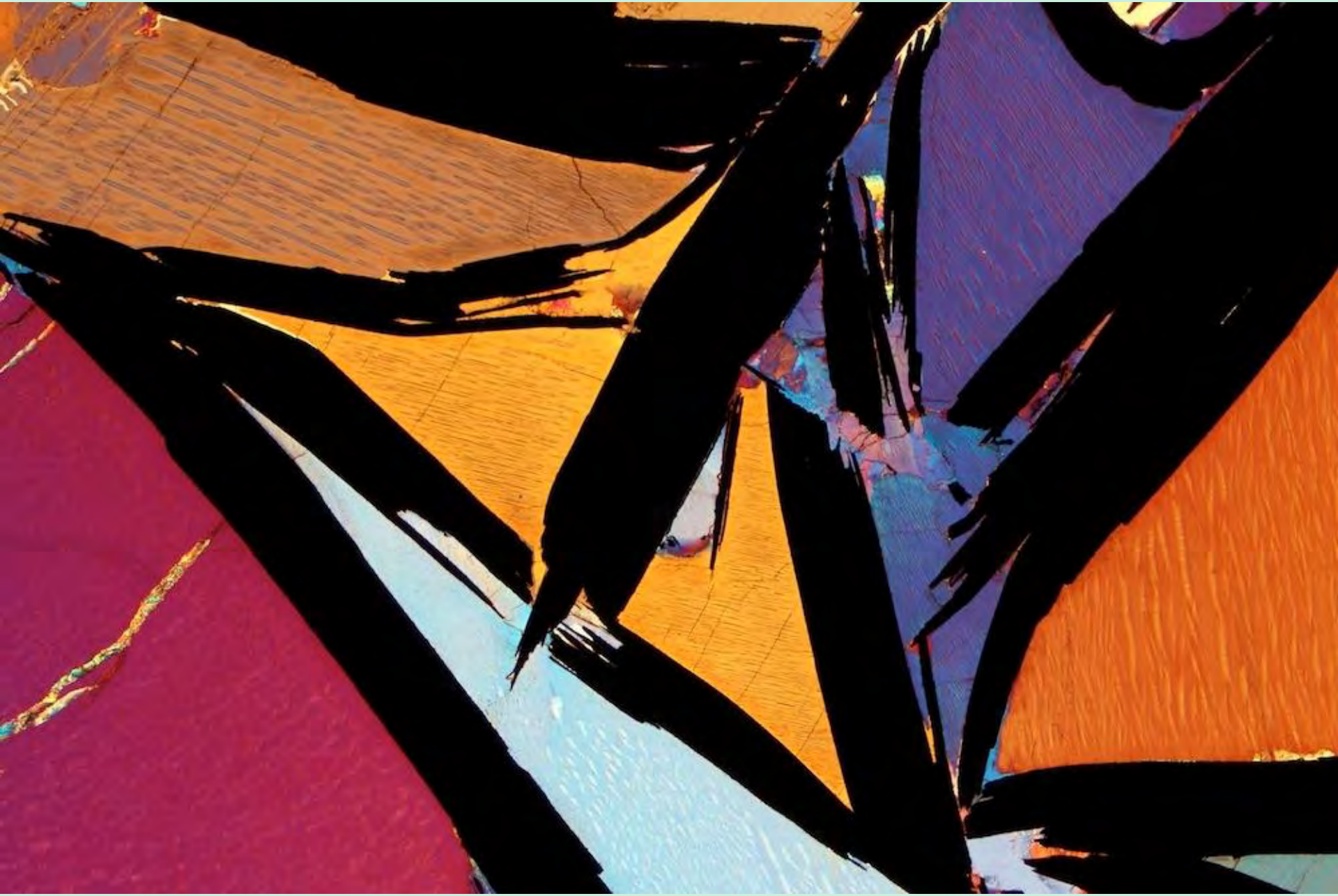
Hyderabad International Convention Centre
21 - 28 August 2017, Hyderabad, India

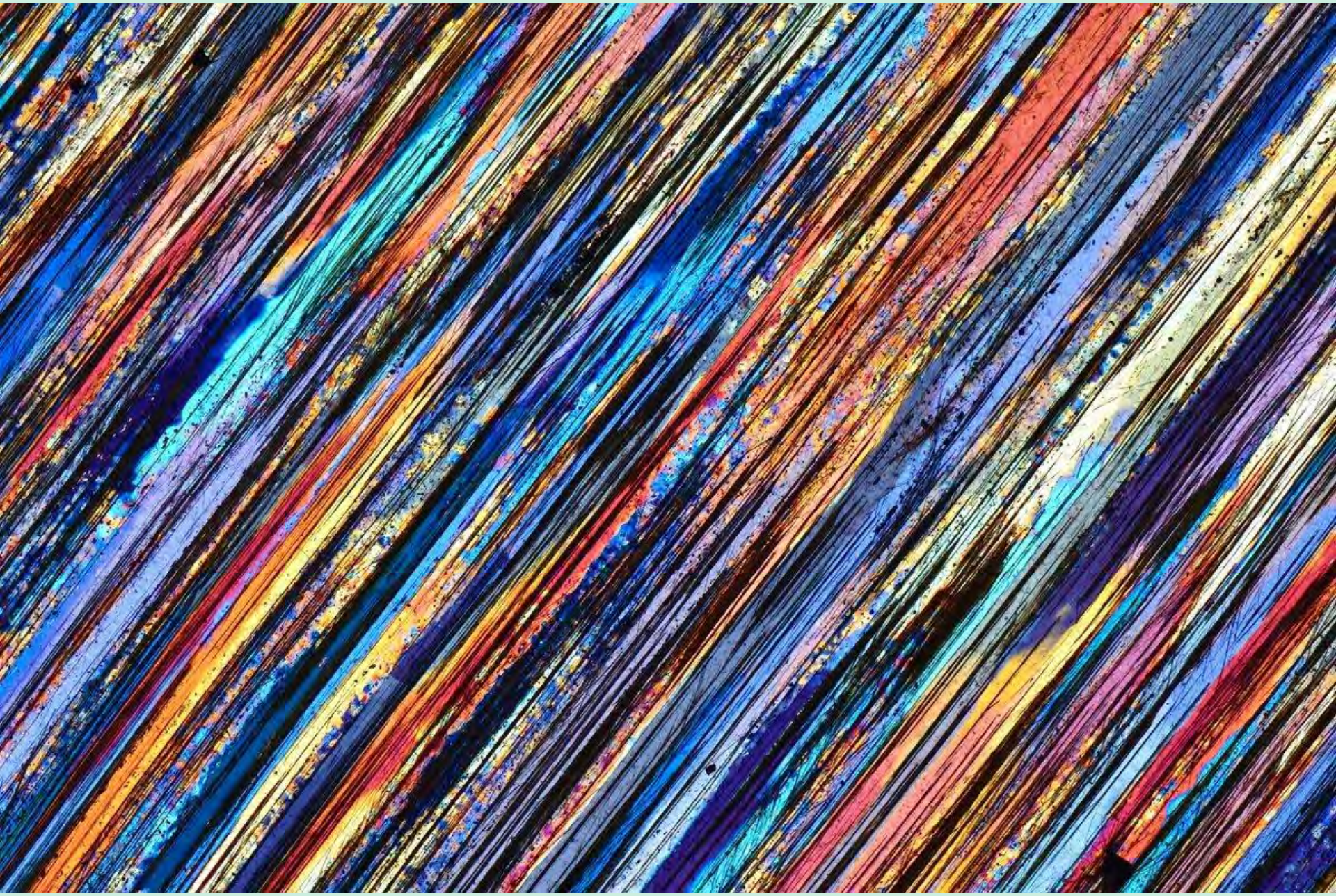
ART EXHIBITION

By micROCKScopica

Polarized Light Photo Micrograph of
Ocean Jasper

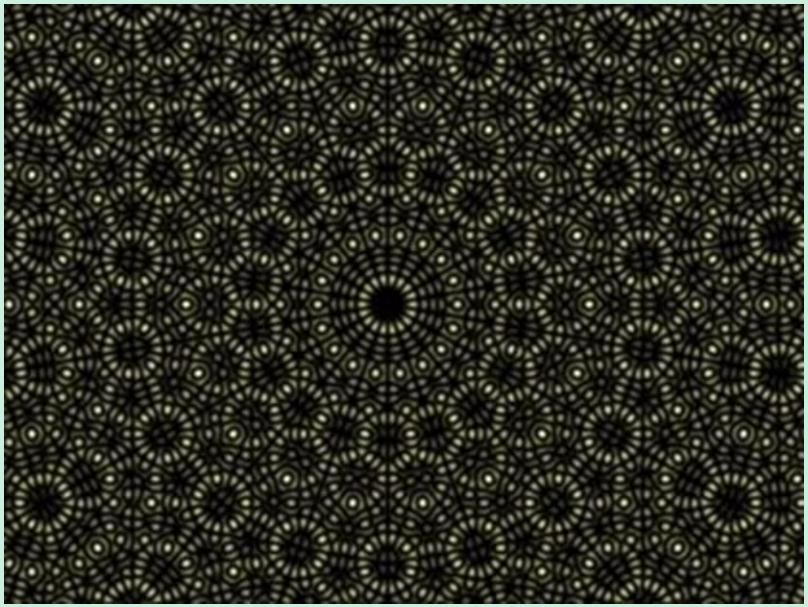


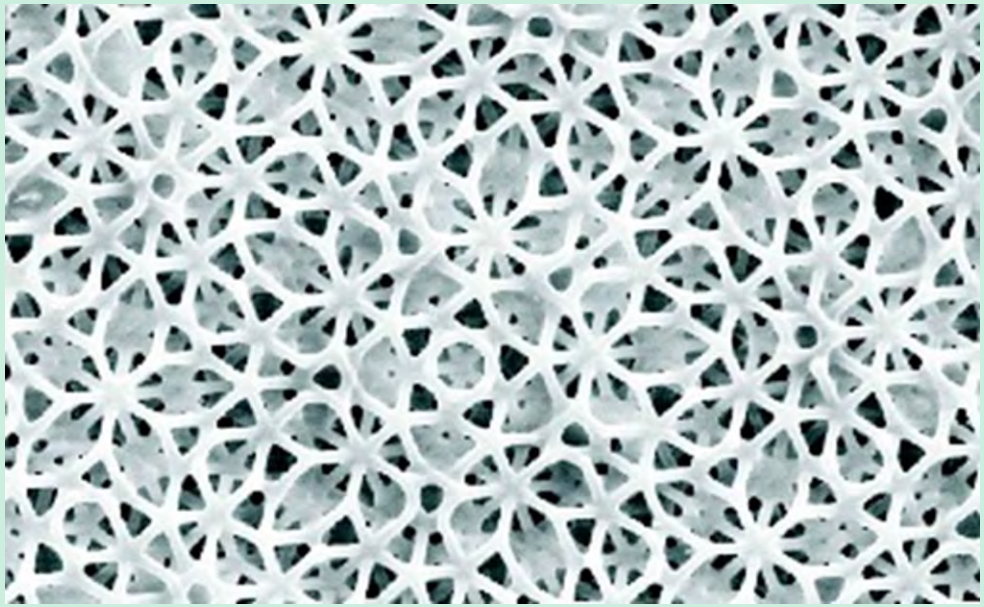


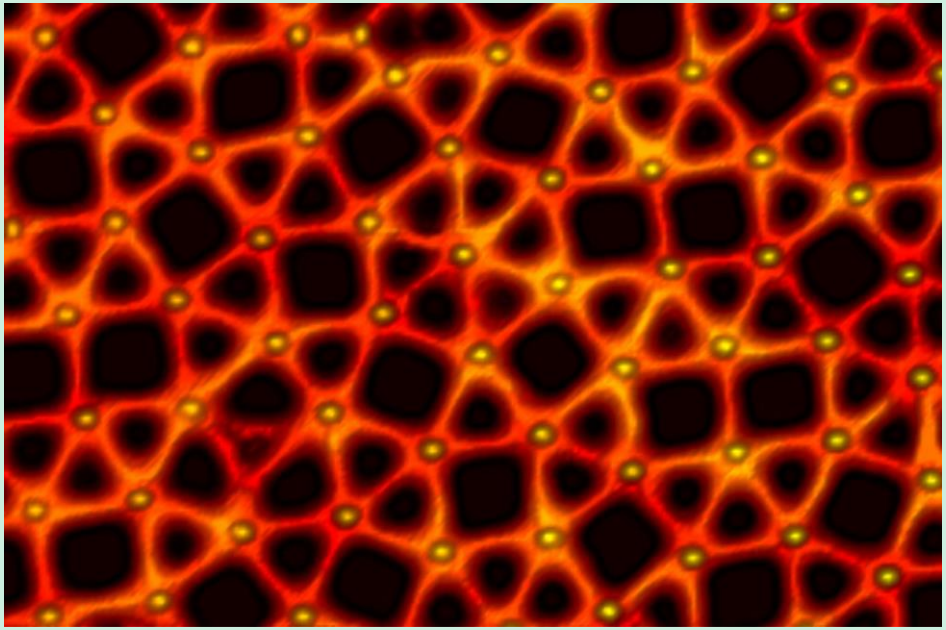


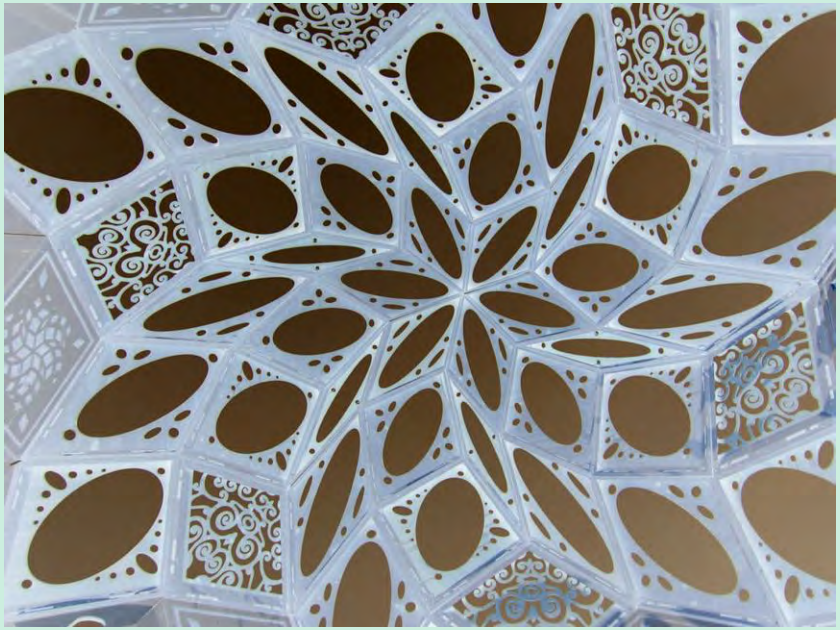
microckscopica.altervista.org

micROCKScopica - a rock's art project by Bernardo Cesare - home



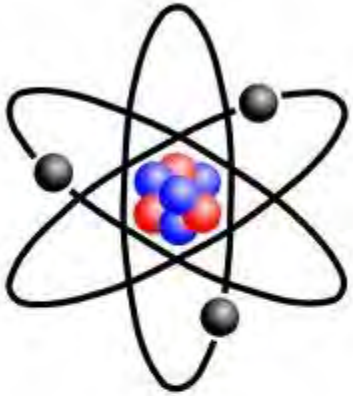


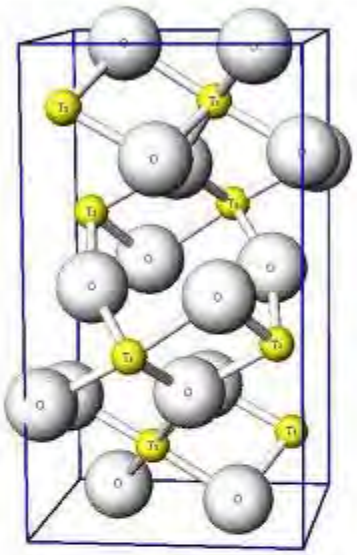




Oltre il fascino …

10^{-10} 10^{-9} Size (m) 10^{-4} 10^{-1}





Electronic level
Atomic level

Crystal
structure level

Phase
assemblage level

Macroscopic level

spectroscopy

microscopy - imaging

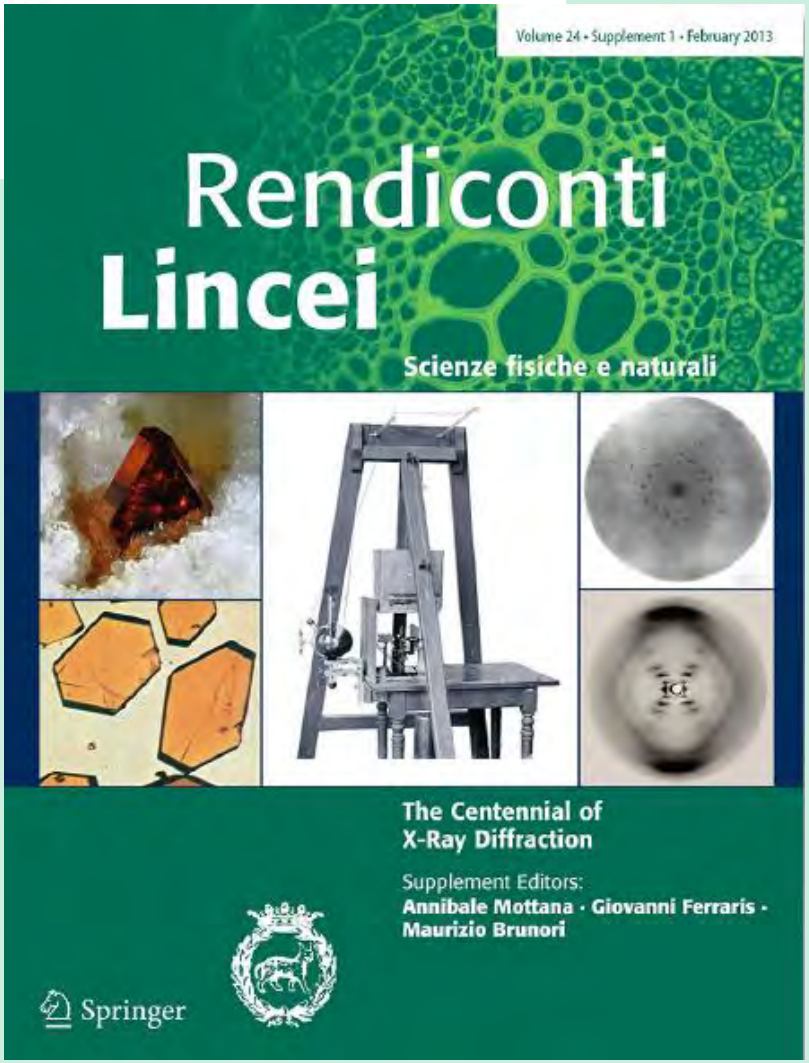
diffraction

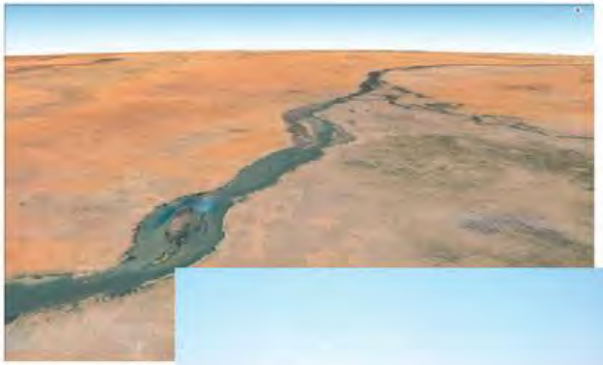
Rend. Fis. Acc. Lincei (2013) 24 (Suppl 1):S55–S62
DOI 10.1007/s12210-012-0207-z

X-RAY DIFFRACTION

Science for the cultural heritage: the contribution of X-ray diffraction

Gilberto Artioli



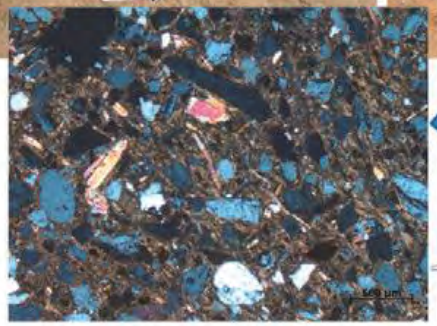


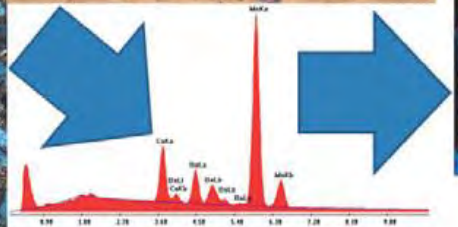
Remote / Large scale survey

Field / Site survey

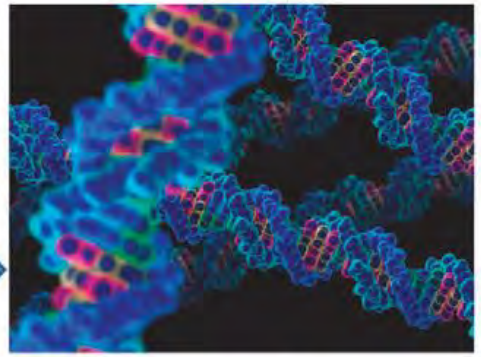
Excavation / Stratigraphy

Nature of materials



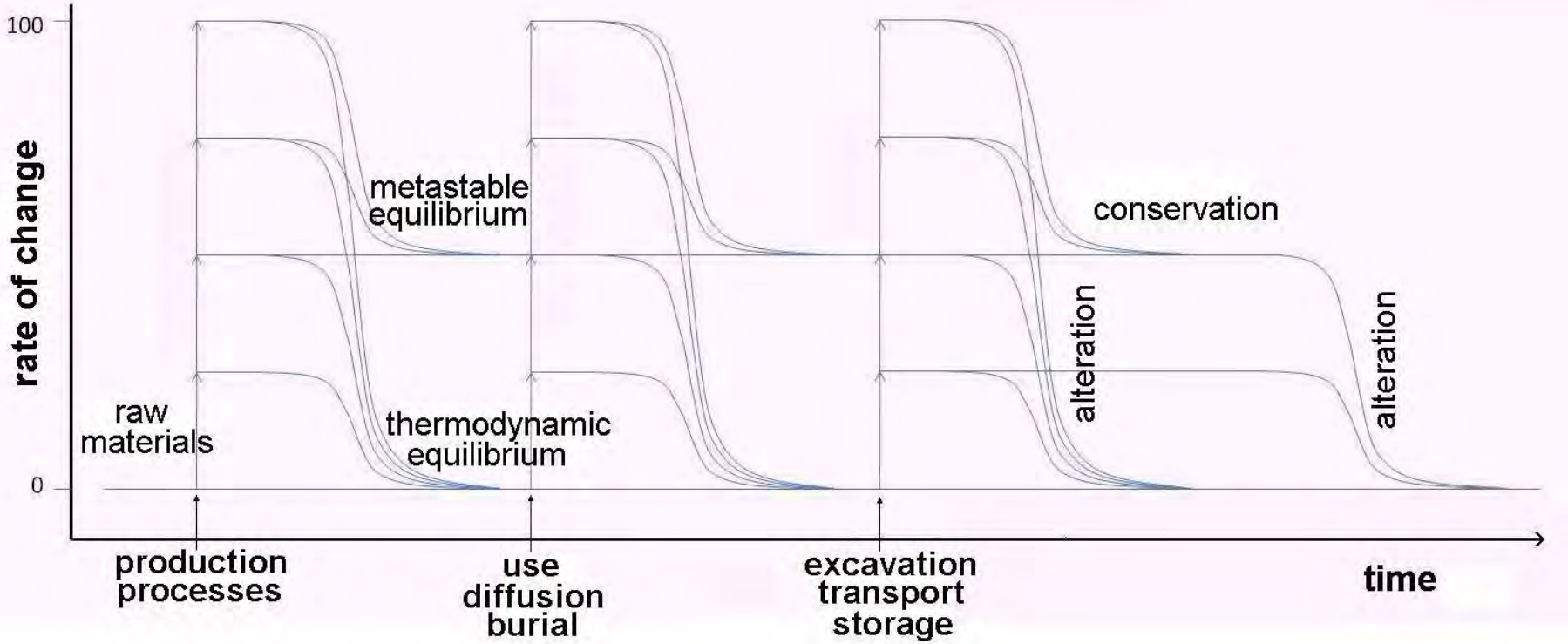


Laboratory analyses



Molecular archaeology

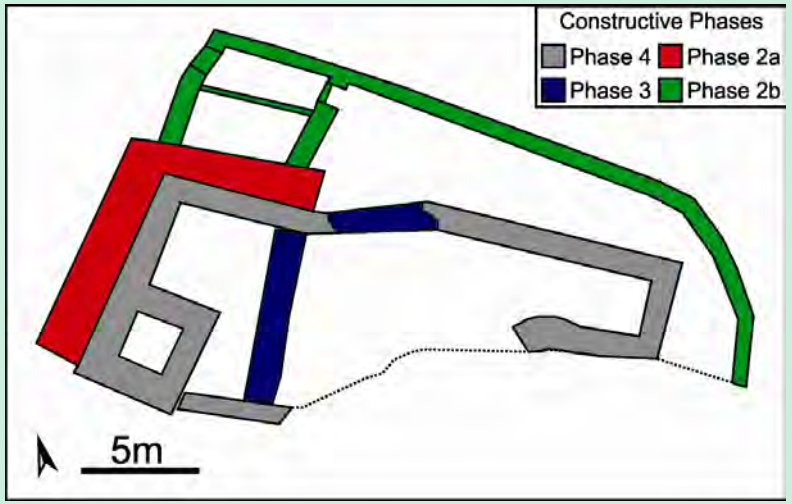
Il fine ultimo delle ricerche scientifiche su materiali / oggetti pertinenti a beni culturali è quello di **(ri)collocarli nella scala temporale delle attività umane** che li hanno prodotti.

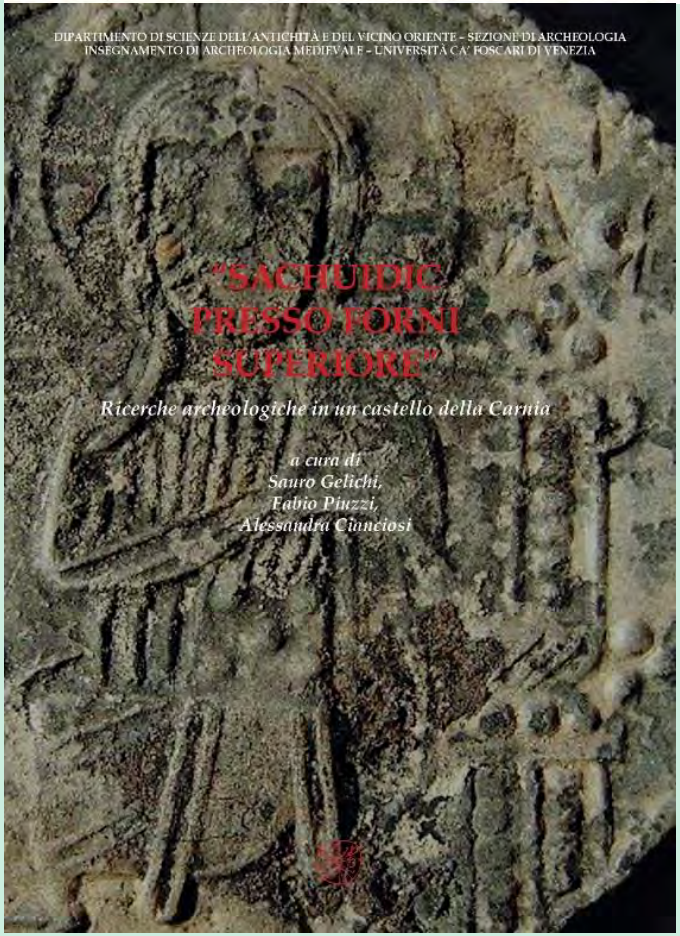


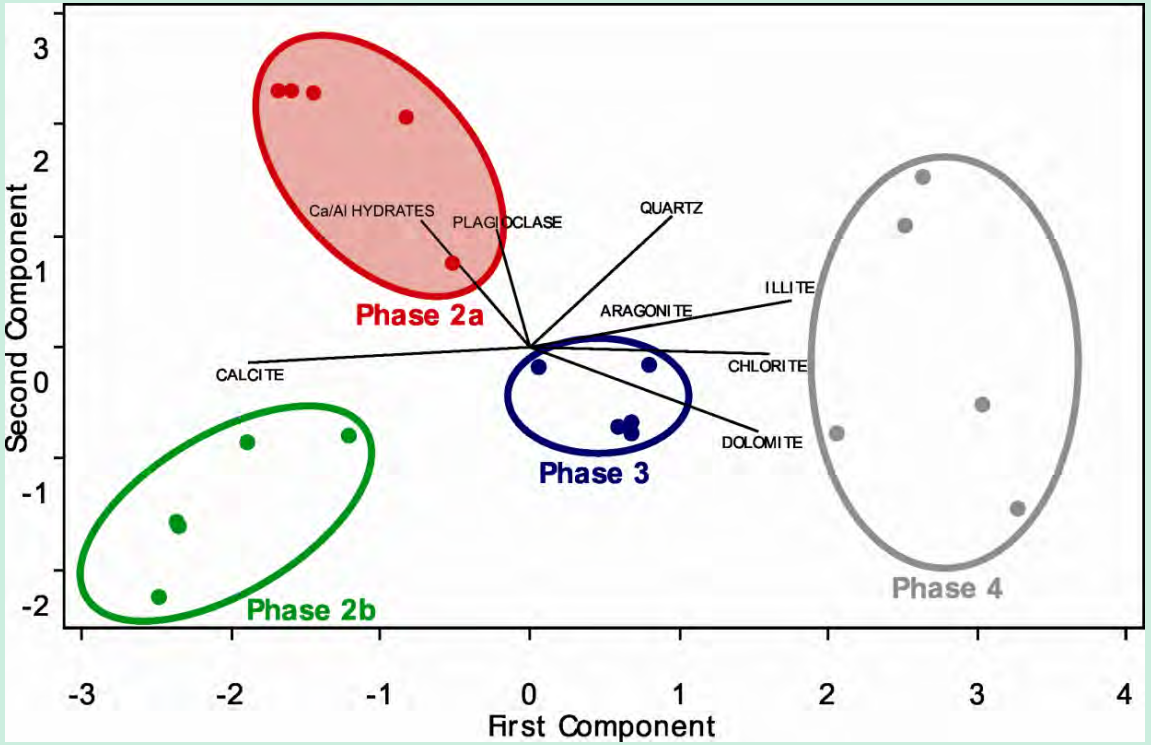
Archeometria
Diagnosi tecnica per l'arte

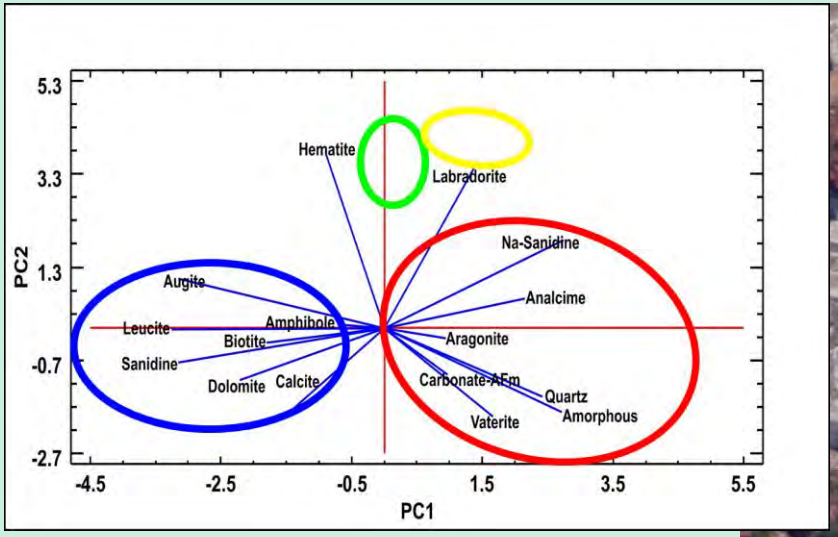
Conservazione e restauro

Ricostruzione architettonica


Constructive Phases
Phase 4
Phase 2a
Phase 3
Phase 2b
5m


DIPARTIMENTO DI SCIENZE DELL'ANTICHITÀ E DEL VICINO ORIENTE - SEZIONE DI ARCHEOLOGIA
INSEGNAMENTO DI ARCHEOLOGIA MEDIEVALE - UNIVERSITÀ CA' FOSCARI DI VENEZIA
"SACHUIDIC PRESSO FORNI SUPERIORE"
Ricerche archeologiche in un castello della Carnia
a cura di
Sauro Gelichi,
Fabio Piuzzi,
Alessandra Cianciosi

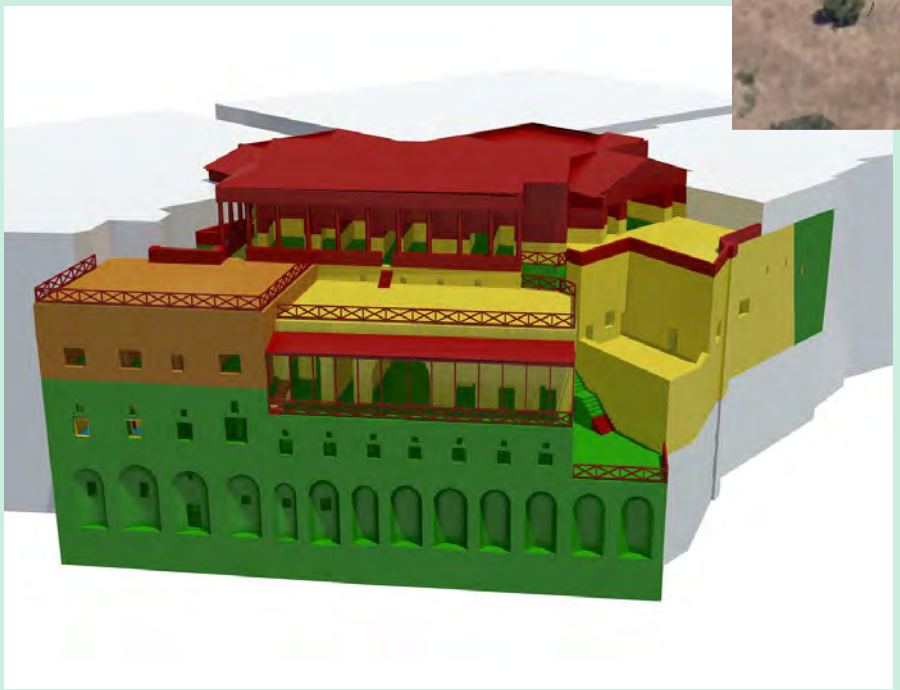

Second Component
First Component
3
2
1
0
-1
-2
-3
-2
-1
0
1
2
3
4
Ca/Al HYDRATES
PLAGIOCLASE
QUARTZ
ILLITE
ARAGONITE
CALCITE
CHLORITE
DOLOMITE
Phase 2a
Phase 3
Phase 2b
Phase 4



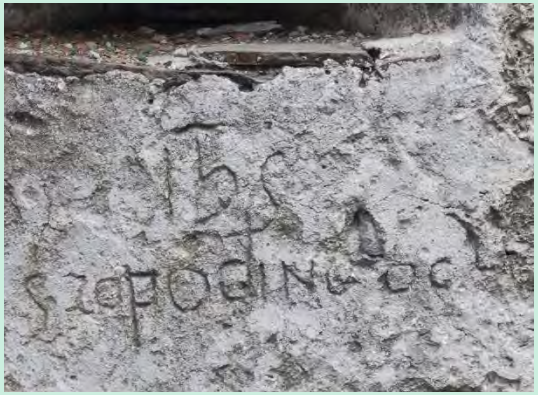
Pompeii special issue
Journal of Cultural Heritage 40 (2019) 265–273

Mineralogical clustering of the structural mortars from the Sarno Baths, Pompeii: A tool to interpret construction techniques and relative chronologies

Michele Secco[a,b,*], Caterina Previato[c], Anna Addis[d], Giulia Zago[b], Angelique Kamsteeg[a], Simone Dilaria[c], Caterina Canovaro[d], Gilberto Artioli[b,d], Jacopo Bonetto[c]



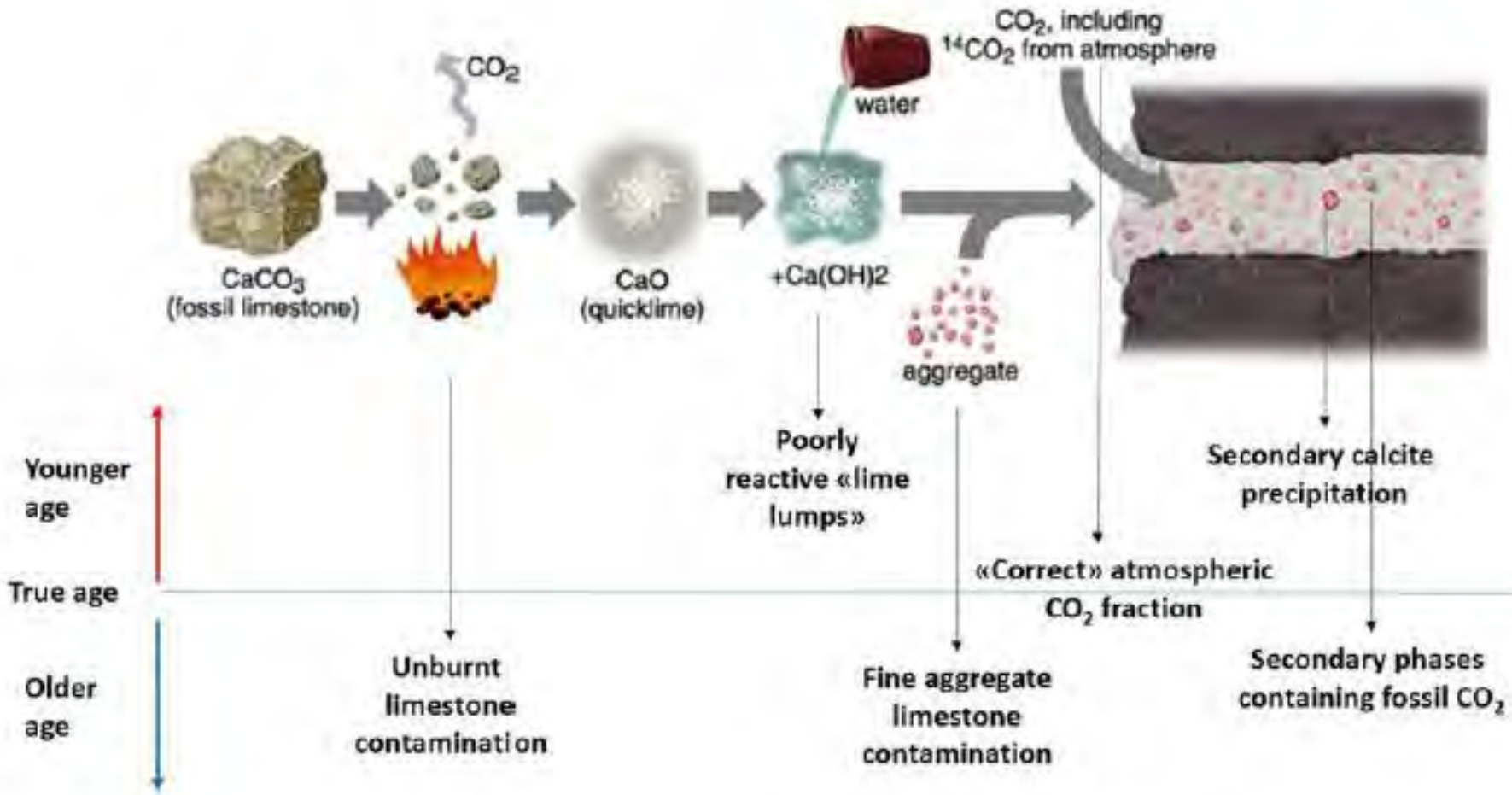
Datazione



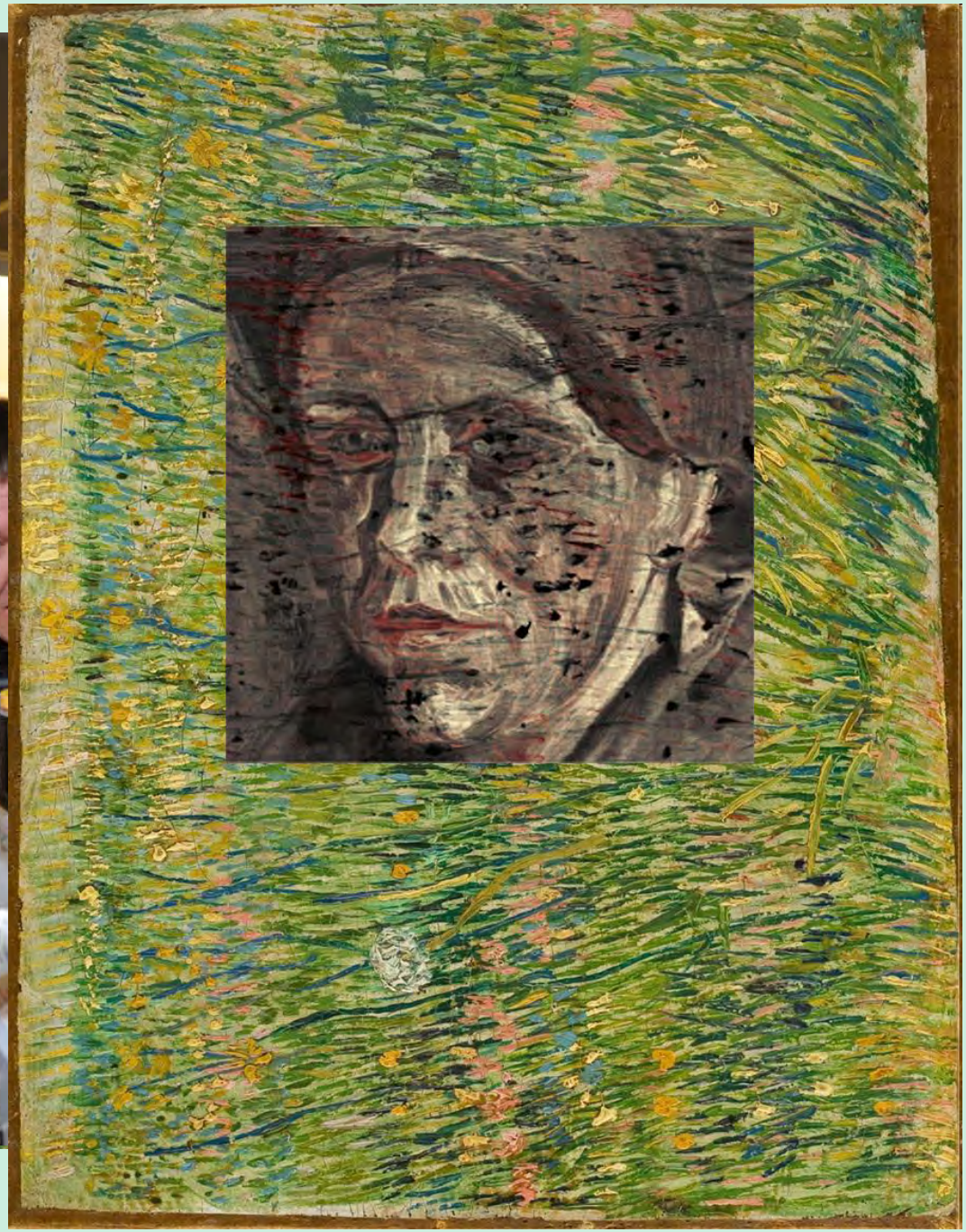
Radiocarbon, Vol 62, Nr 3, 2020, p 617–631 DOI:10.1017/RDC.2020.31
Selected Papers from the Mortar Dating International Meeting, Pessac, France, 25–27 Oct. 2018

THE CANNERO CASTLE (ITALY): DEVELOPMENT OF RADIOCARBON DATING METHODOLOGIES IN THE FRAMEWORK OF THE LAYERED DOUBLE HYDROXIDE MORTARS

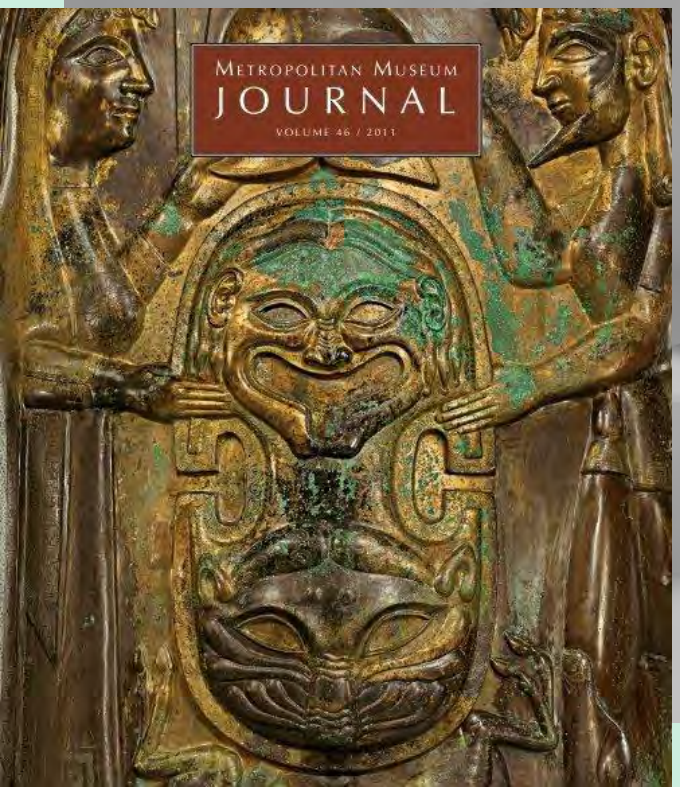
Giulia Ricci[1,2*] • Michele Secco[2,3] • Fabio Marzaioli[4] • Filippo Terrasi[4] • Isabella Passariello[4] • Anna Addis[5] • Paolo Lampugnani[6] • Gilberto Artioli[1,2]


CO_2
water
CO_2, including $^{14}CO_2$ from atmosphere
$CaCO_3$ (fossil limestone)
CaO (quicklime)
+Ca(OH)2
aggregate
Younger age
True age
Older age
Unburnt limestone contamination
Poorly reactive «lime lumps»
Fine aggregate limestone contamination
«Correct» atmospheric CO_2 fraction
Secondary calcite precipitation
Secondary phases containing fossil CO_2

Diagnosi opere d'arte



Autenticazione

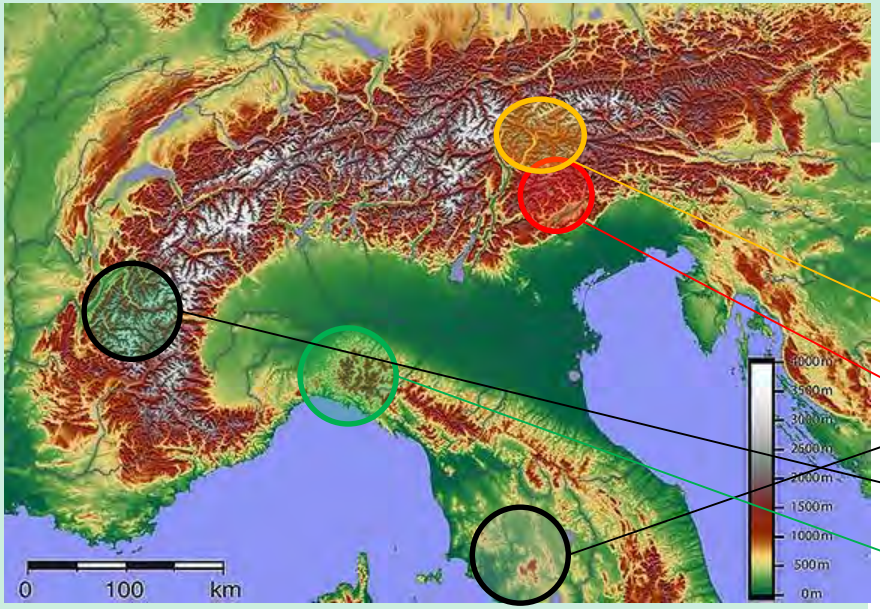

METROPOLITAN MUSEUM
JOURNAL
VOLUME 46 / 2011

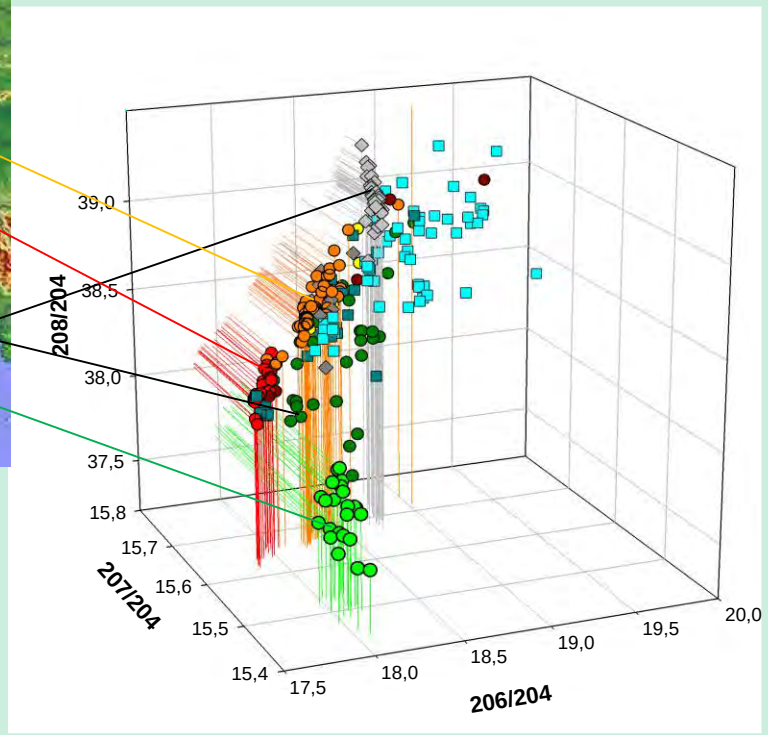






Provenienza





Archaeometry **62**, Suppl. 1 (2020) 53–85

LIA OF PREHISTORIC METALS IN THE CENTRAL MEDITERRANEAN AREA: A REVIEW*

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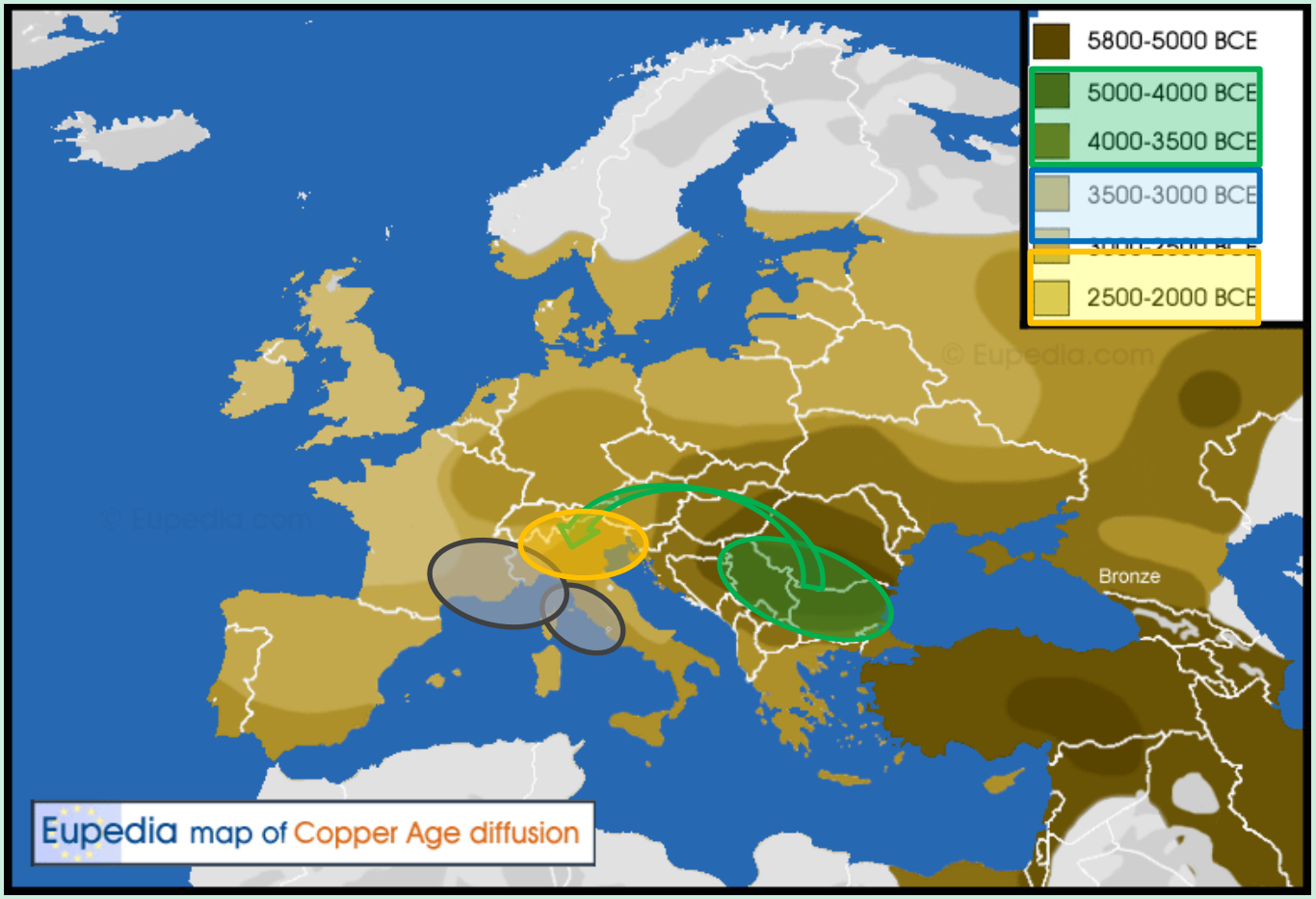
PLOS ONE

RESEARCH ARTICLE

Long-distance connections in the Copper Age: New evidence from the Alpine Iceman's copper axe

Gilberto Artioli[1,2]*, Ivana Angelini[2,3], Günther Kaufmann[4], Caterina Canovaro[1,2], Gregorio Dal Sasso[1], Igor Maria Villa[5,6]


5800-5000 BCE
5000-4000 BCE
4000-3500 BCE
3500-3000 BCE
2500-2000 BCE
© Eupedia.com
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Bronze
Eupedia map of Copper Age diffusion

Trasmissione culturale

Knucklebone
Astragalus
Tali

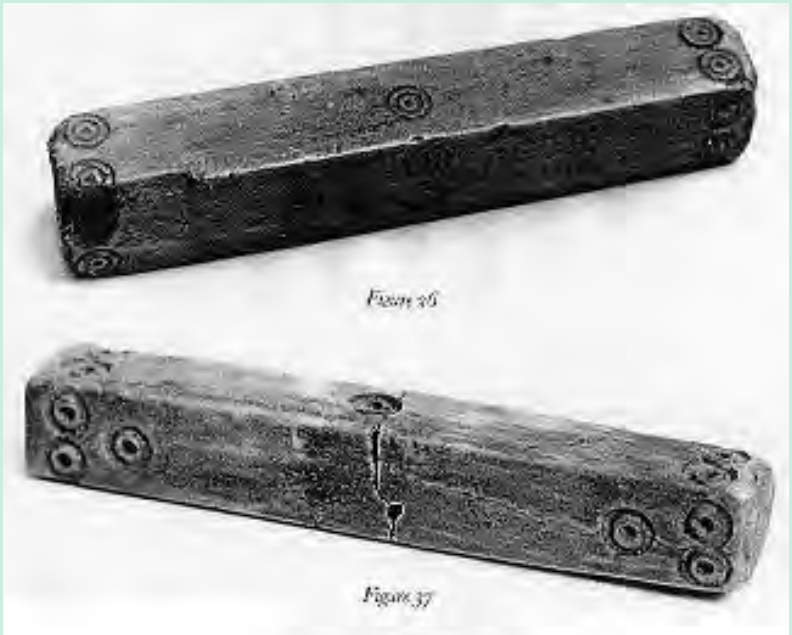
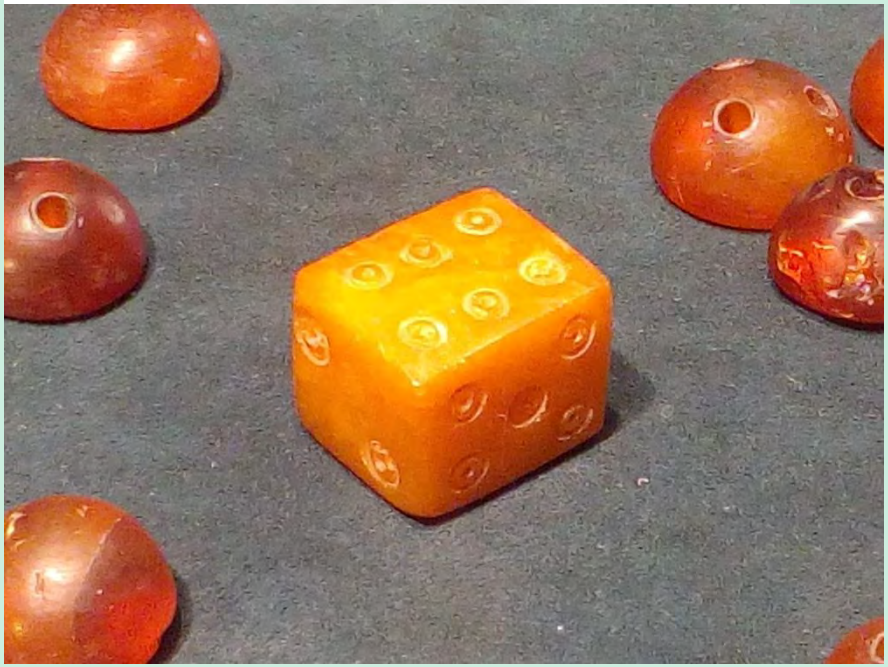


Figure 36

Figure 37



Archaeometry ••, •• (2011) ••–••

doi: 10.1111/j.1475-4754.2011.00596.x

GAMBLING WITH ETRUSCAN DICE: A TALE OF NUMBERS AND LETTERS*

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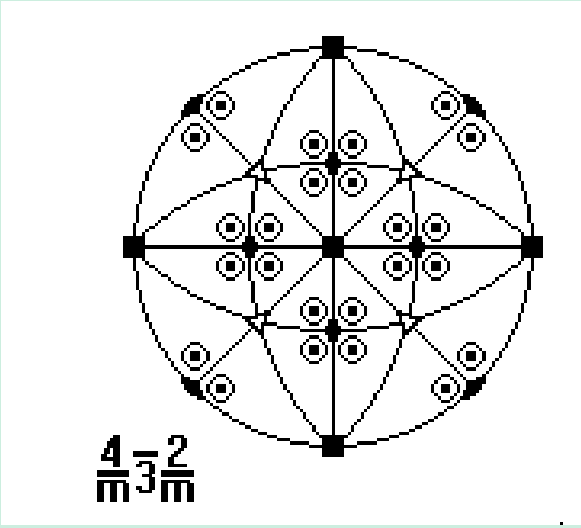
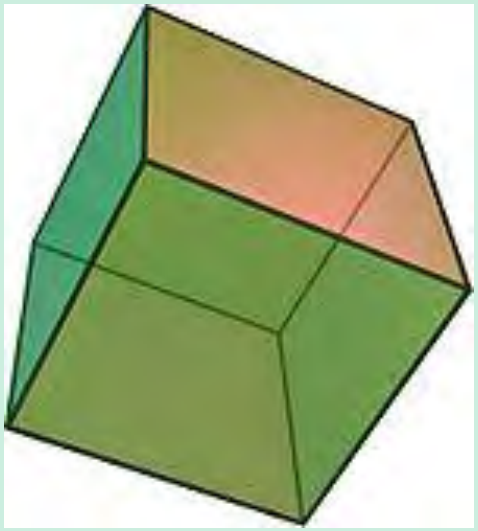
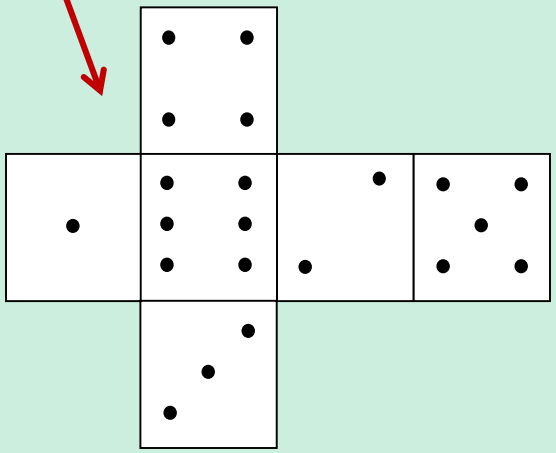
theory of **random permutations** tells us that 6 numbers can be distributed on the 6 faces of the cube in **6! permutations**, thus offering **720** independent combinations containing no repetitions

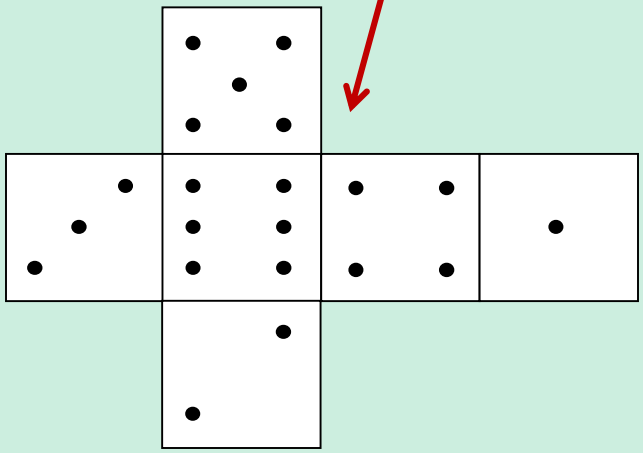




$$6!/48 = 720/48 = 15$$

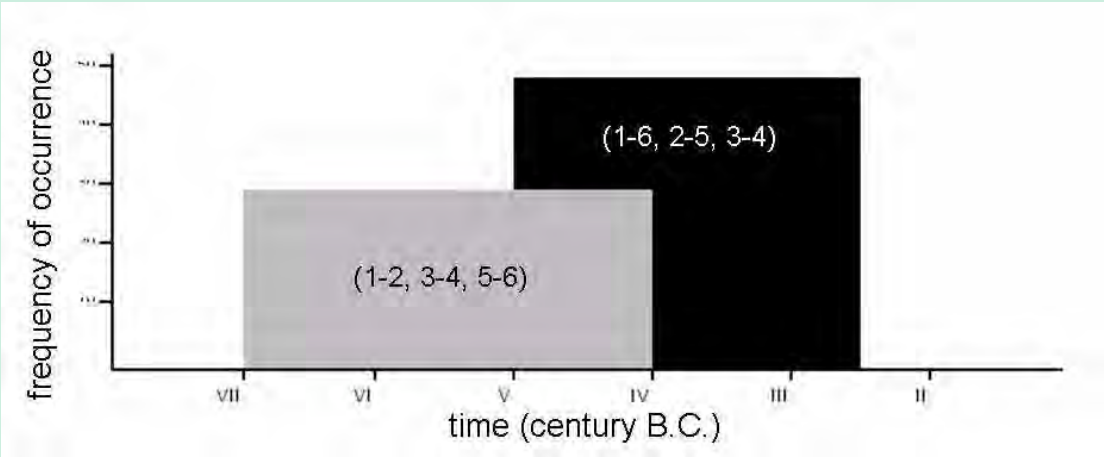
(1-2, 3-4, 5-6)	(1-3, 2-4, 5-6)	(1-4, 2-3, 5-6)	(1-5, 2-3, 4-6)	(1-6, 2-3, 4-5)
(1-2, 3-5, 4-6)	(1-3, 2-5, 4-6)	(1-4, 2-5, 3-6)	(1-5, 2-4, 3-6)	(1-6, 2-4, 3-5)
(1-2, 3-6, 4-5)	(1-3, 2-6, 4-5)	(1-4, 2-6, 3-5)	(1-5, 2-6, 3-4)	(1-6, 2-5, 3-4)





Difference = 1

Sum = 7



Production bias in cultural evolution: An examination of cubic dice variation in experimental and archaeological contexts

Alex de Voogt [a,*], Jelmer W. Eerkens [b], Rachel Sherman-Presser [a]

Journal of Anthropological Archaeology 40 (2015) 151–159

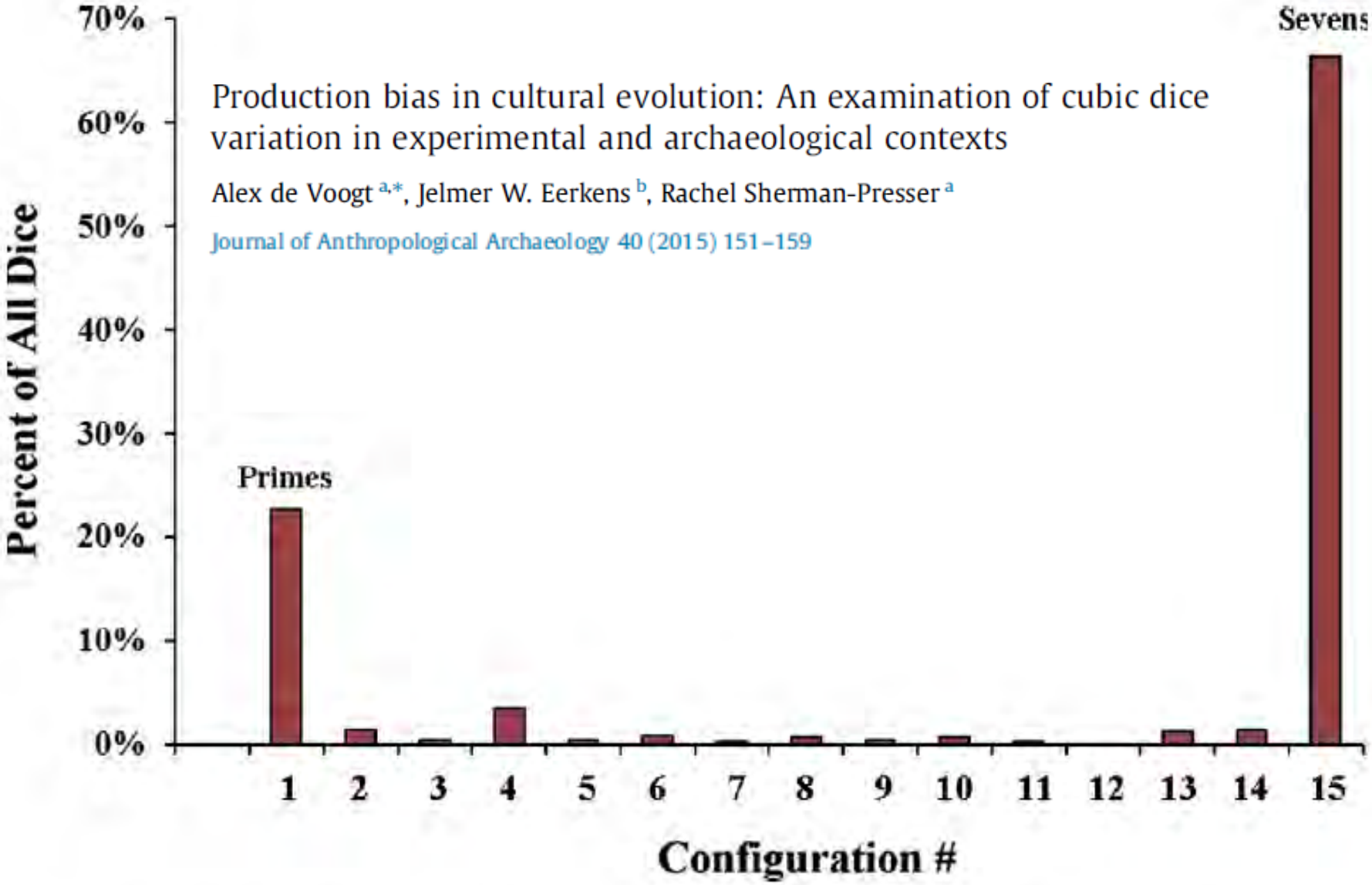


Fig. 2. Distribution of die configurations in a sample of ancient dice.

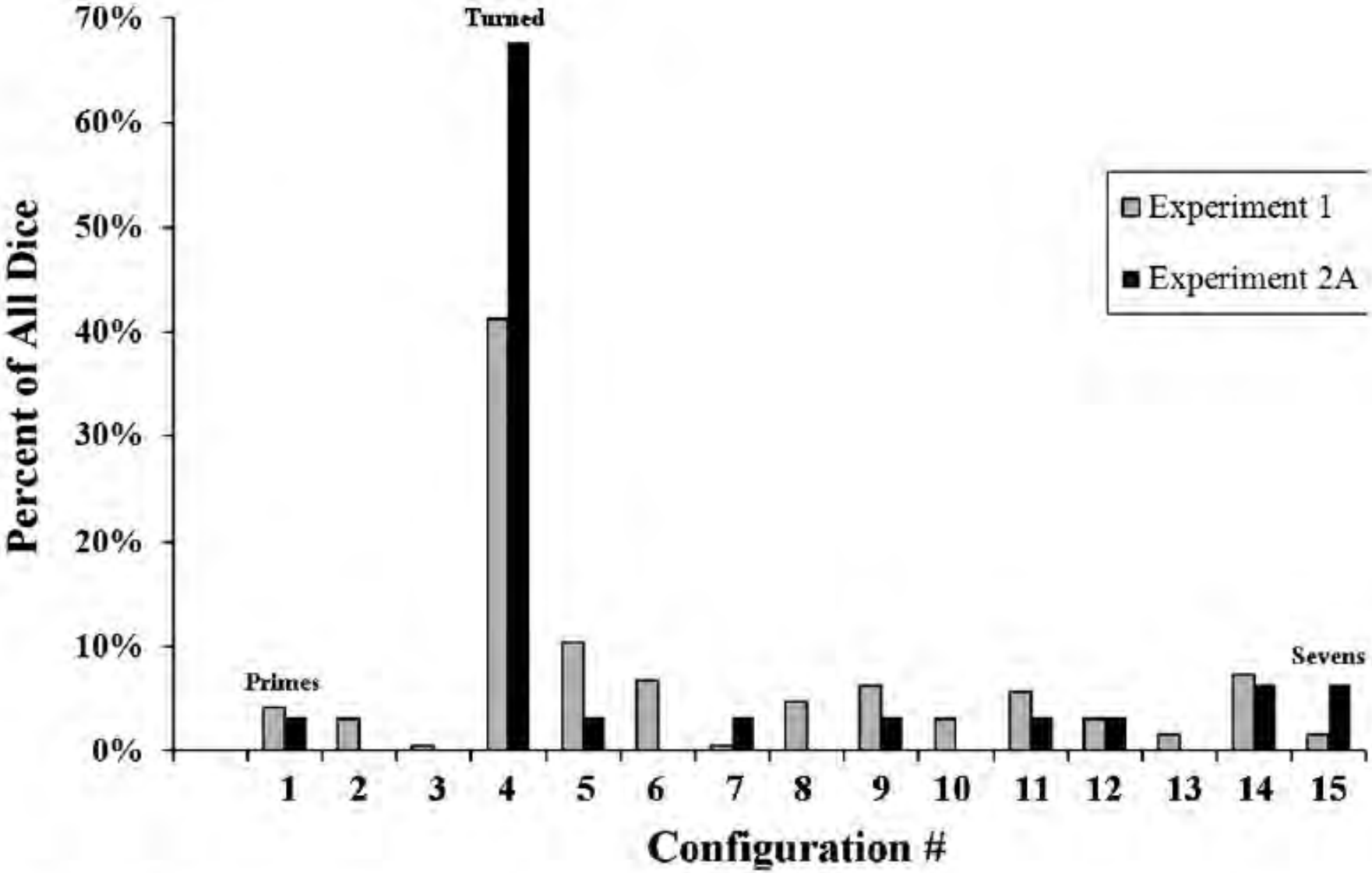


Fig. 4. Results of Experiments 1 and 2A, showing dominance of the "Turned" configuration.

Etruscan numerals

From Wikipedia, the free encyclopedia

The **Etruscan numerals** were used by the ancient Etruscans. The system was adapted from the Greek Attic numerals and formed the inspiration for the later Roman numerals.

Etruscan	Decimal	Symbol *
θu	1	I
maχ	5	Λ
śar	10	X
muvalχ	50	↑
?	100	Ж or C

There is very little surviving evidence of these numerals. Examples are known of the symbols for larger numbers, but it is unknown which symbol represents which number.

Thanks to the numbers written out on the Tuscania dice, there is agreement about the fact that **zal**, **ci**, **huθ** and **śa** are the numbers up to 6 (besides 1 and 5). The assignment depends on the answer to the question whether the numbers on opposite faces on Etruscan dice add up to seven, like nowadays. Some dice found do not show this proposed pattern.

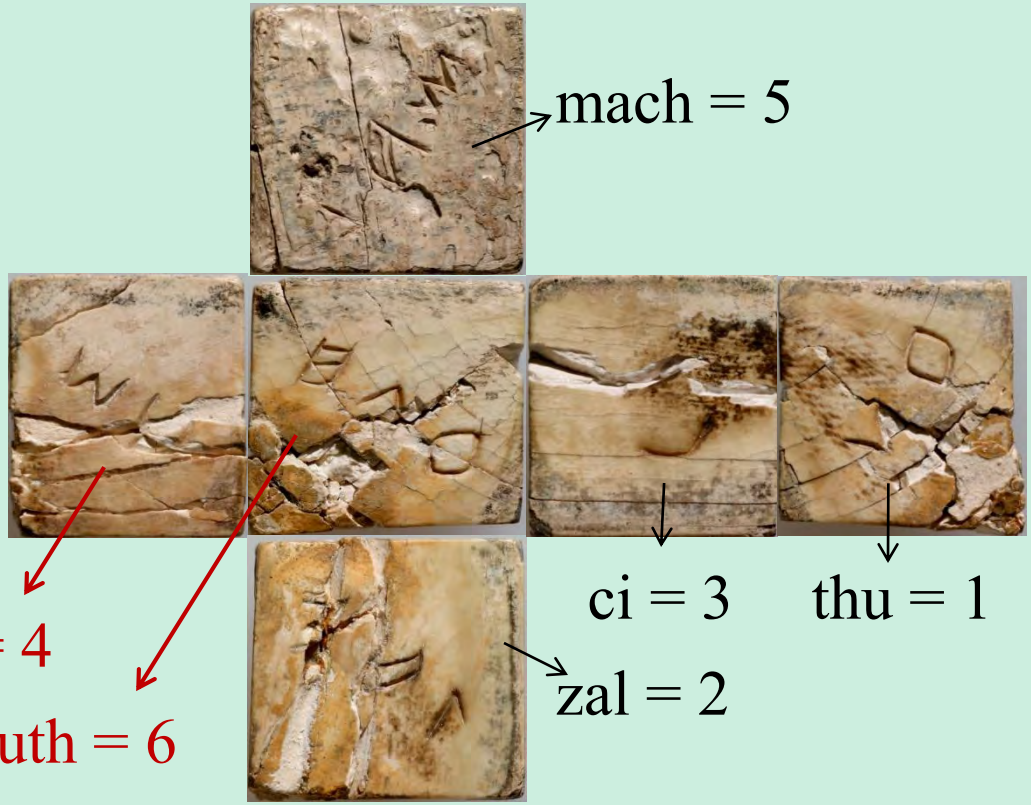
The general consensus

[edit]

Despite the continuing debate specifically about which of huθ and śa are "four" and "six", the general agreement among Etruscologists nowadays is the following:

Etruscan	Decimal
θu	1
zal	2
ci	3
huθ	4
maχ	5
śa	6

Year	Author	Numerical assignment					
		1	2	3	4	5	6
1968	Olzscha	*thu*	*zal*	*ci*	*huth*	*mach*	*sa*
1969	Pfiffig	*thu*	*zal*	*ci*	*sa*	*mach*	*huth*
1973	Cristofani	*thu*	*zal*	*ci*	*huth (sa?)*	*mach*	*sa (huth?)*
1976	Savelli	*thu*	*huth*	*zal*	*mach*	*Ci*	*sa*
1983	Bonfante	*thu*	*zal*	*ci*	*sa*	*mach*	*huth*
1984	Pallottino	*thu*	*zal*	*ci*	*huth (sa?)*	*mach*	*sa (huth?)*
1989	Rix	*thu*	*zal*	*ci*	*huth*	*mach*	*sa*
1990	Pittau	*thu*	*zal*	*ci*	*huth*	*mach*	*sa*
1991	Morandi	*thu*	*zal*	*ci*	*huth*	*mach*	*sa*
1995	Agostiniani	*thu*	*zal*	*ci*	*sa*	*mach*	*huth*

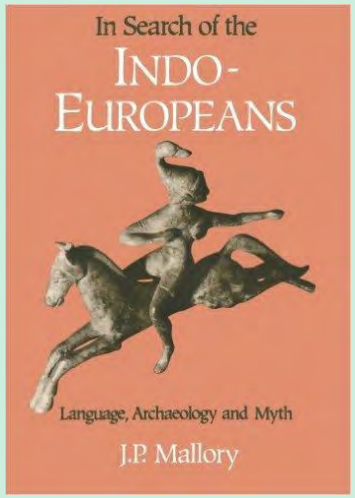


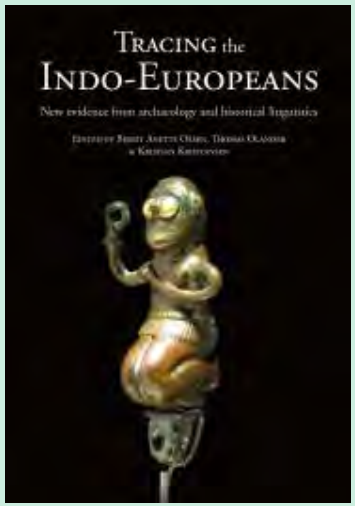
https://en.wikipedia.org/wiki/Etruscan_numerals

…. in this connection, in October 2011, Artioli and colleagues presented evidence from 93 Etruscan dice "**allowing the firm attribution of the numeral 6 to the graphical value huth and 4 to sa**".

Much debate has been carried out about a possible Indo-European origin of the Etruscan cardinals. In the words of Larissa Bonfante (1990), "**What these numerals show, beyond any shadow of a doubt, is the non-Indo-European nature of the Etruscan language**".[4]

The Yamnaya and the Indo-European language family





Garcia-Ruiz, Juan Manuel.
"2001: The Crystal Monolith." Substantia 2.2 (2018): 19-25.

… crystals were the earliest catalysts of the abstract thinking, symbolism, and consciousness