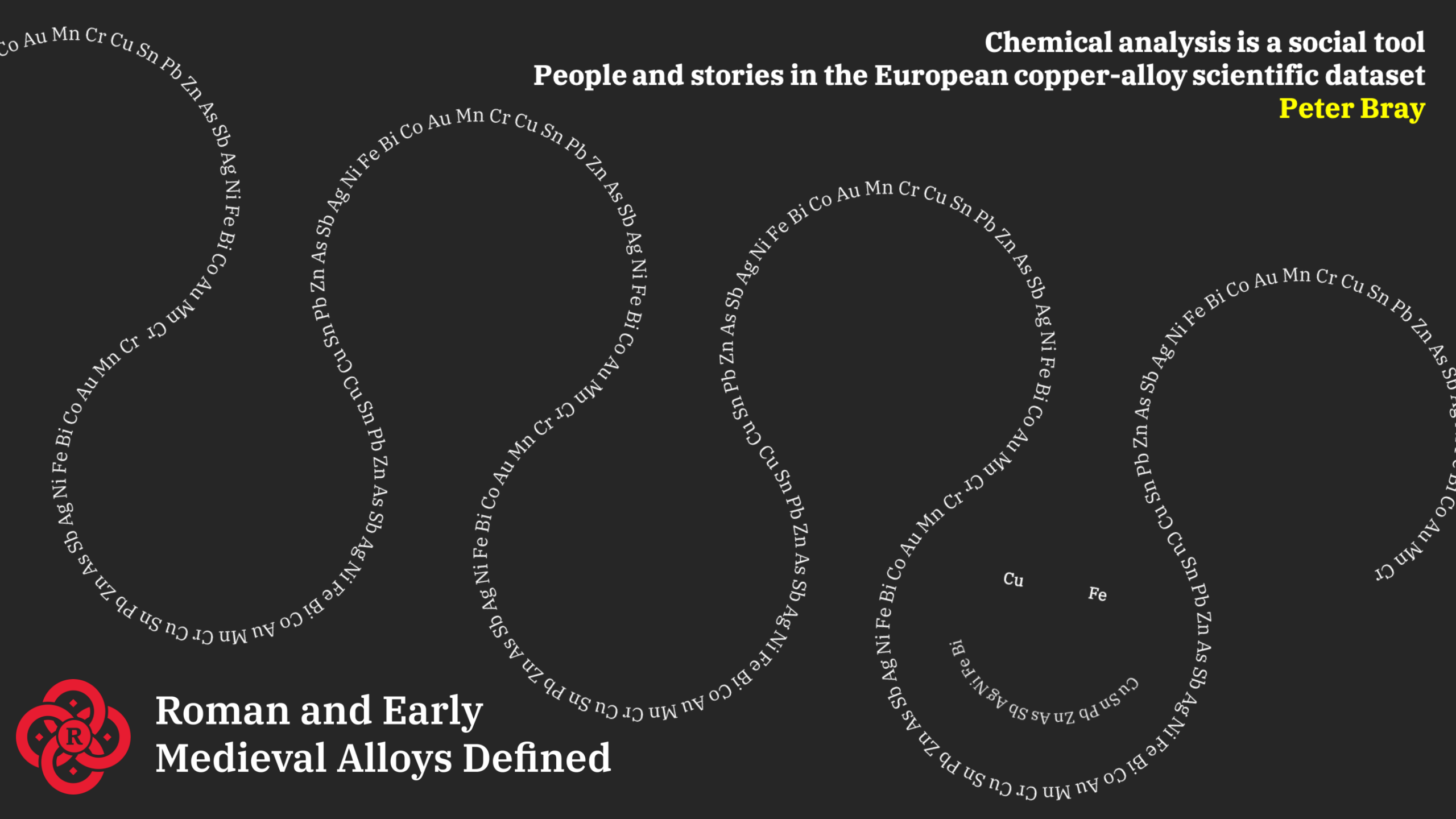
Chemical analysis is a social tool
People and stories in the European copper-alloy scientific dataset

Peter Bray



Roman and Early Medieval Alloys Defined

Why chemically analyse copper-alloy artefacts?

Why chemically analyse *thousands* of copper-alloy artefacts?

What information is in these datasets?

What is required to extract that information?

Why REMADE?


Chemical analysis of copper is a
(very powerful) tool for
understanding society

THE OHIO JOURNAL OF SCIENCE

VOL. XLVIII JANUARY, 1948 No. 1

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EARLE R. CALEY
Department of Chemistry
The Ohio State University

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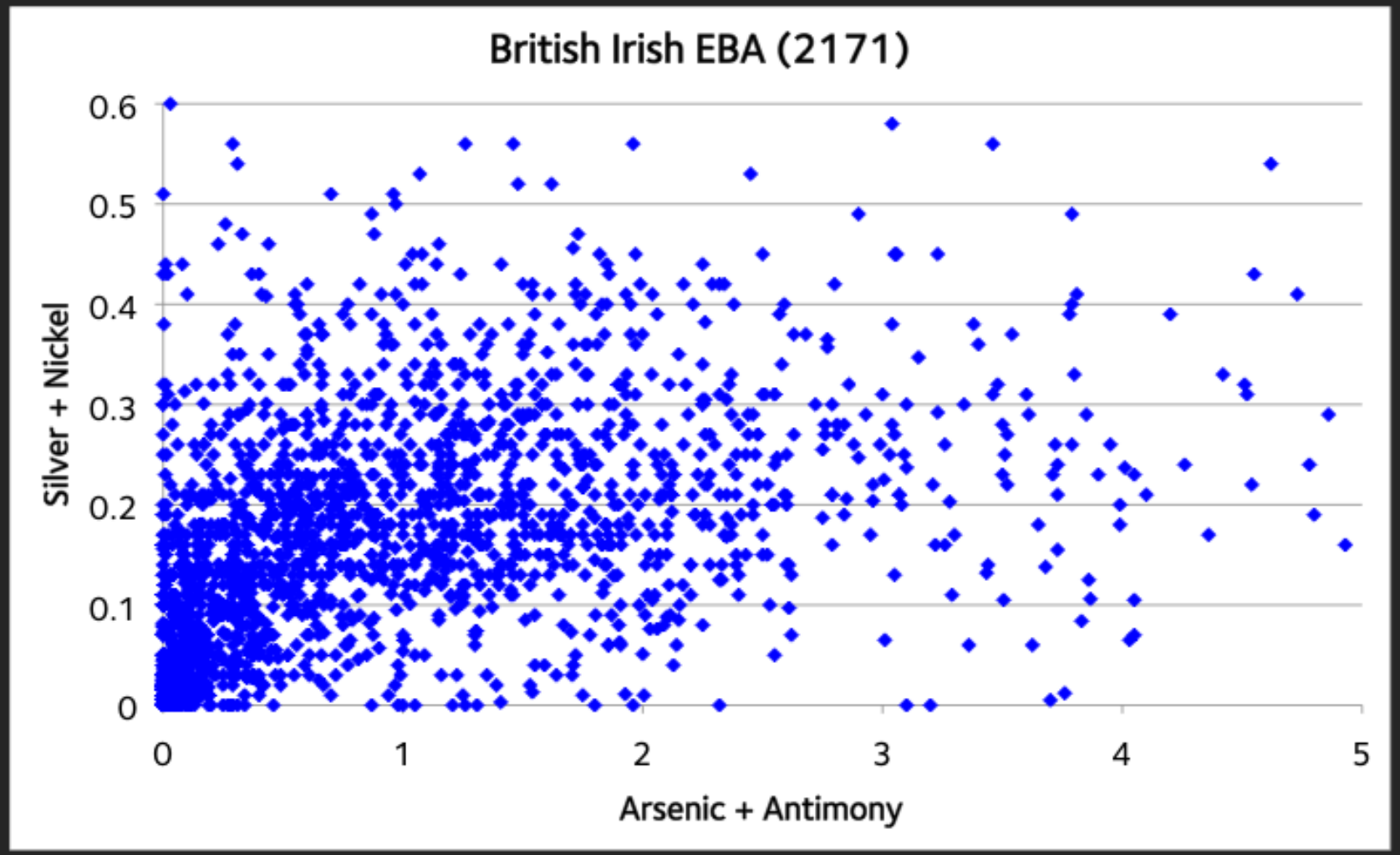
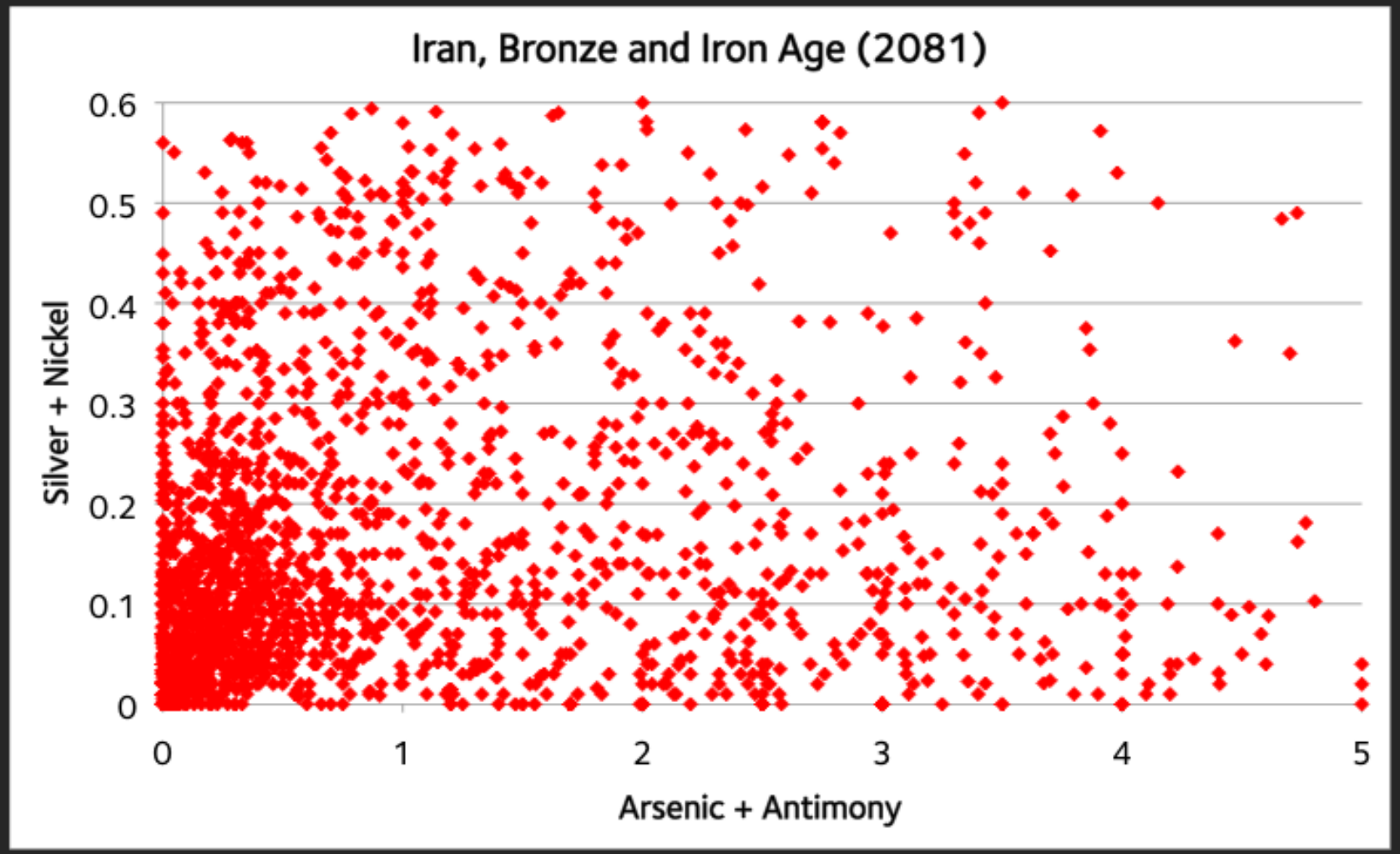
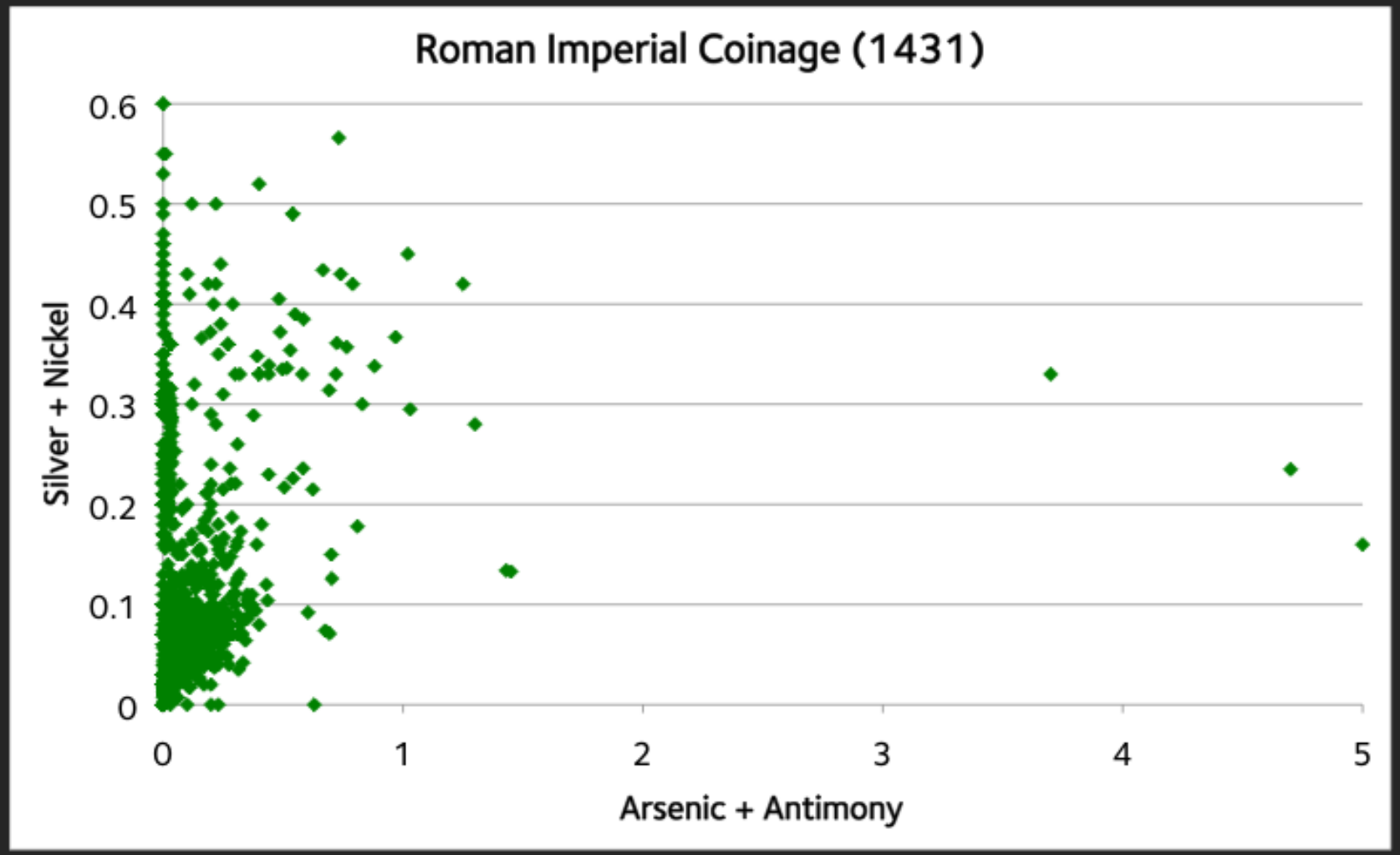
Central to this work is the concept of scientific analysis as a dependable fixed point. The impersonal linking of geology to object within the 'Provenance Hypothesis'.

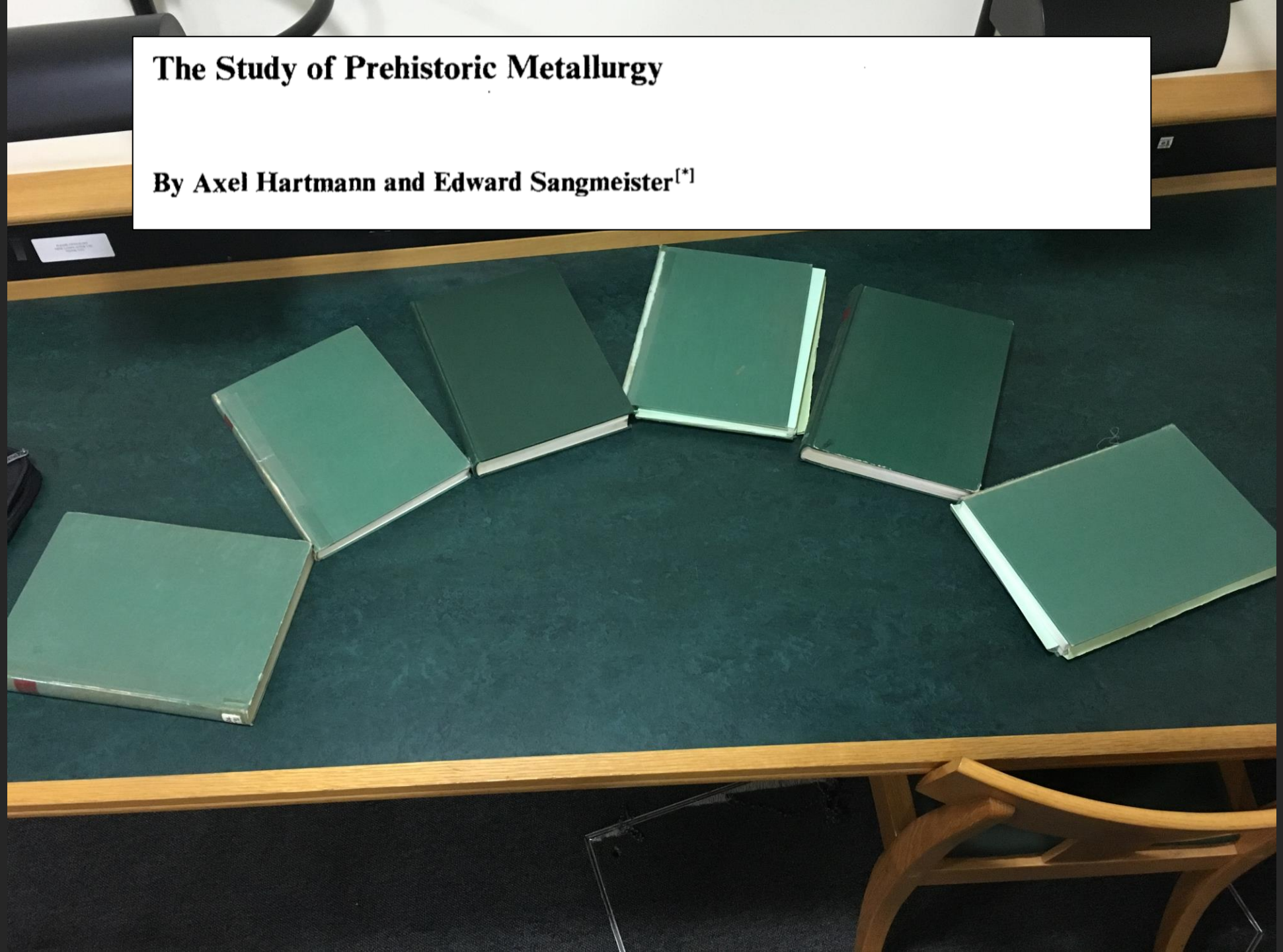

British Irish EBA (2171)
Silver + Nickel
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
Arsenic + Antimony

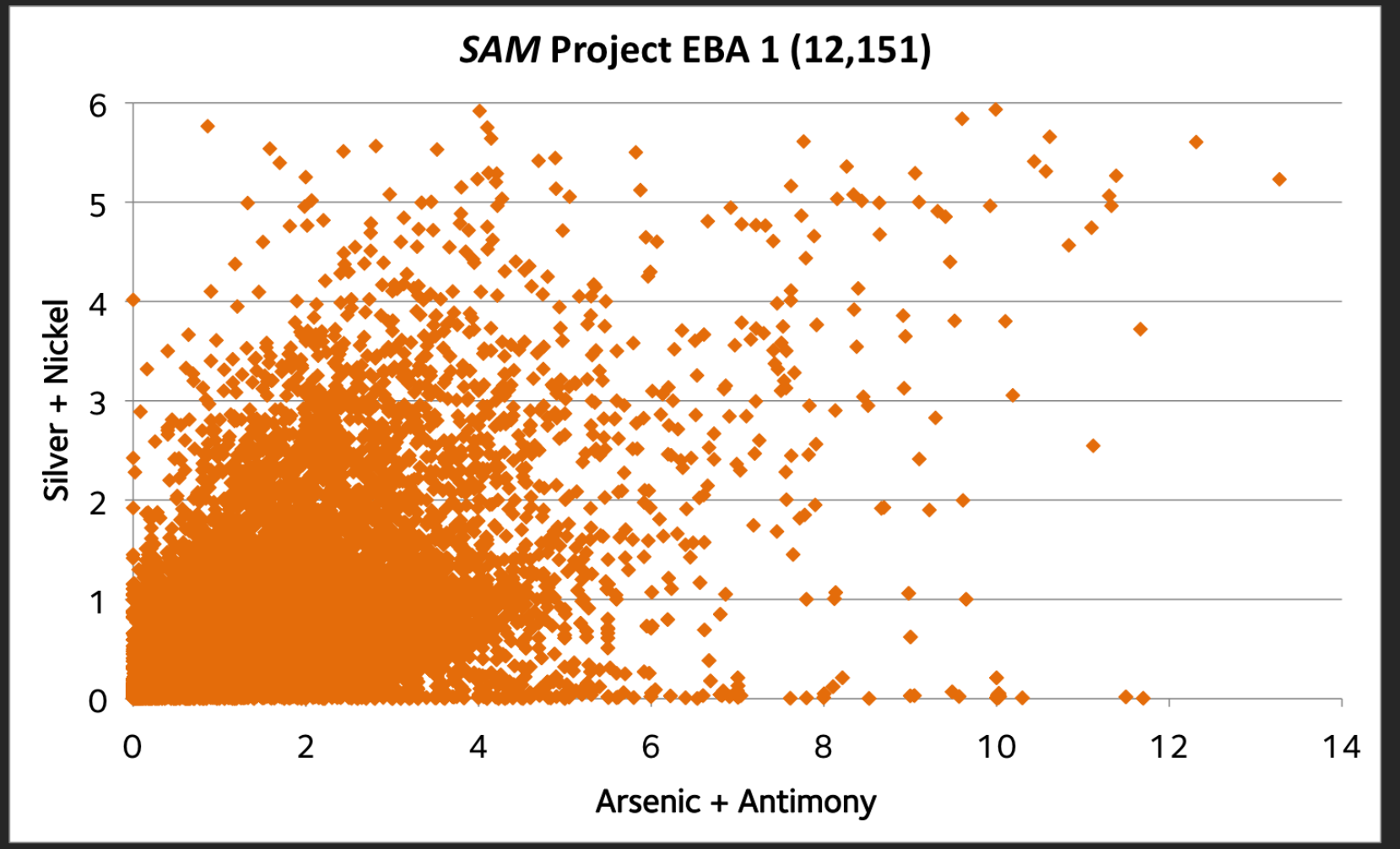

Iran, Bronze and Iron Age (2081)
Silver + Nickel
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
Arsenic + Antimony


Roman Imperial Coinage (1431)
Silver + Nickel
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
Arsenic + Antimony

The Study of Prehistoric Metallurgy

By Axel Hartmann and Edward Sangmeister[*]




SAM Project EBA 1 (12,151)
Silver + Nickel
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14
Arsenic + Antimony

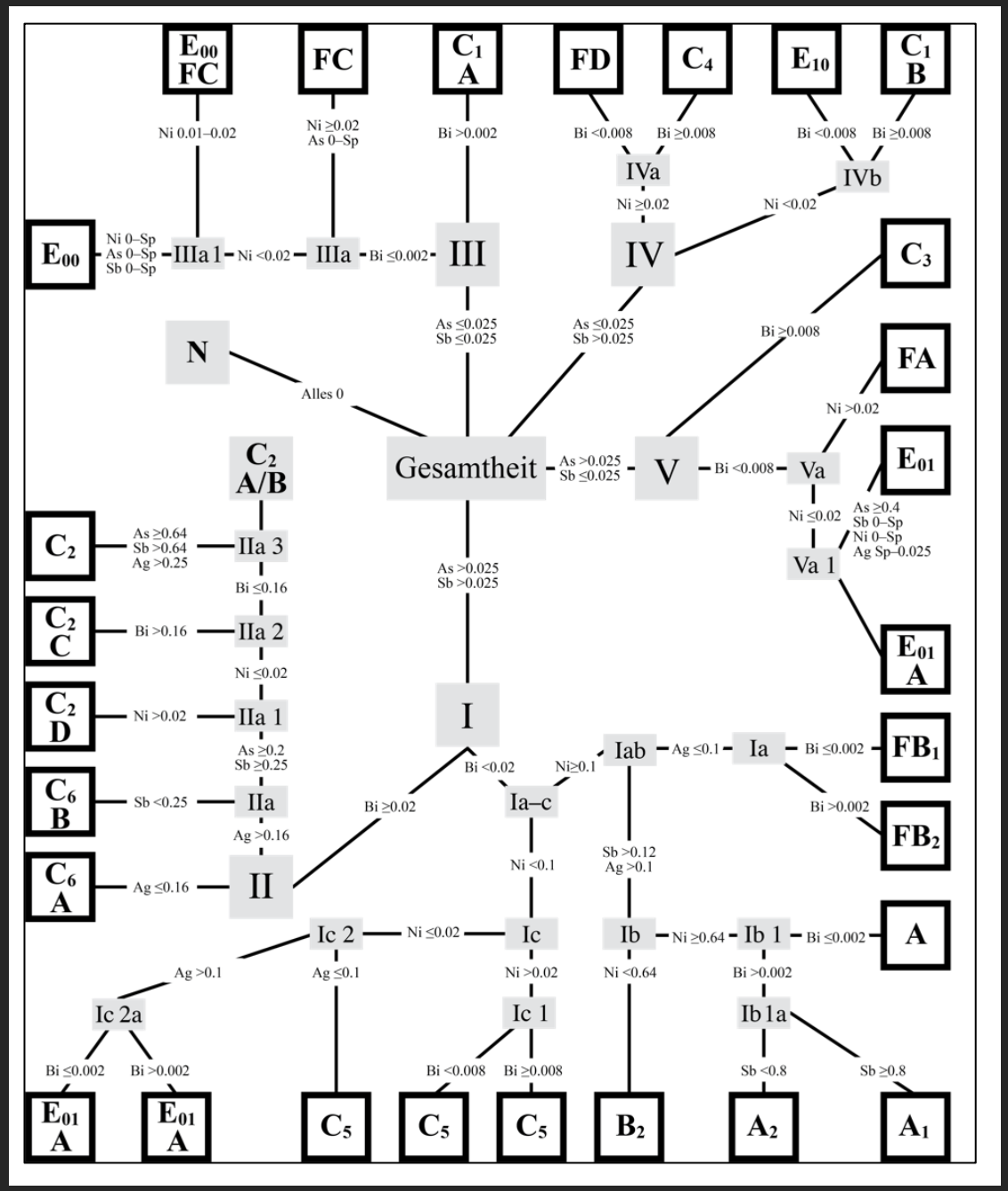
THE JOURNAL OF GEOLOGY

January 1960

THE SKEW FREQUENCY DISTRIBUTIONS AND THE FUNDAMENTAL LAW OF THE GEOCHEMICAL PROCESSES[1]

ANDREW B. VISTELIUS
Laboratory of Aeromethods, Academy of Sciences U.S.S.R., Leningrad

ABSTRACT



Under this mathematical model (and those that it continues to inspire), the aim is to find the best *matching* criteria between source and object.

Here, an individual analysis is useful, as this approach emphasizes seeking a series of matches to an underlying geological signal

The working of copper-arsenic alloys in the Early Bronze Age and the effect on the determination of provenance

HUGH MCKERRELL
National Museum of Antiquities of Scotland
R. F. TYLECOTE
University of Newcastle-upon-Tyne

Proceedings of the Prehistoric Society (1972)

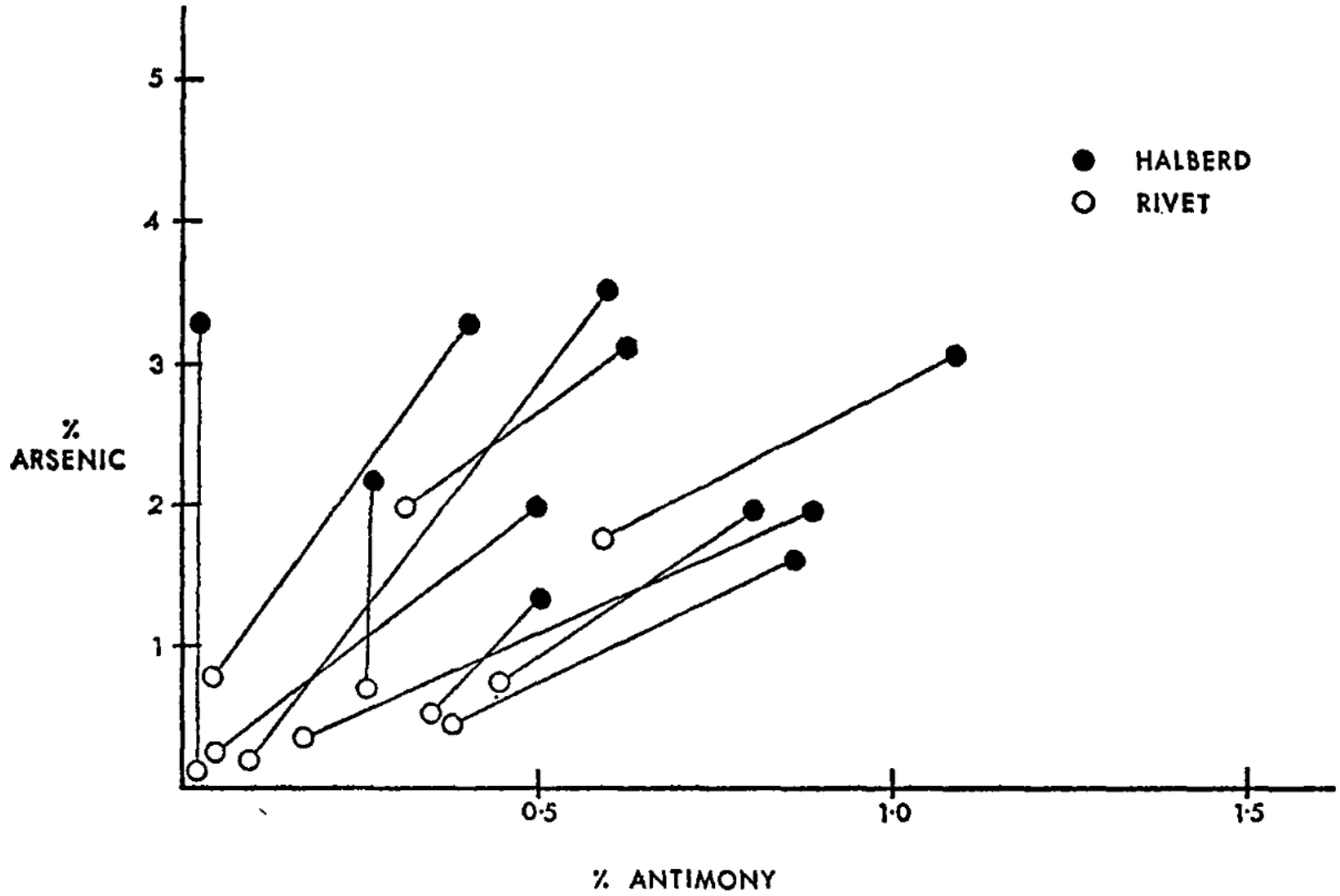


Fig. 2

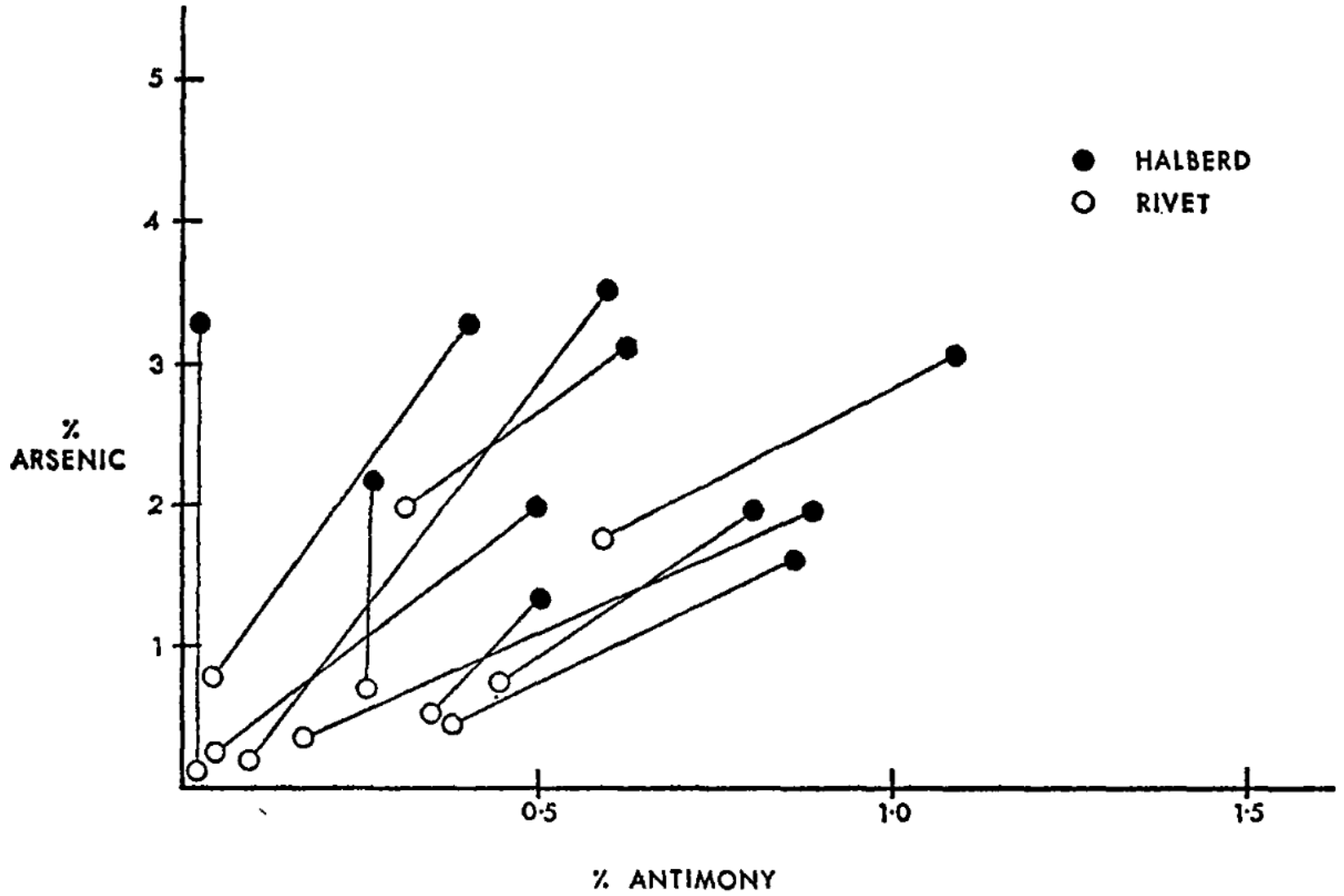


Fig. 2

caution in use of rigid analytical levels as an indication of provenance seems desirable.

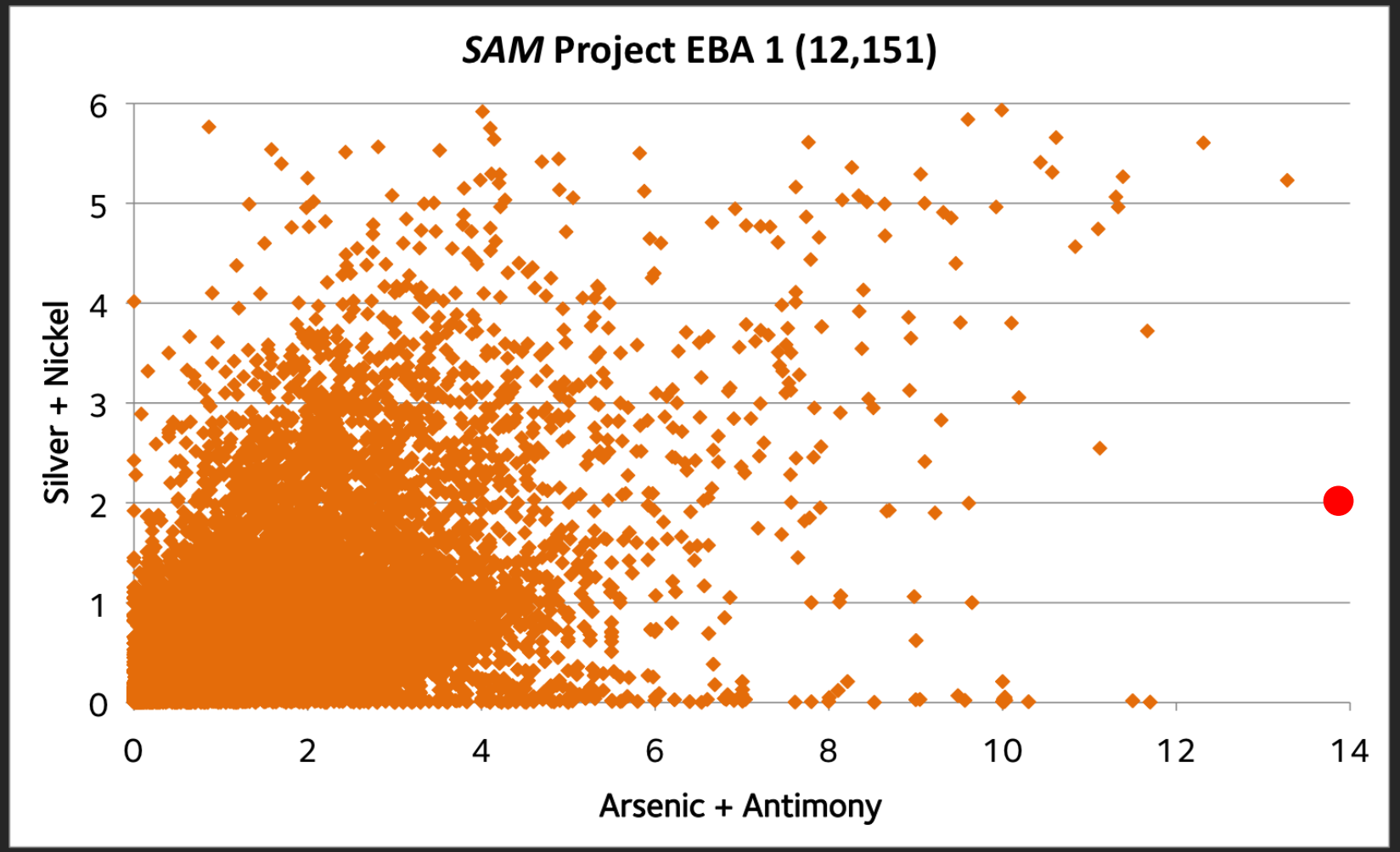
archaeometry

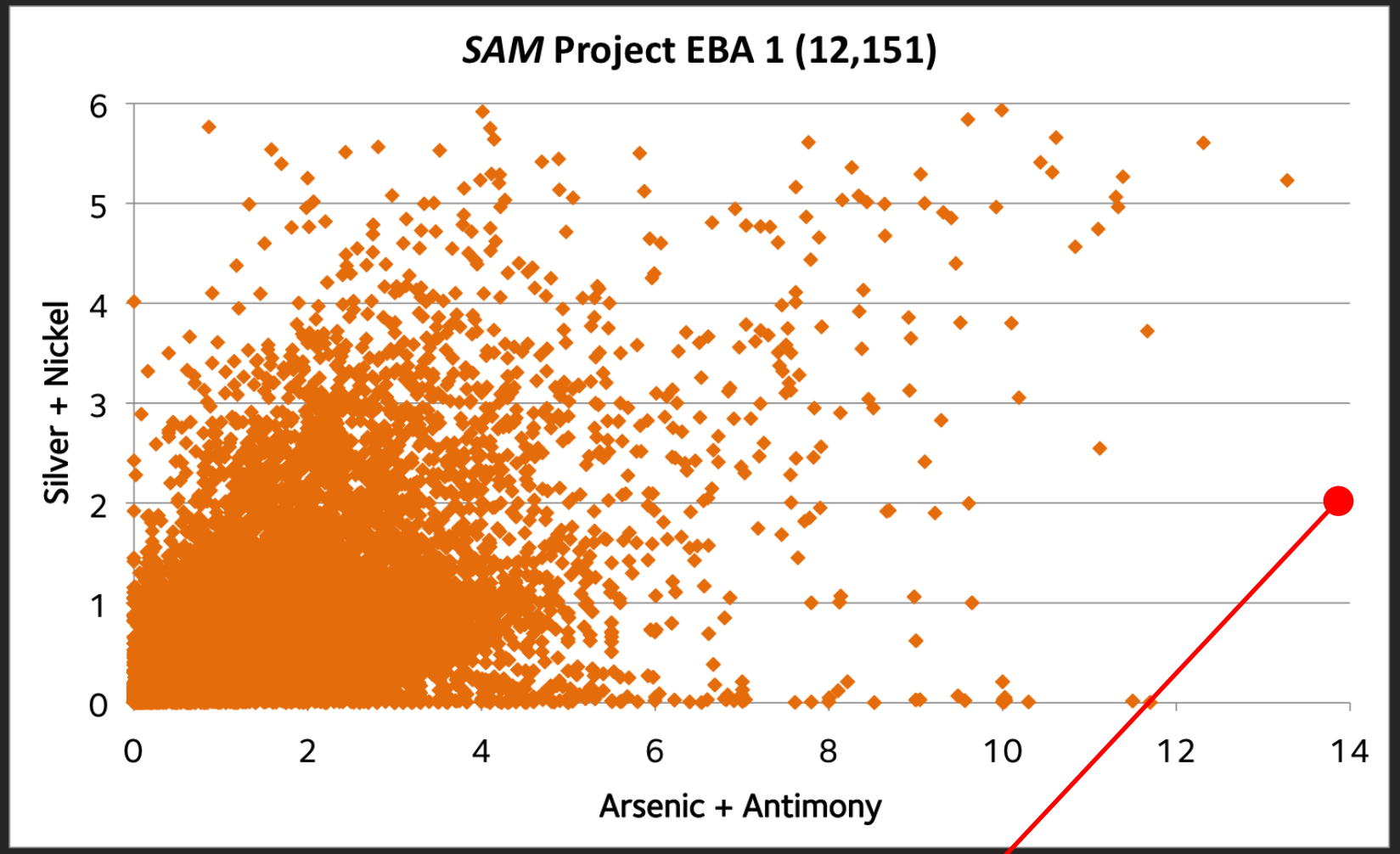
Archaeometry **55**, 5 (2013) 923–945 doi: 10.1111/j.1475-4754.2012.00709.x

MINERALOGICAL AND PETROLOGICAL INVESTIGATIONS OF EARLY BRONZE AGE COPPER-SMELTING REMAINS FROM THE KIECHLBERG (TYROL, AUSTRIA)*

M. KRISMER,[1]† U. TÖCHTERLE,[2] G. GOLDENBERG,[2] P. TROPPER[1] and F. VAVTAR[1]

[1]*Institute of Mineralogy and Petrography, University of Innsbruck, Innrain 52, A-6020 Innsbruck, Austria*
[2]*Institute of Archaeology, University of Innsbruck, Langer Weg 11, A-6020 Innsbruck, Austria*


SAM Project EBA 1 (12,151)
Silver + Nickel
Arsenic + Antimony
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14


SAM Project EBA 1 (12,151)
Silver + Nickel
Arsenic + Antimony
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14
Kiechlberg bulk raw copper

THE JOURNAL OF GEOLOGY

January 1960

THE SKEW FREQUENCY DISTRIBUTIONS AND THE FUNDAMENTAL LAW OF THE GEOCHEMICAL PROCESSES[1]

ANDREW B. VISTELIUS
Laboratory of Aeromethods, Academy of Sciences U.S.S.R., Leningrad

ABSTRACT

Normal and lognormal data distribution in geochemistry: death of a myth. Consequences for the statistical treatment of geochemical and environmental data

C. Reimann · P. Filzmoser

Normal and lognormal data distribution in geochemistry: death of a myth. Consequences for the statistical treatment of geochemical and environmental data

C. Reimann · P. Filzmoser

On the other hand graphical, exploratory data analysis is sometimes even defamed as “simple”. This may be a reason why this powerful tool is rarely used.

RECONSTRUCTION OF BRONZE AGE COPPER SMELTING,

EXPERIMENTS BASED ON ARCHAEOLOGICAL EVIDENCE

FROM TIMNA, ISRAEL

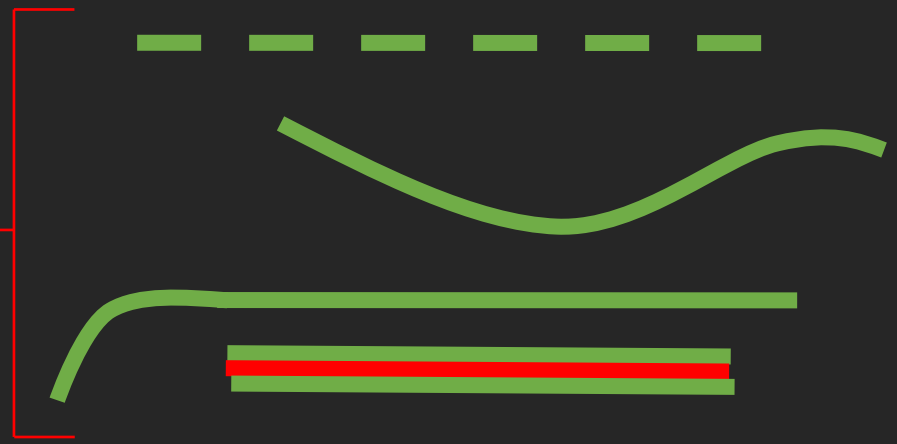
BY

JOHN FREDERICK MERKEL

The fire-refined copper was 99.7% pure. McKerrell and Tylecote (1972) had already shown that concentrations of As and Sb are affected by metalworking. Using the chemical analysis for comparison, the Ag and Sn are "concentrated" in the refined copper. Again, such increases may lead to further confusion in comparing trace element patterns.

Prime metal

Which then undergoes [some or no] processes,
A palimpsest



Not ‘confusion’, but instead a wonderful opportunity

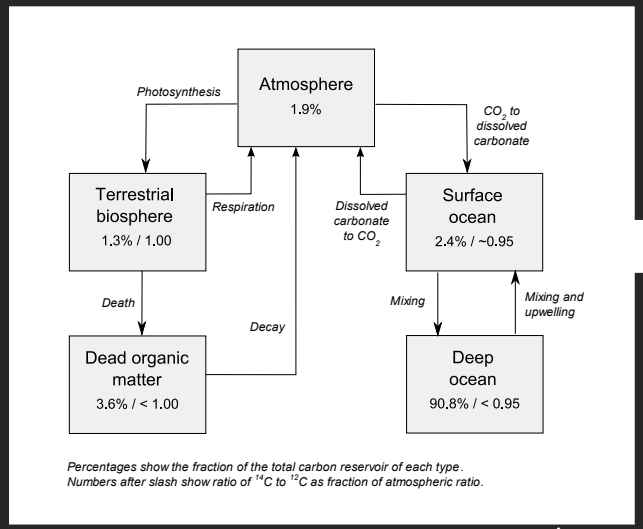
What we need is:
Relative Chemistry not Absolute Chemistry

The extraction, processing, use, reuse, mixing and manipulation of copper-alloy imprints itself in the datasets

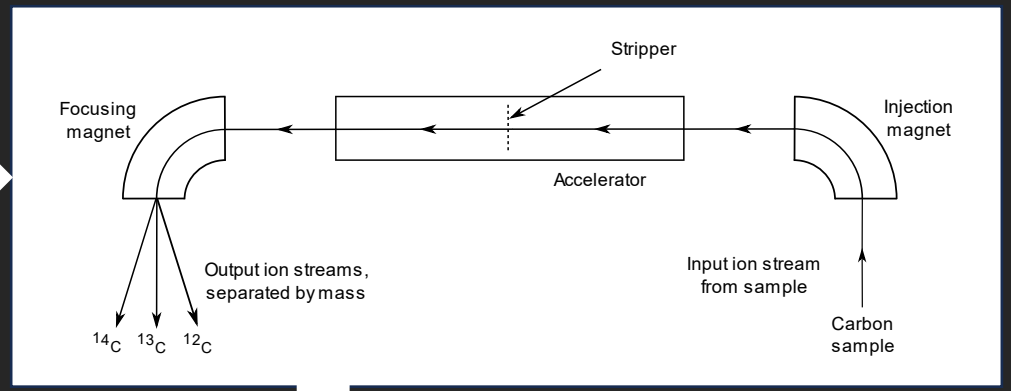
Any combination and level of elements requires context and process to explain it.

(think calibration and then Bayesian modelling of radiocarbon dates)

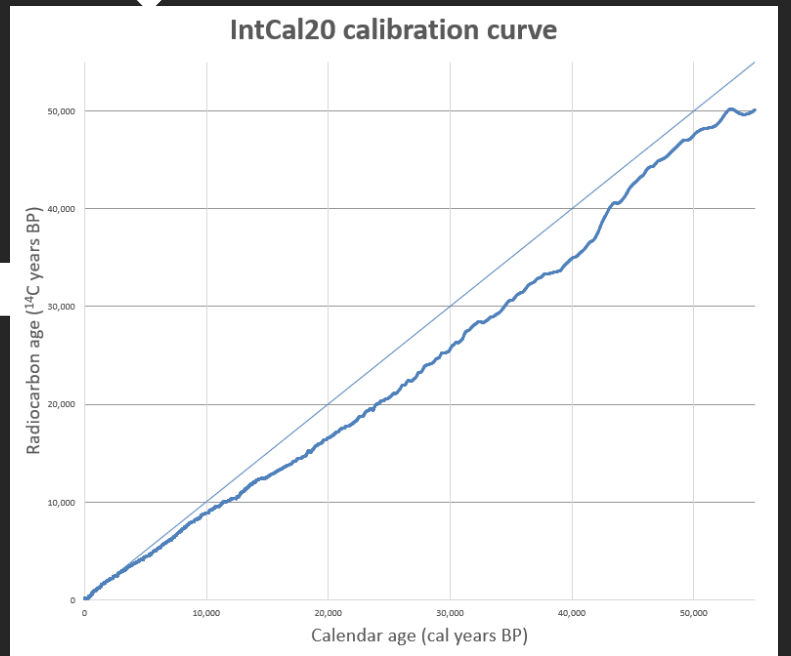
Understanding variety in the system



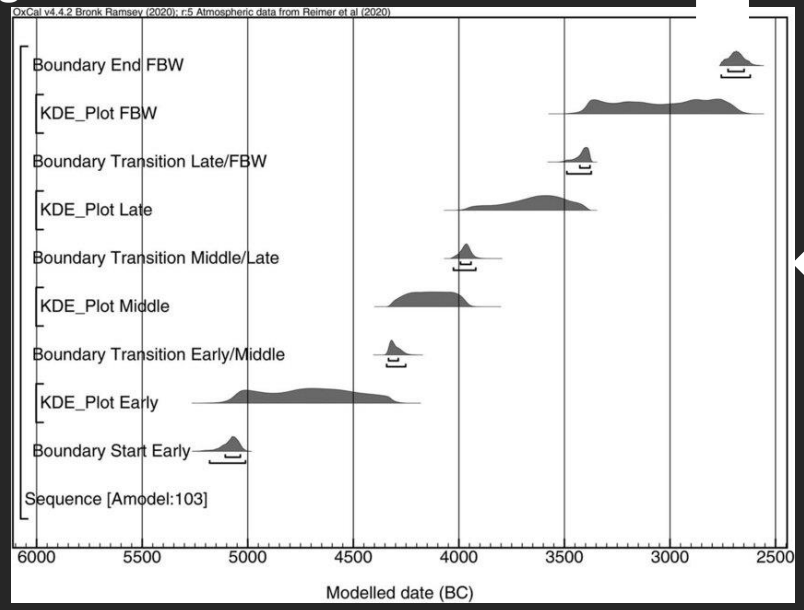
Individual radiocarbon measurement



Date Calibration



Bayesian model of an assemblage of dates



What we also need is a huge amount of data and collaboration as we want to see the shape, character, processes, people, choices, time, and connections in the data

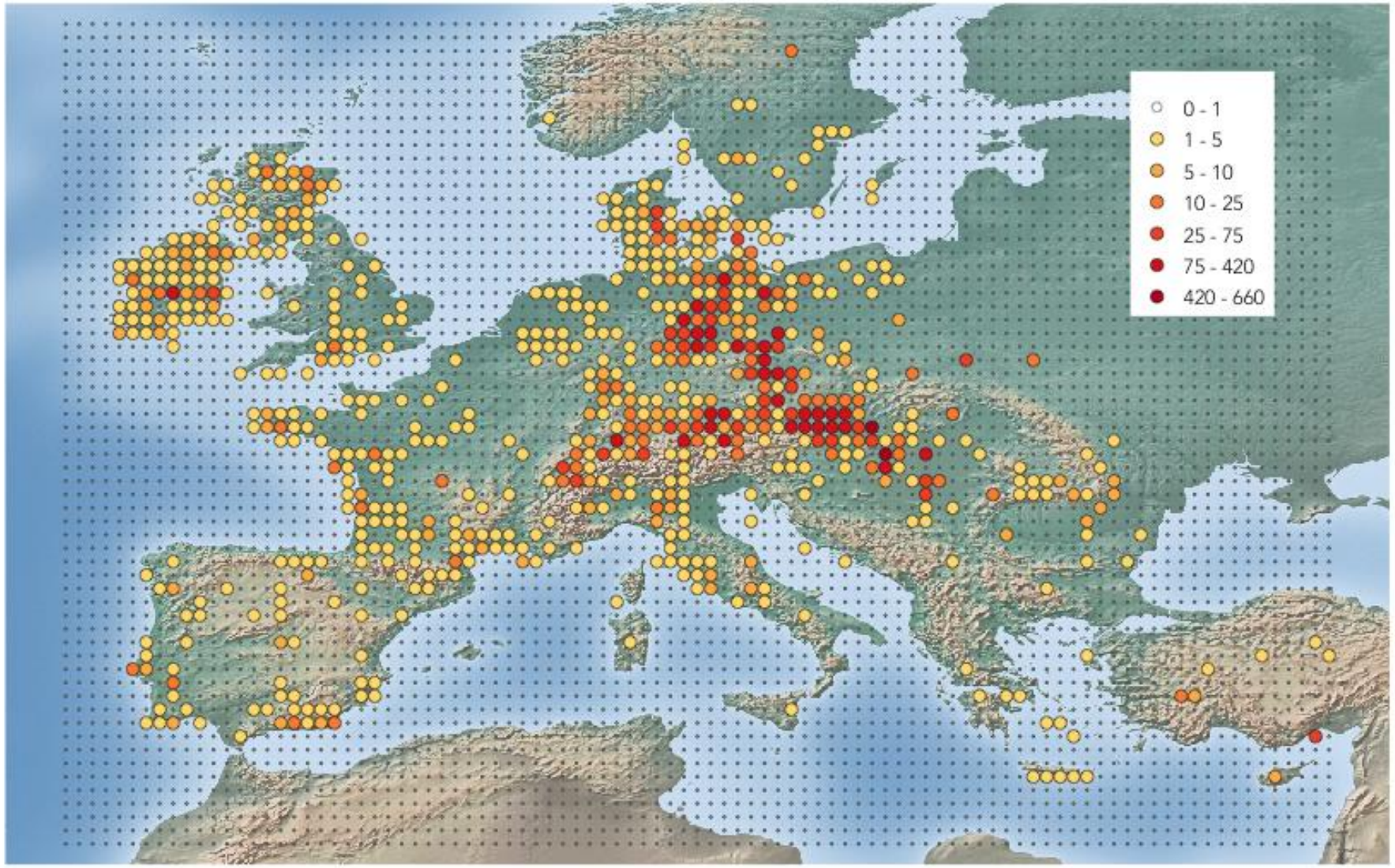
Thanks to the volume of work on Bronze Age material (often through the lens of provenance), we know where that tipping point occurs.

We need a new chemical framework, to reach that tipping point as quickly, and coherently as possible.
That framework then unlocks the potential of further individual analyses

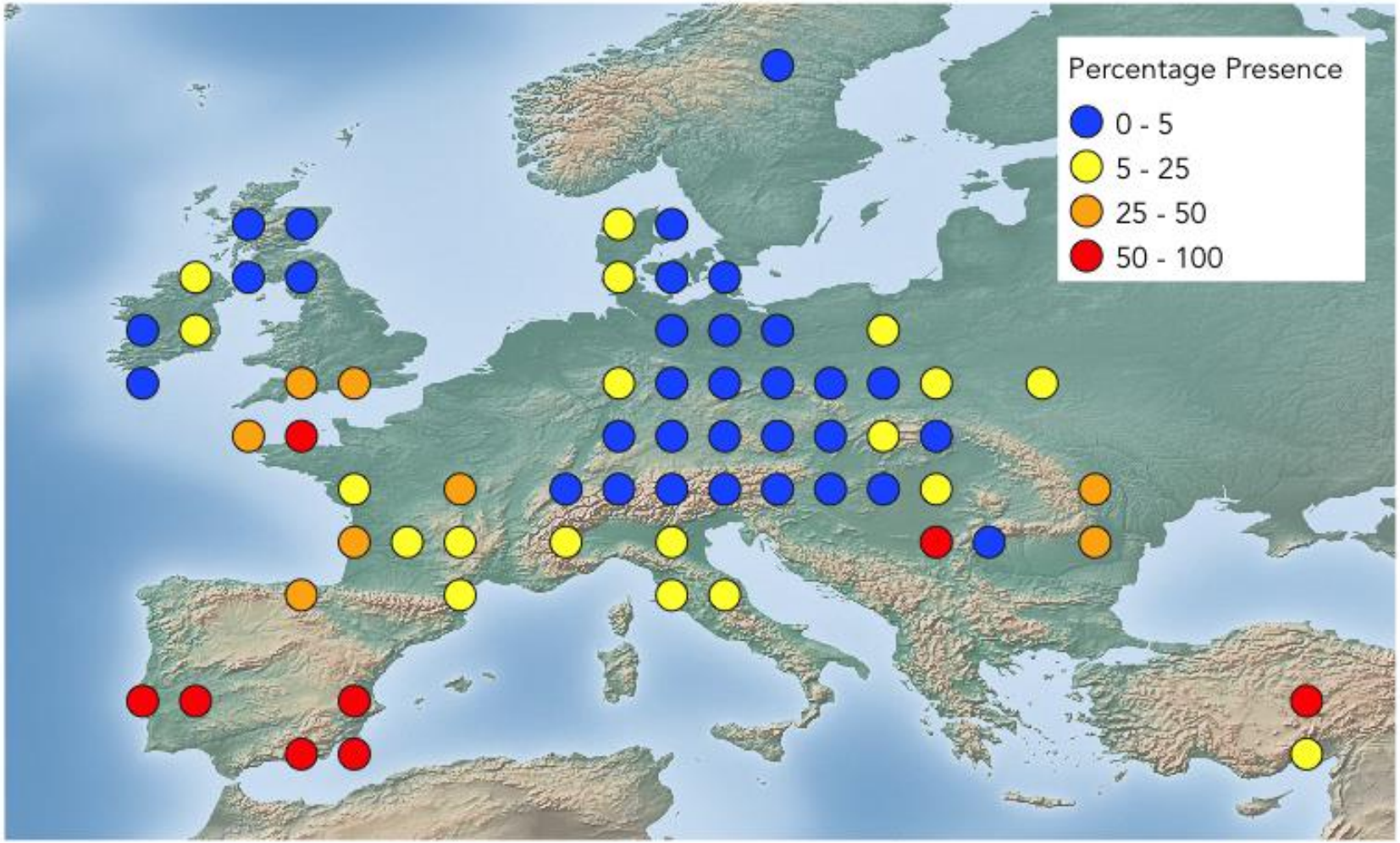
Copper is an ideal framework material – shows up in so many facets of life, across all places and strata of society.

Copper-alloys tie times, places and people together, and record change

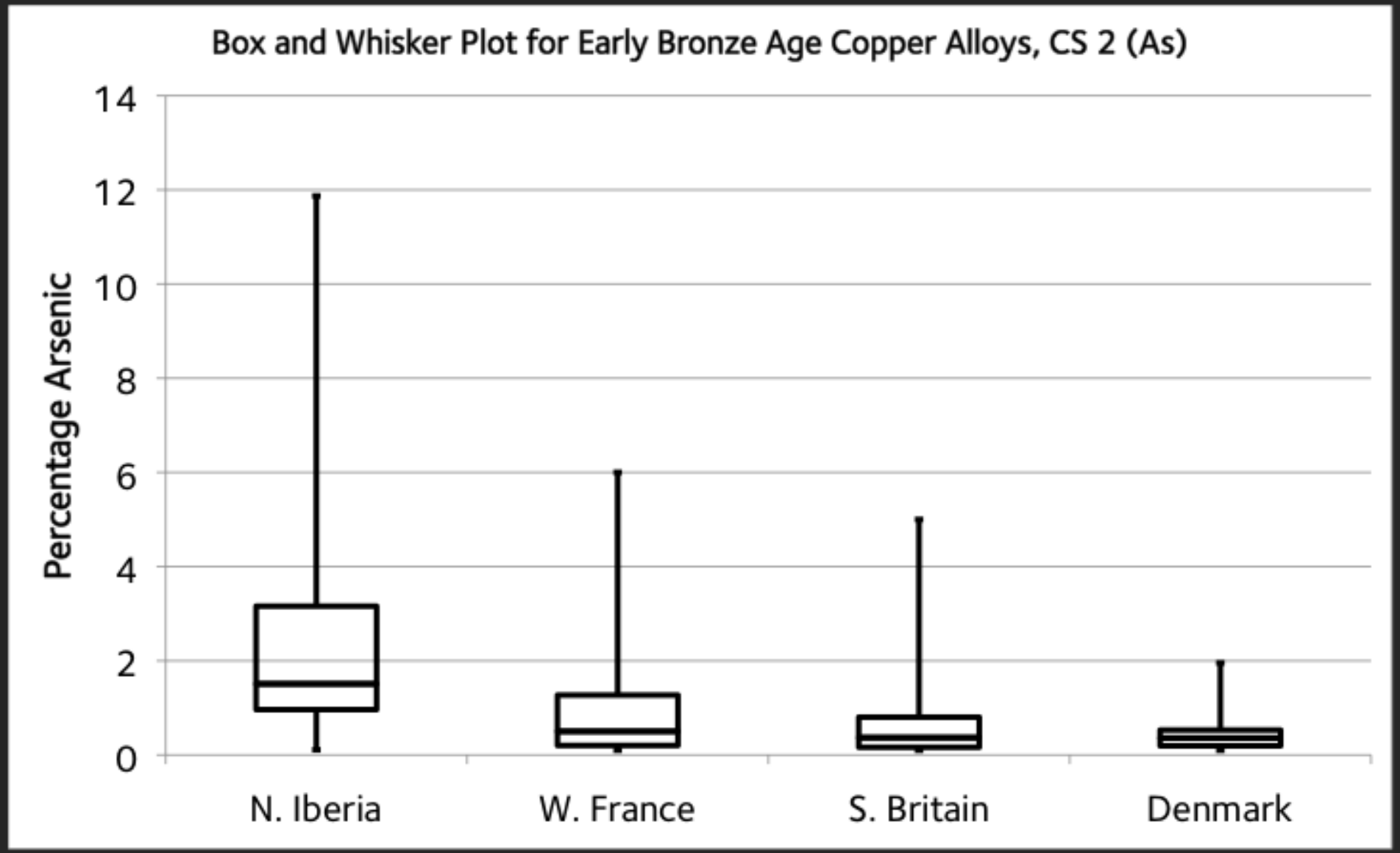
Total Analyses, SAM, EBA1, 0.5 Degree Grid



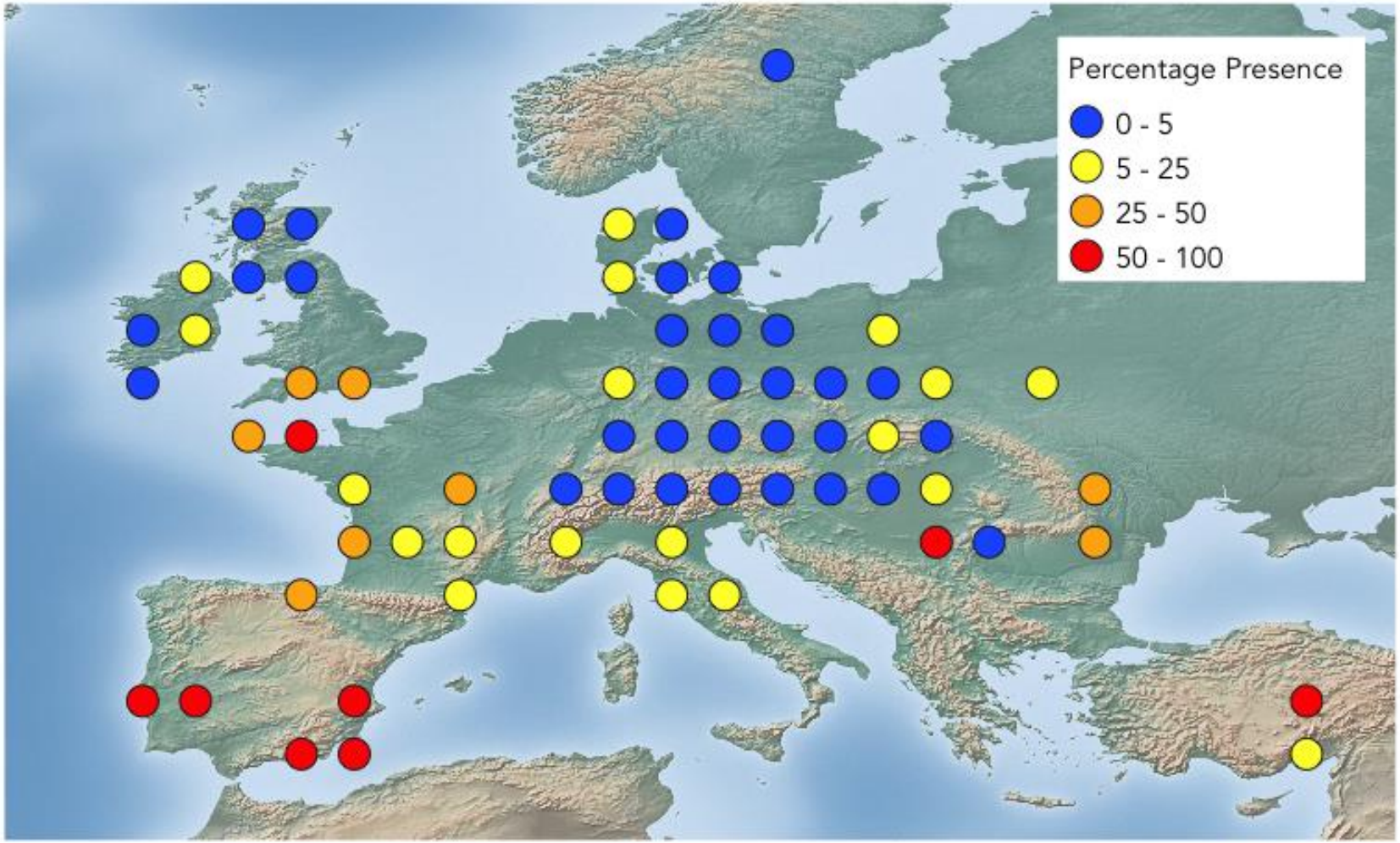
Percentage Presence CS 2 (Cu + As), EBA 1
SAM Data, 2 Degree Grid



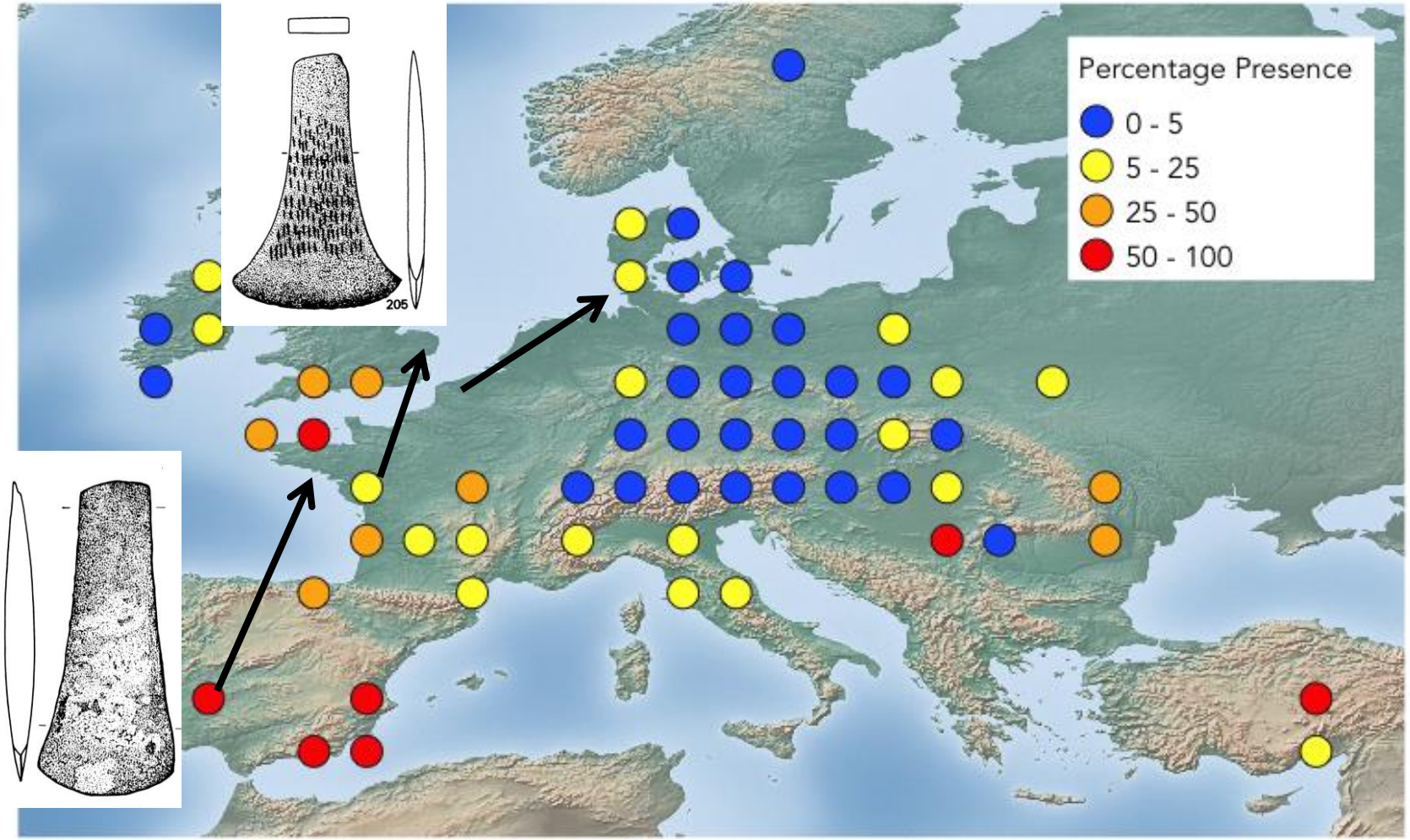
Early Bronze Age (Chronology is a tremendous challenge)

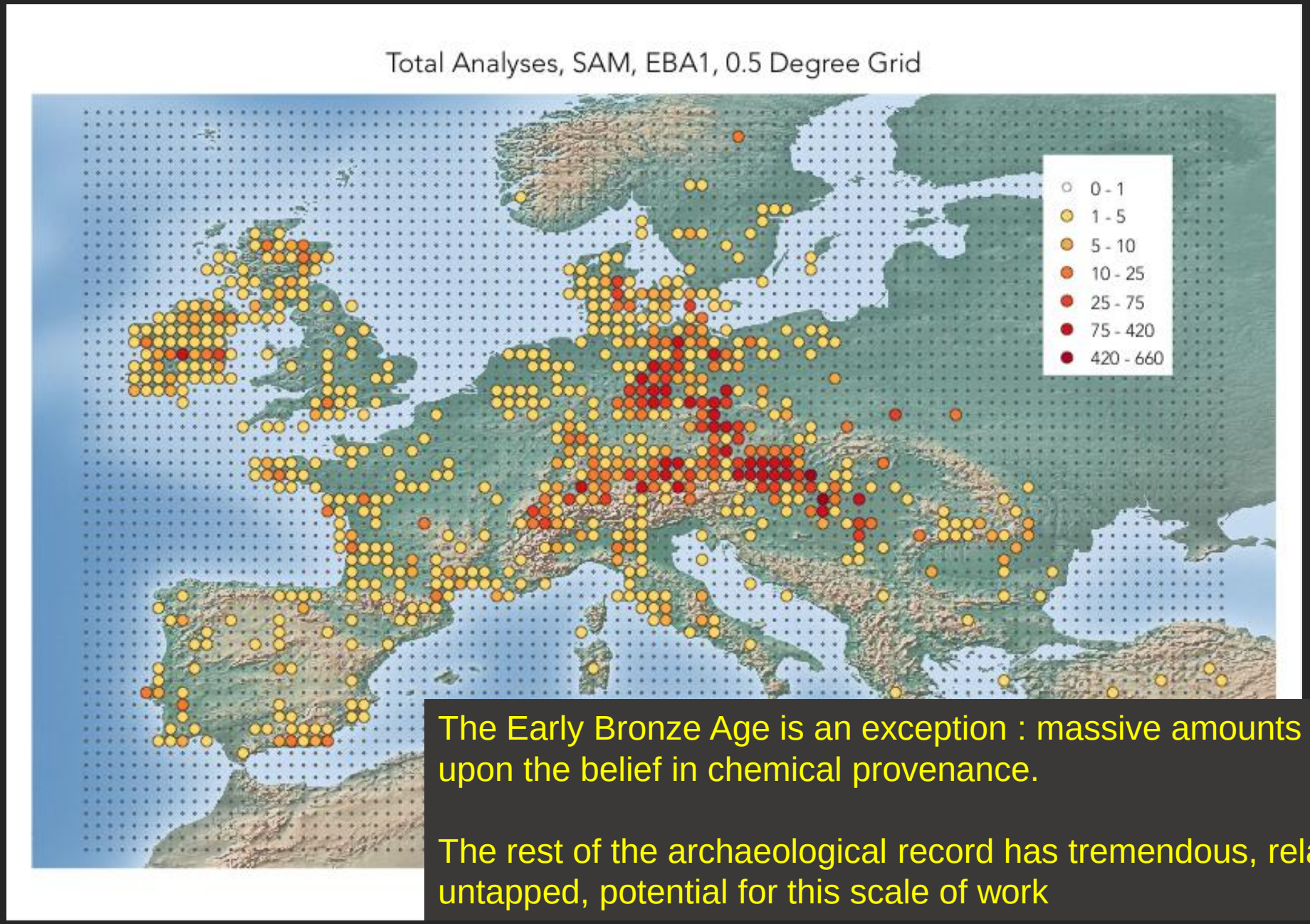


Percentage Presence CS 2 (Cu + As), EBA 1
SAM Data, 2 Degree Grid



Percentage Presence CS 2 (Cu + As), EBA 1
SAM Data, 2 Degree Grid



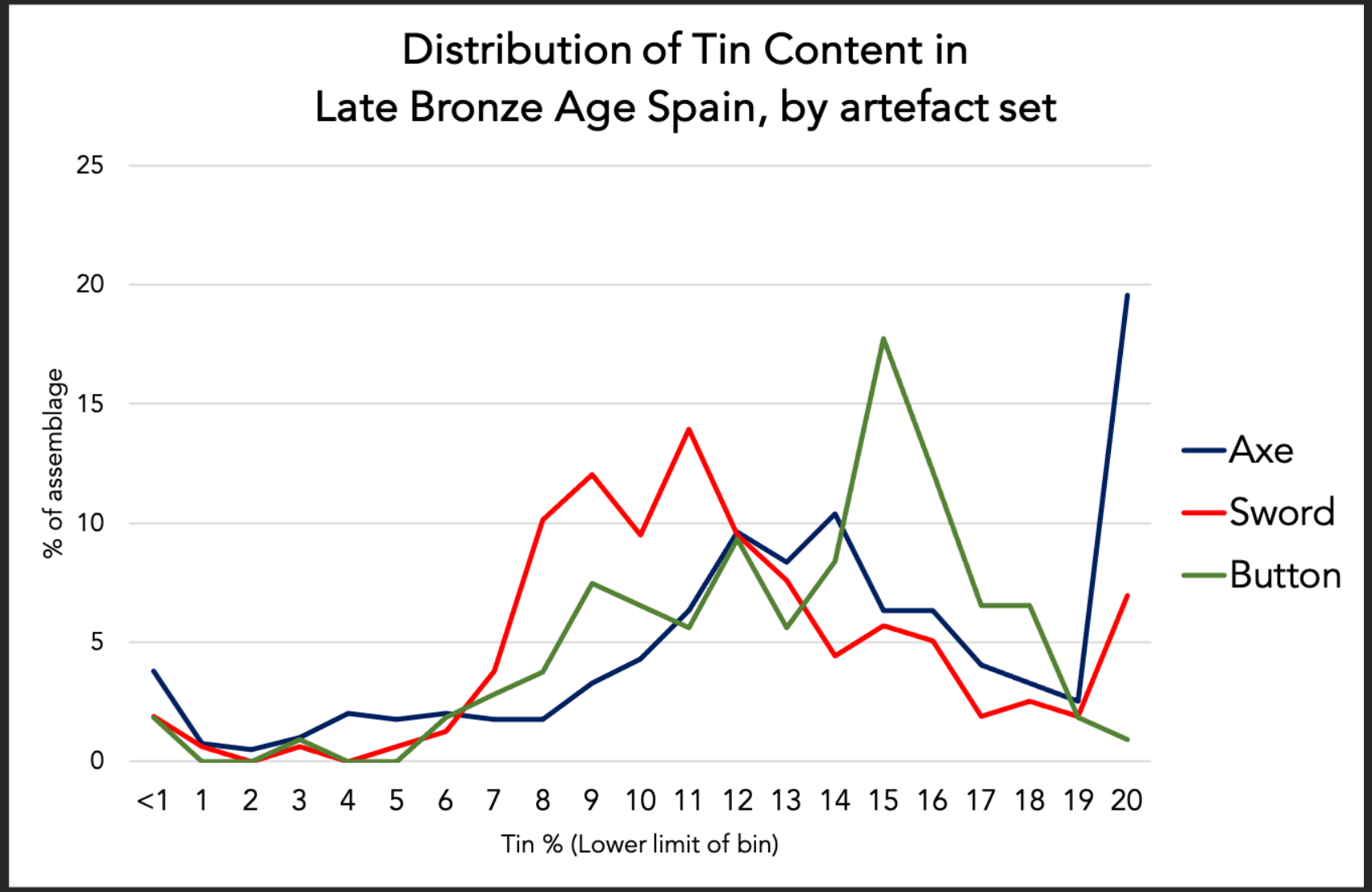


The Early Bronze Age is an exception : massive amounts of data built upon the belief in chemical provenance.

The rest of the archaeological record has tremendous, relatively untapped, potential for this scale of work

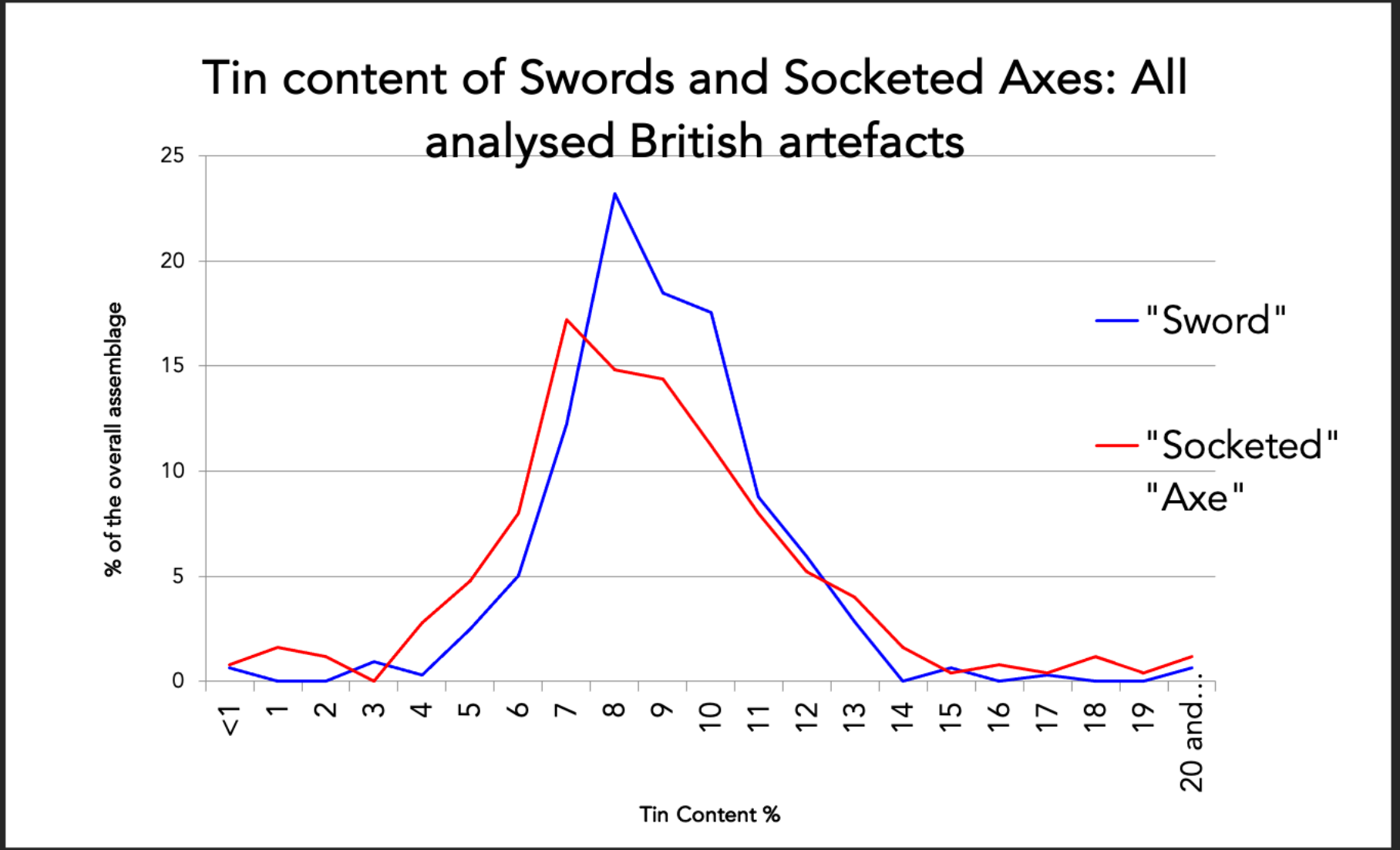
Neil Burridge

Surprising how rarely alloys were (finely) designed, except near production regions
Metal was inherited, adapted, mixed, reimagined
Objects are impermanent



Data:
Ignacio
Montero

Surprising how rarely alloys were (finely) designed, except near production regions
Metal was inherited, adapted, mixed, reimagined
Objects are impermanent



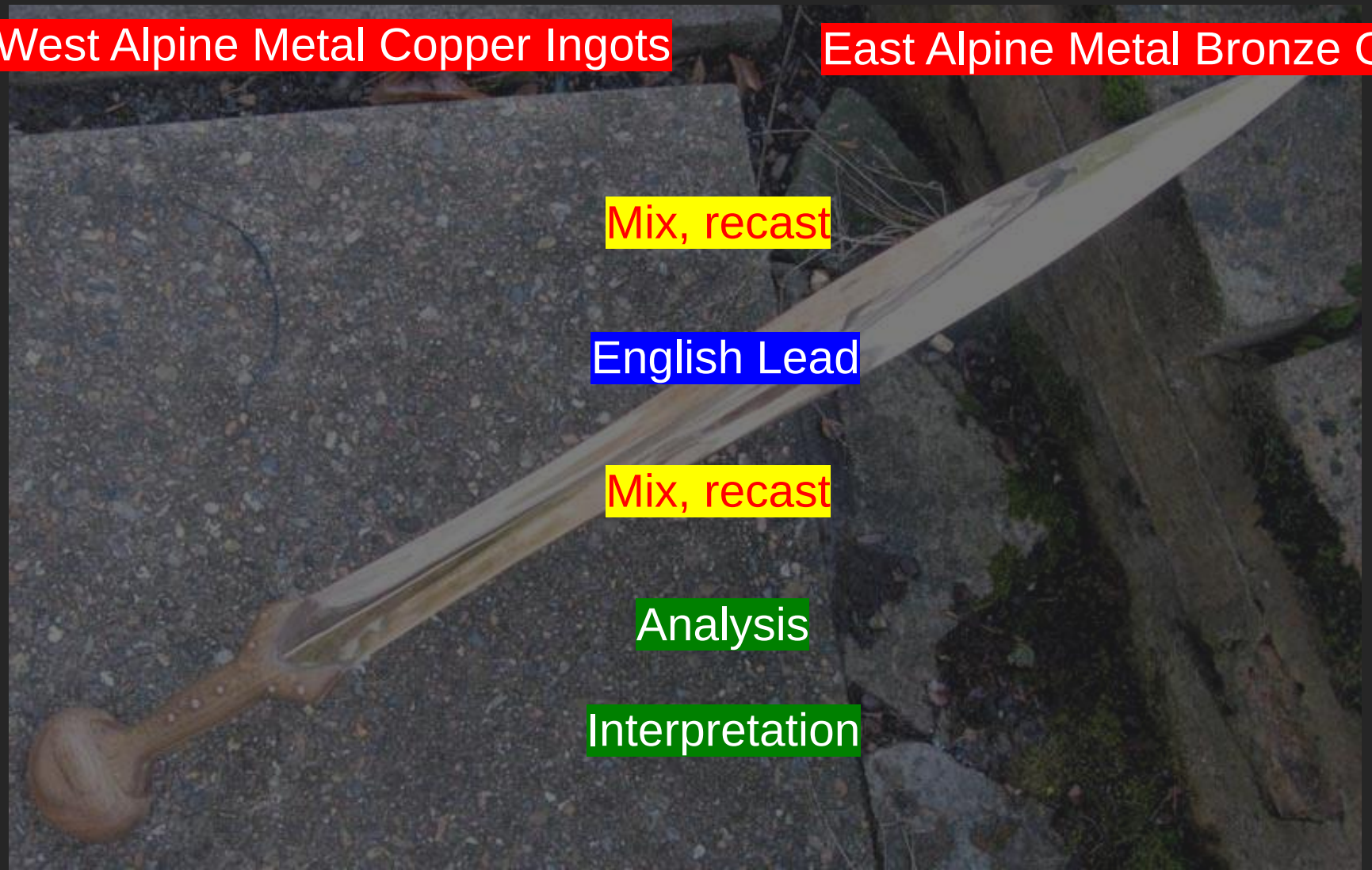
Data:
Peter
Northover

Surprising how rarely alloys were (finely) designed, except near production regions
Metal was inherited, adapted, mixed, reimagined
Objects are impermanent

(made out of the same metal as the socketed axes)

Neil Burridge

Surprising how rarely alloys were (finely) designed, except near production regions
Metal was inherited, adapted, mixed, reimagined
Objects are impermanent



Surprising how rarely alloys were (finely) designed, except near production regions
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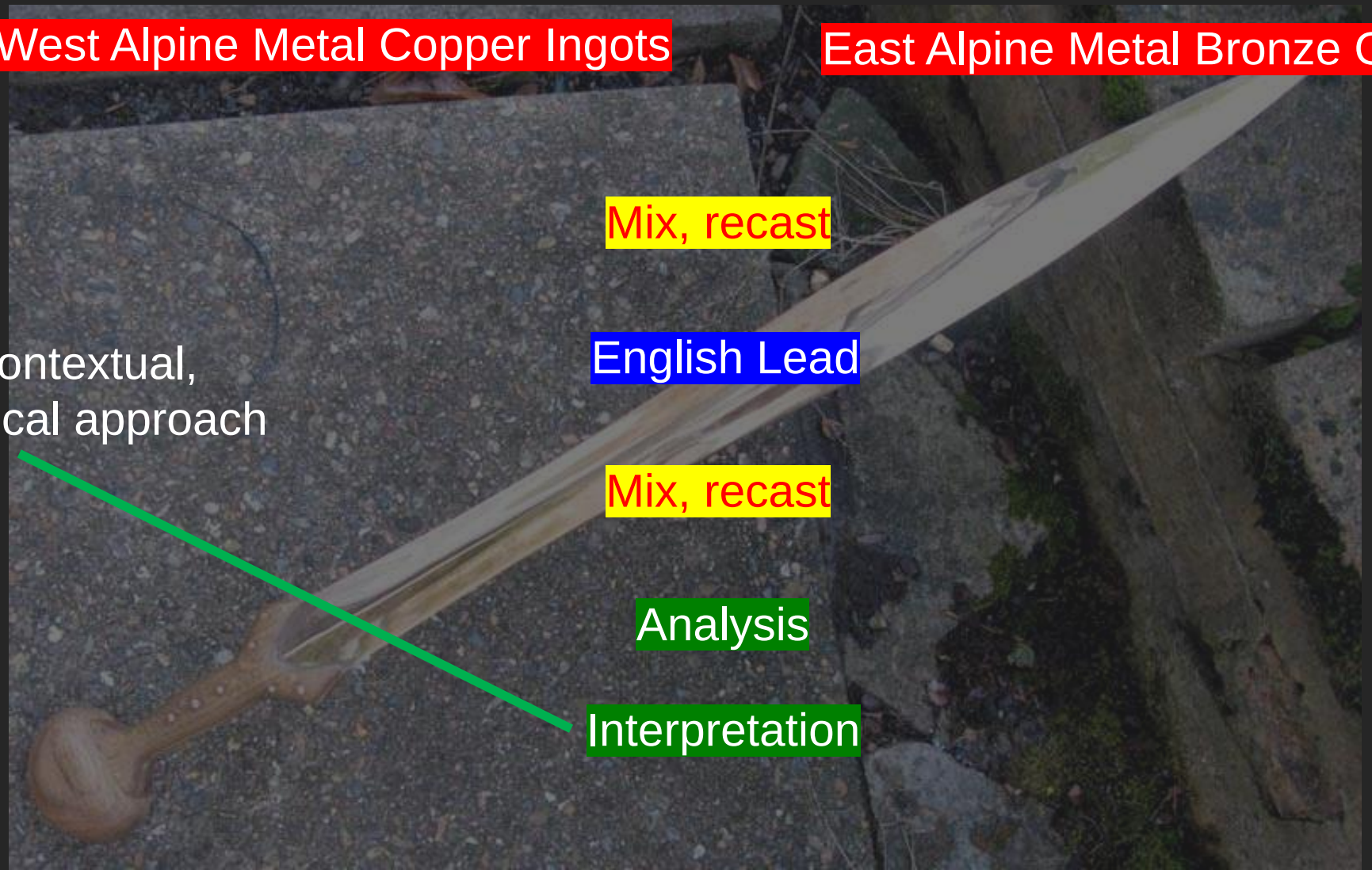
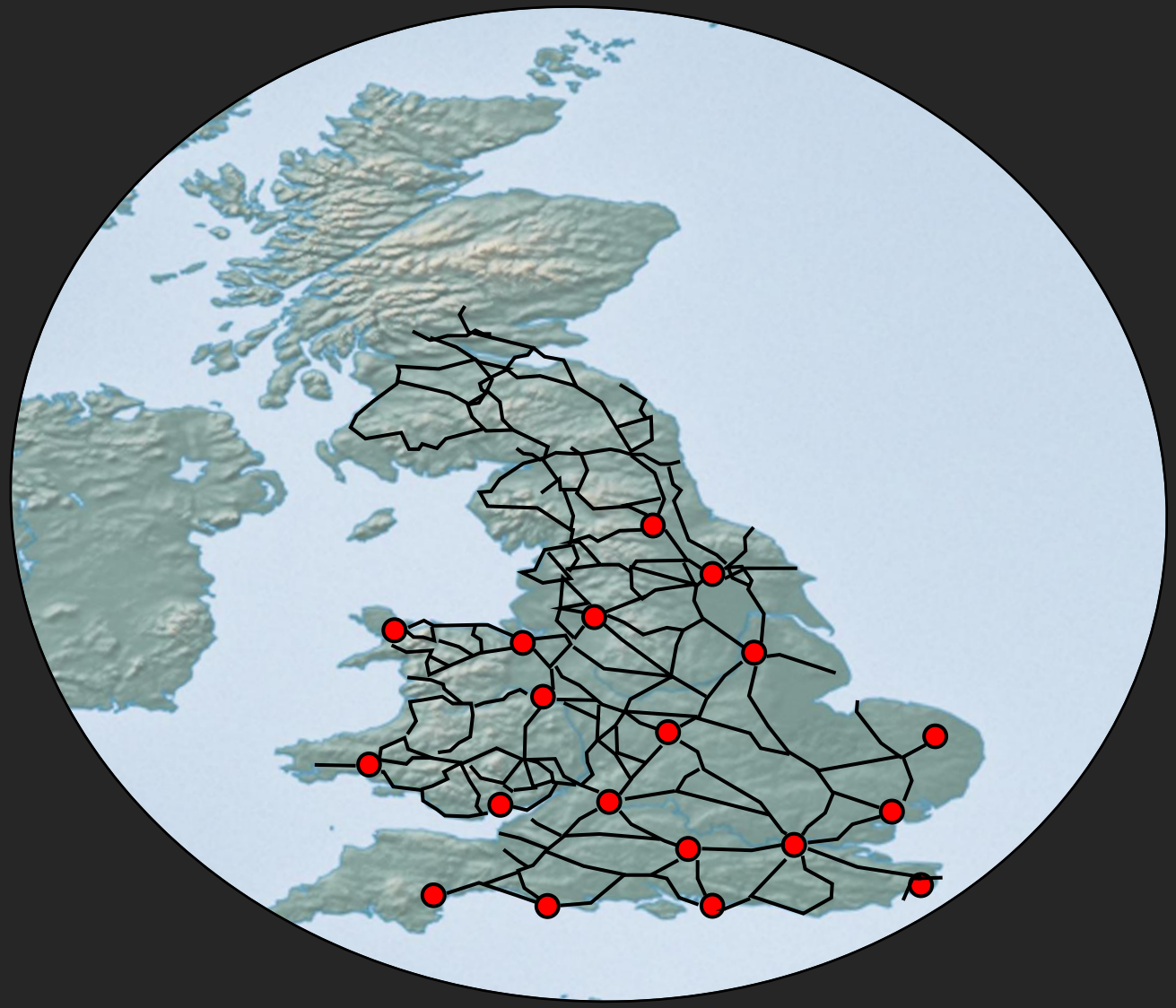
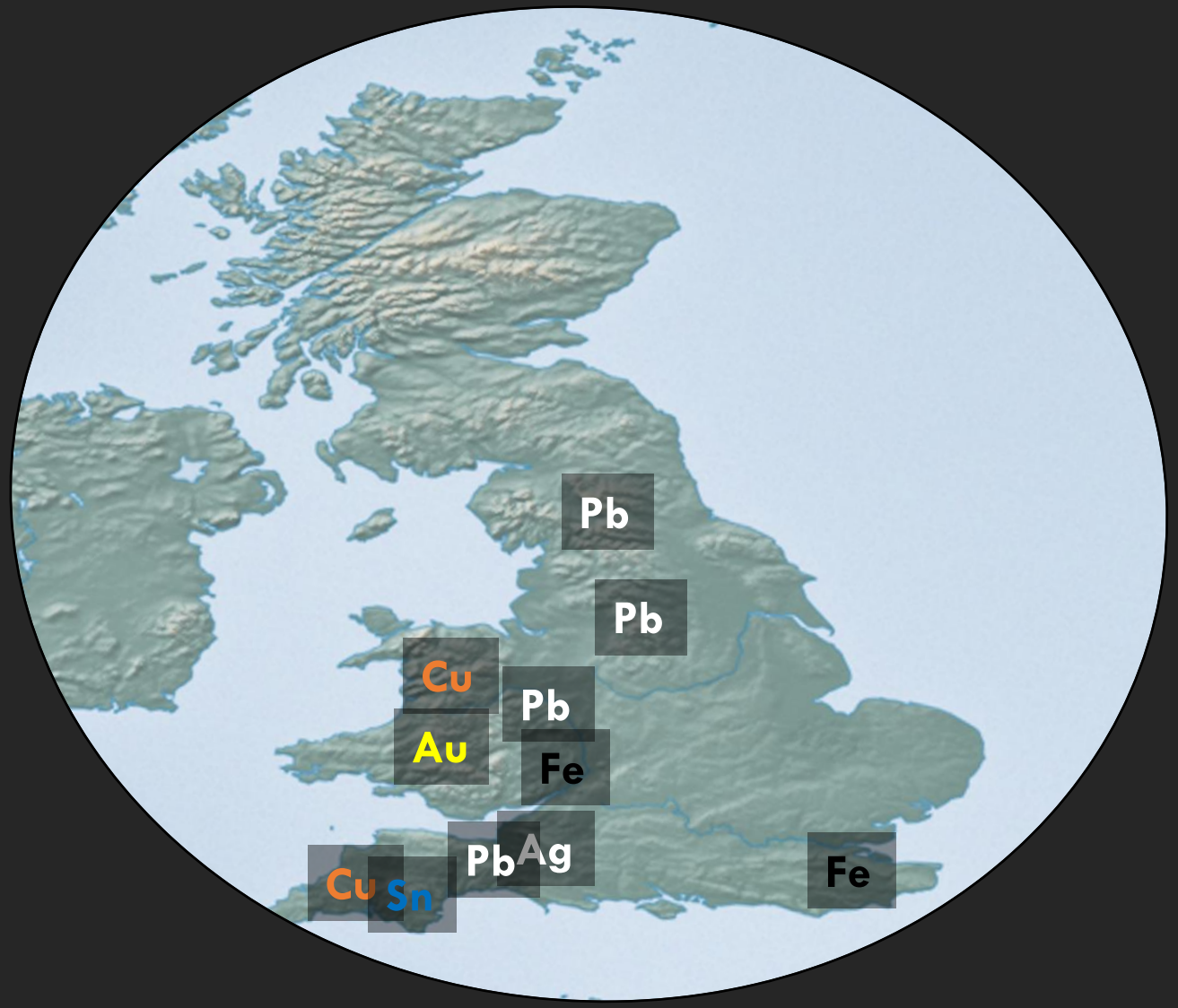
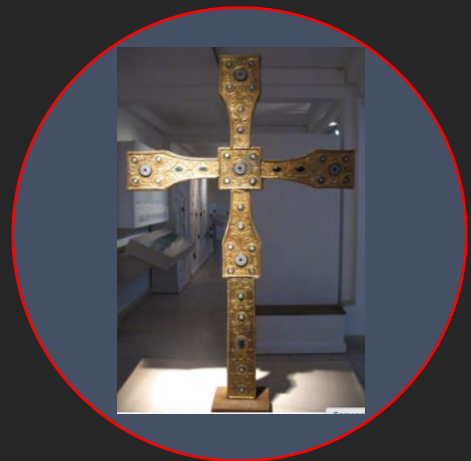


A relative, contextual,
Archaeological approach

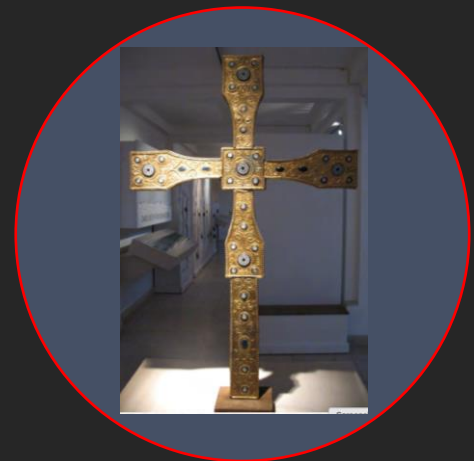

The 1st Millennium AD UK copper-alloy assemblage urgently requires more analysis



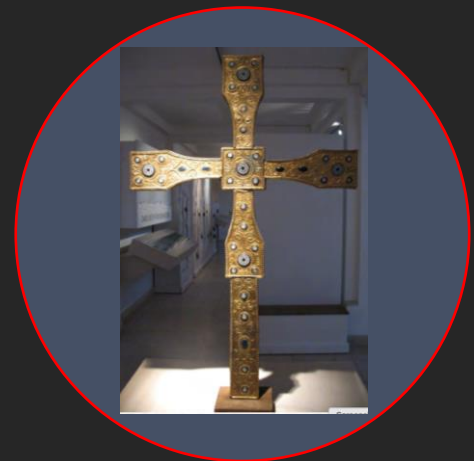

Pb
Pb
Cu
Pb
Au
Fe
Pb
Ag
Cu
Sn
Fe



Copper alloys were used in all aspects and strata of Roman and Medieval society, with excellent geographical and chronological coverage



Copper-alloy objects are central to creating typo-chronologies and social frameworks for the past, chemistry can be part of that conversation



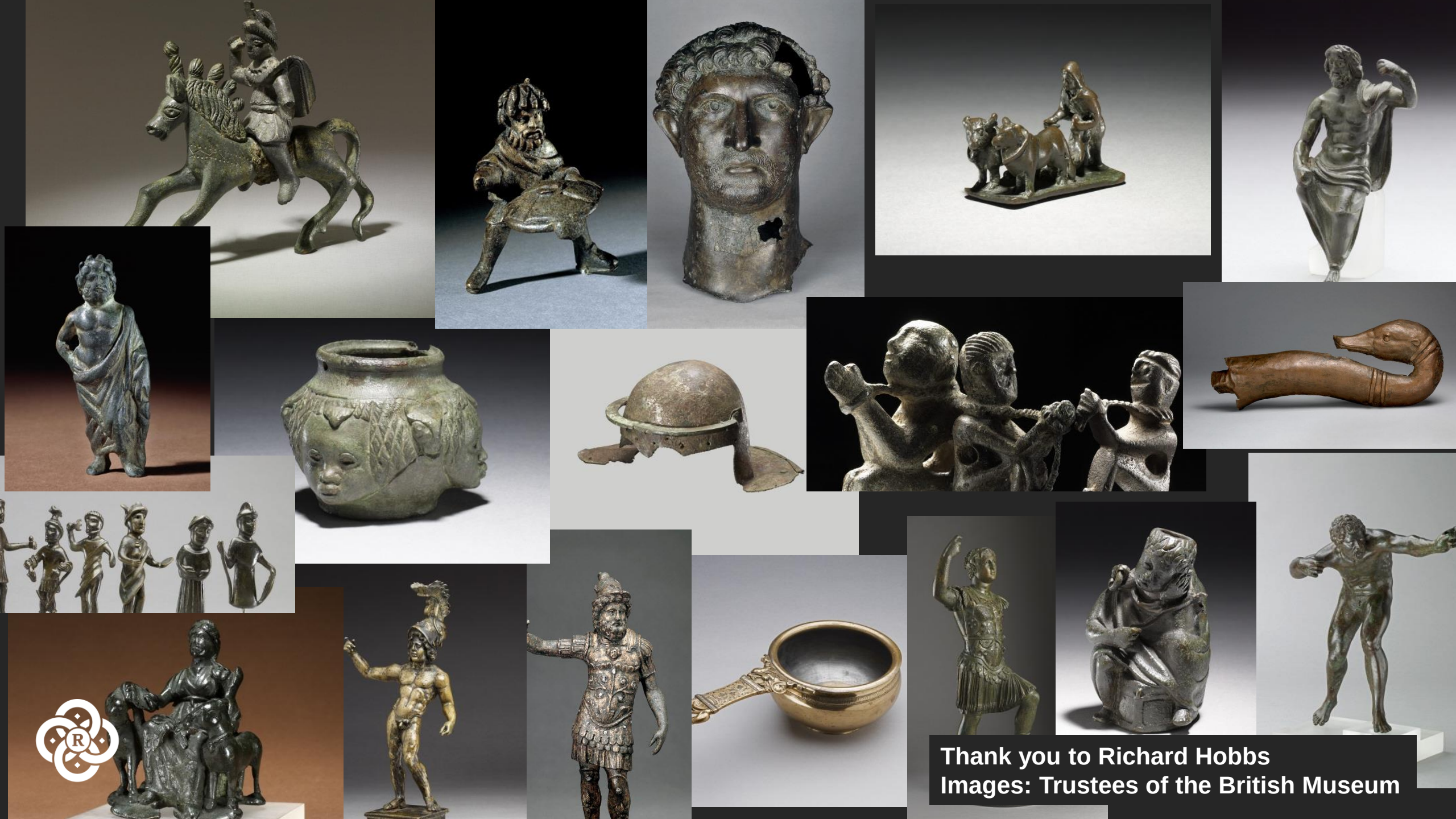
A transformative amount of data

10,000 analyses over 100 case studies

Crossing regional and period divisions

Percentage of the whole Portable Antiquities Scheme (869,826 objects, data retrieved 10/12/2020)

	Paleolithic	Mesolithic	Neolithic	Bronze Age	Iron Age	Roman	Early Medieval	Medieval	Post Medieval	Modern	Total Artefacts
Copper Alloy	0.0	0.0	0.0	0.8	2.2	33.8	2.7	11.4	10.8	0.3	554,834
Silver	0.0	0.0	0.0	0.0	1.9	2.3	0.6	8.1	4.8	0.1	158,126
Flint	0.1	1.1	2.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	35,203
Lead	0.0	0.0	0.0	0.0	0.0	0.3	0.1	1.5	1.6	0.1	34,676
Ceramic	0.0	0.0	0.0	0.0	0.2	1.2	0.1	0.7	0.4	0.0	24,001



Thank you to Richard Hobbs
Images: Trustees of the British Museum

MP-AES facility, Reading

25% of the new data were “solo antimony” compositions.

In the full context of all analyses of pre-modern copper (*c 100,000 sets (?)*) this pattern is remarkable.

“Solo antimony” copper is absent in the record, until the mid 1st century AD in areas under Roman influence.

North African Rider
British Museum
1856, 0701.19
Findspot : London

Cu	Sn	Zn	Pb	Sb
65.24	5.06	0.02	26.96	0.101

North African Rider
British Museum
1856, 0701.19
Findspot : London

Cu	Sn	Zn	Pb	Sb
65.24	5.06	0.02	[illegible]	0.101

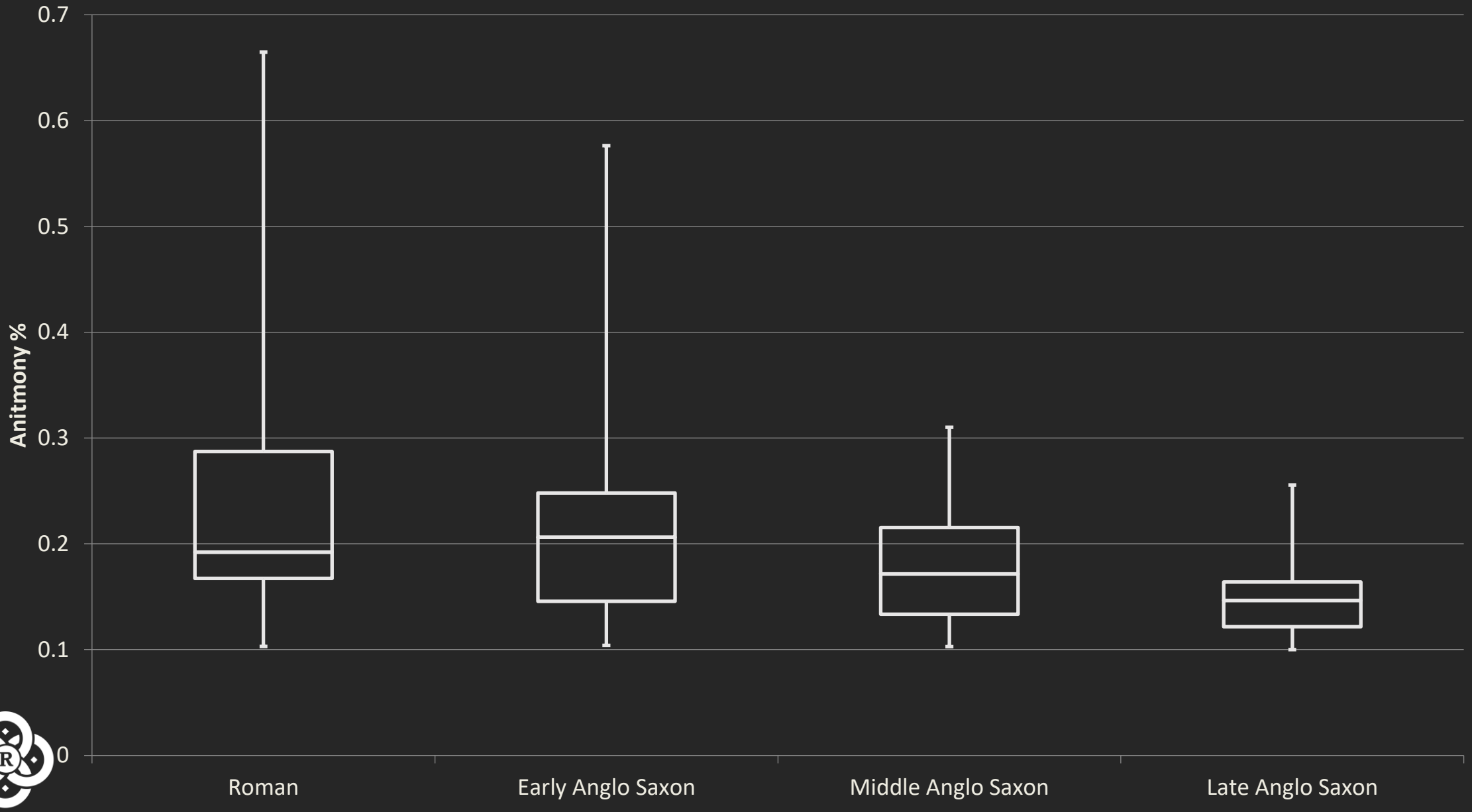
North African Rider
British Museum
1856, 0701.19
Findspot : London

Cu	Sn	Zn	Pb	Sb
65.24	5.06	0.02	26.96	0.101

Issuer	Date	CS 1	CS 2	CS 3
Coponius, Ambivulus	6 to 11	0.0	16.7	0.0
Gratus	15 to 24	44.8	3.4	20.7
Pilate	29 to 31	53.3	6.7	20.0
Felix, Festus, Agrippa	54 to 67	37.0	7.4	33.3

Coinage of the governors of Judea, analysis by Lönnqvist (2003)

The chemical composition of Copper-Alloys containing small amount of antimony and no other minor impurity (CS 3) (Data by Nigel Blades 1995)



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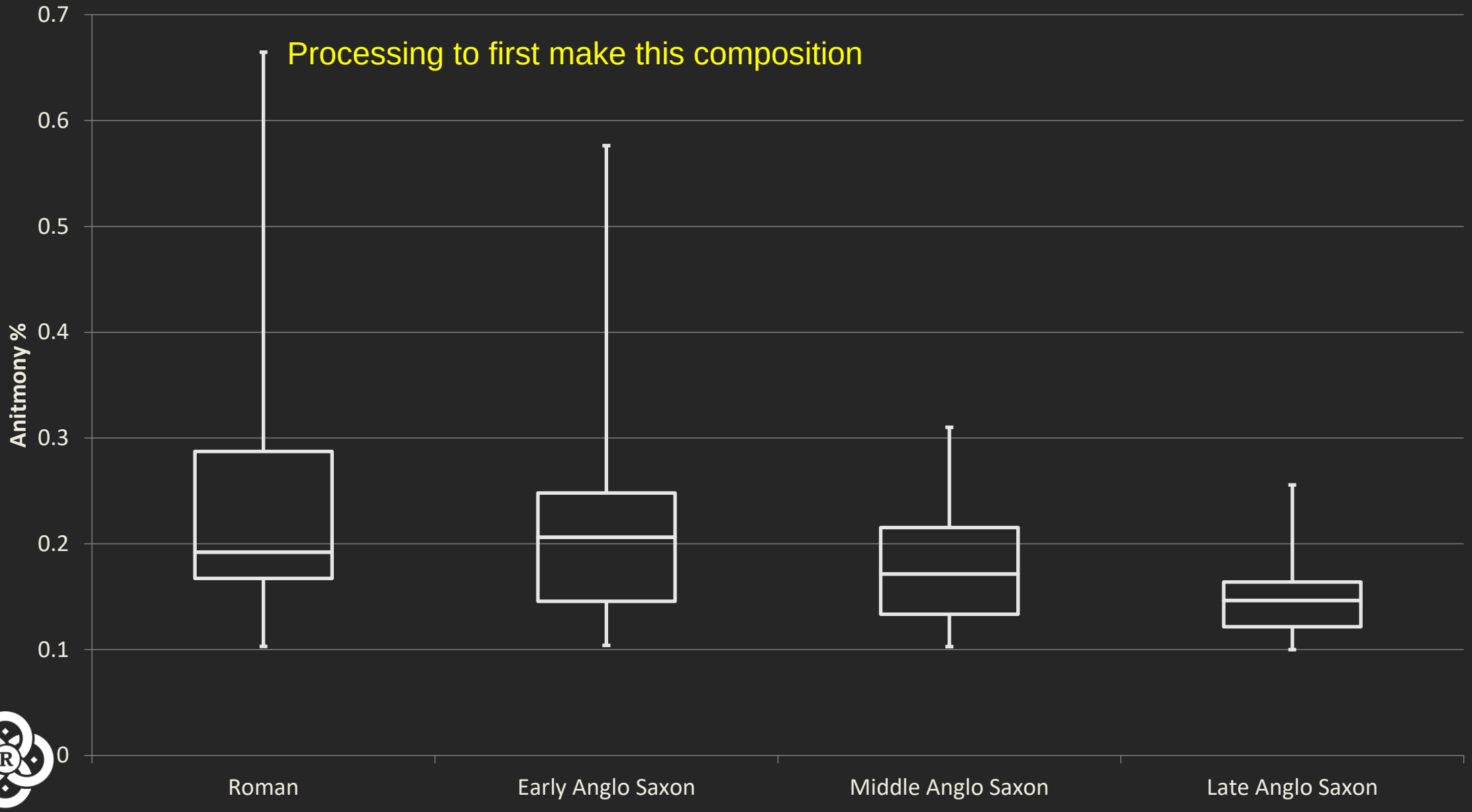

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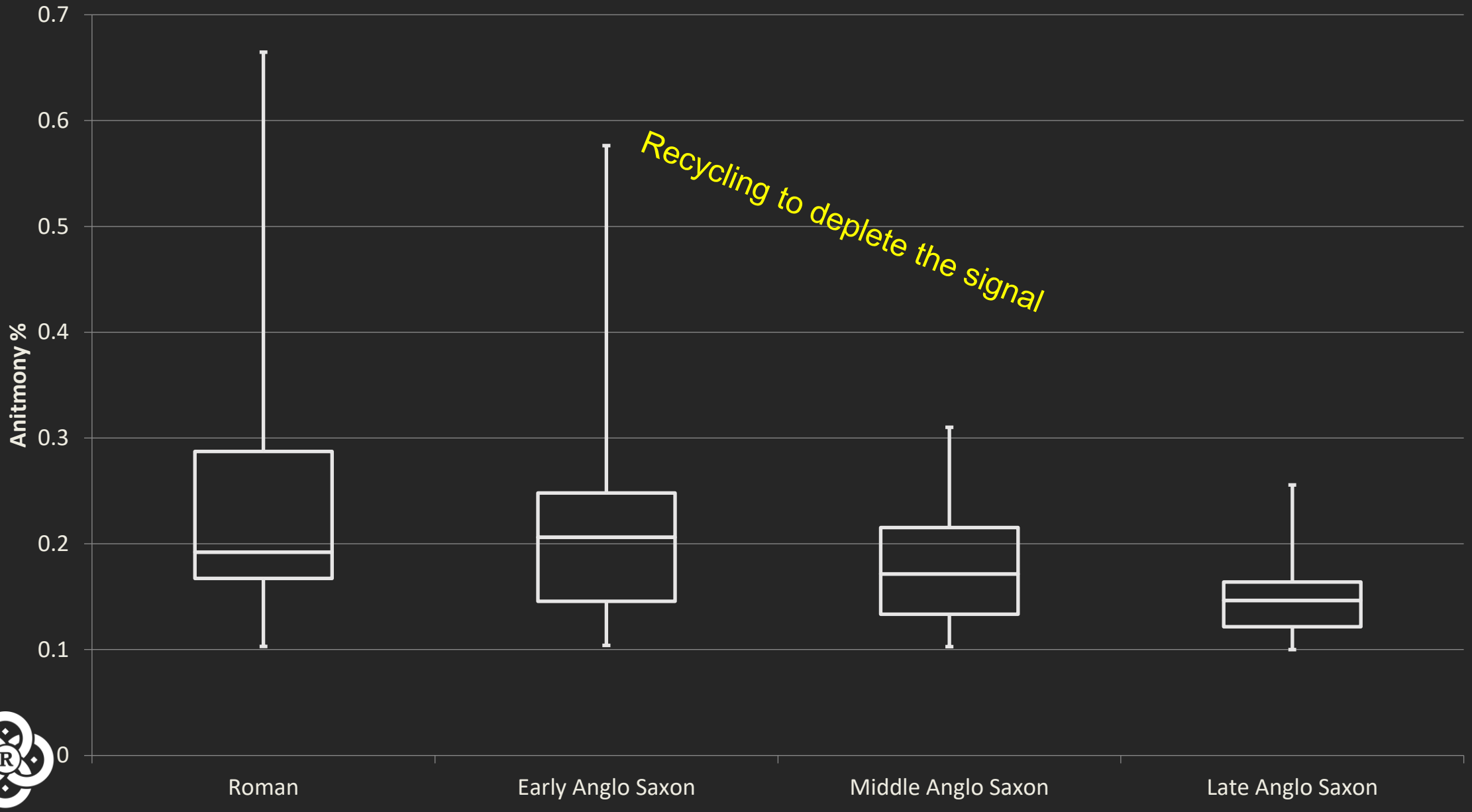

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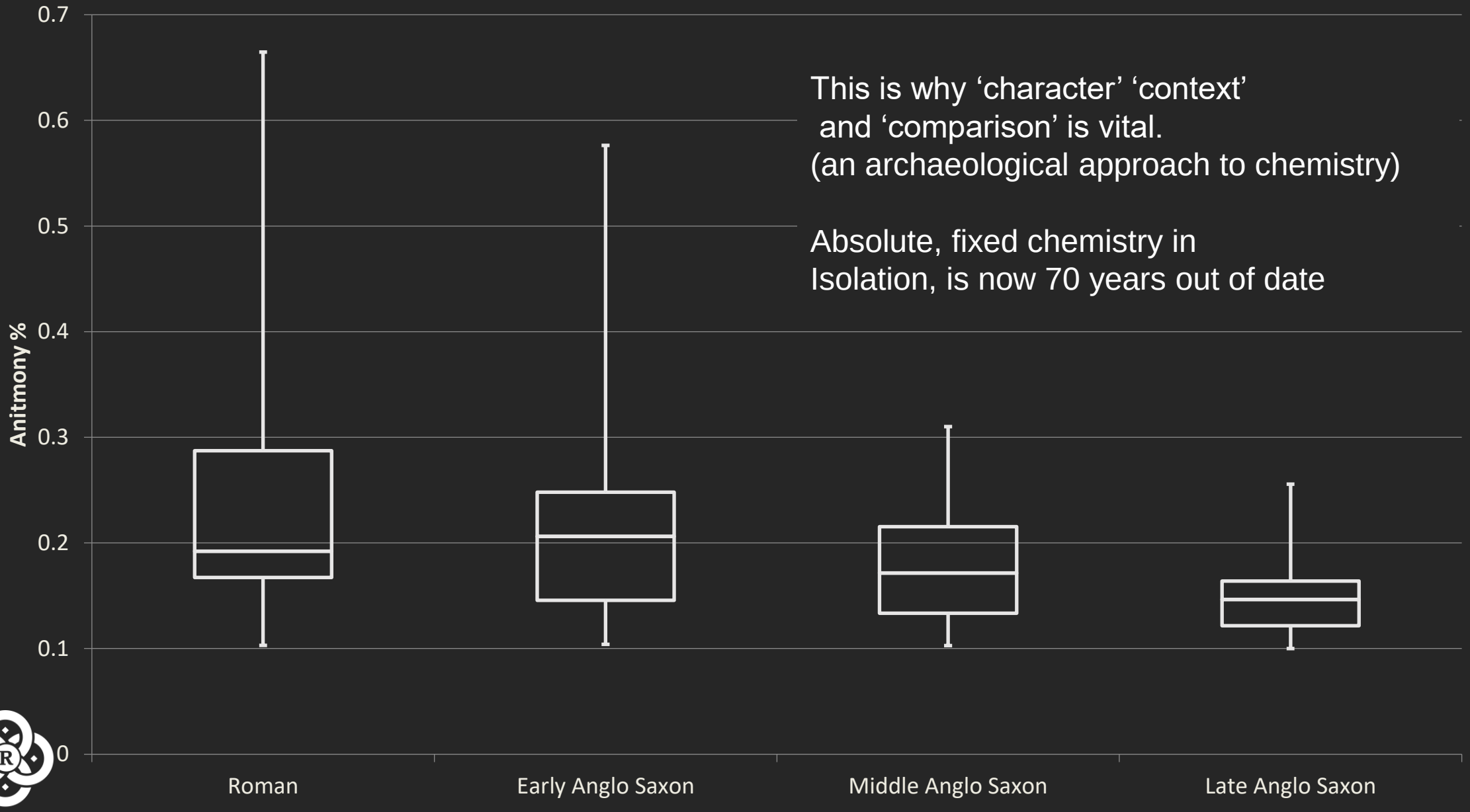

This is why ‘character’ ‘context’
and ‘comparison’ is vital.
(an archaeological approach to chemistry)

Absolute, fixed chemistry in
Isolation, is now 70 years out of date

Tiers of analysis

Legacy Data (including Bronze Age, Iron Age, Roman, and Medieval from across Europe [and beyond])

pXRF – travelling data collection, surface, triage

Dedicated MP-AES laboratory in Reading

10 mg of drilled sample, digested in *aqua regia*

Thank you to the community of analysts

SAM Project:	35,490
Northover Archive:	13,955
Montero Iberia:	12,471
Roman, non-coin:	3866
Roman Coinage:	2684
Chernykh Cent. Asia	2305
Britain and Ireland EBA:	2171
Iran, Bronze and Iron Age:	2081
China, Shang, W. Zhou:	1734
France Early Bronze Age:	1512
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Anatolia Bronze Age:	1223
Craddock Archive:	872

Plus several thousand and thousands more…

Thank you to the community of analysts

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Caley
Calliari
Canovaro
Carter
Commaille
Cope
Crawford
Étienne
Genth
Giesecke
Girardin
Göbel
Grueber
Helm
Hoffmann
Klaproth
Klein
Mattingly
McDowall
Northover
Phillips
Riederer
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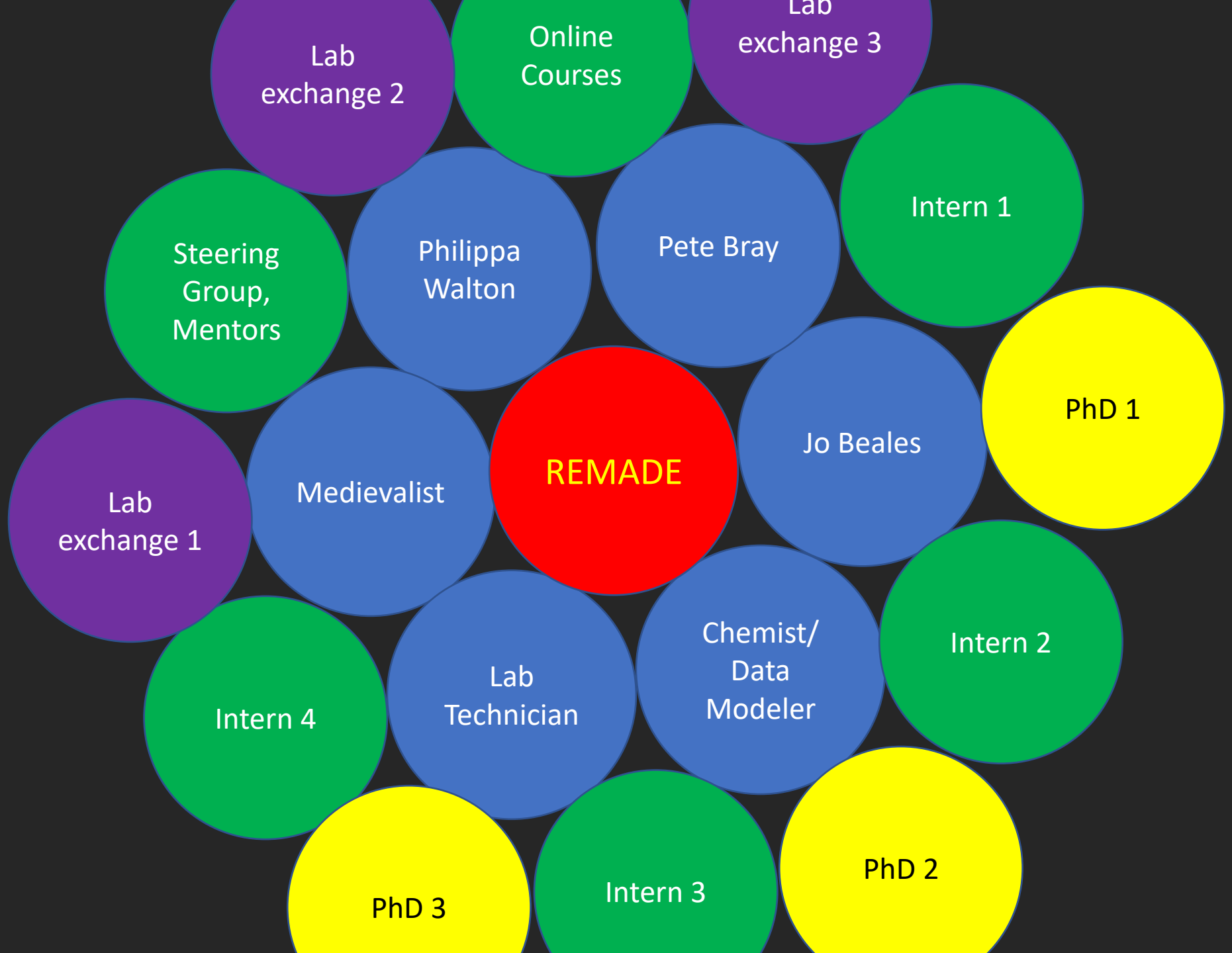
Lab exchange 2
Online Courses
Lab exchange 3
Intern 1
Steering Group, Mentors
Philippa Walton
Pete Bray
PhD 1
Jo Beales
Lab exchange 1
Medievalist
REMADE
Intern 2
Chemist/ Data Modeler
Intern 4
Lab Technician
PhD 2
Intern 3
PhD 3

FIXED

Highest quality data we can achieve

Data shared shared with the wider community

ACTIVE and FLUID

Extraction, processing, use, reuse, mixing and manipulation of copper-alloy imprints itself in the datasets

Data used and reused

Interpretation and use of those data has to happen with the wider community

Antiquity 2021 Vol. 95 (380): 367–381
https://doi.org/10.15184/aqy.2020.148

Research Article

Objectscapes: a manifesto for investigating the impacts of object flows on past societies

Martin Pitts[1,*] & Miguel John Versluys[2]

DE GRUYTER

(2016): 367–381

Praehistorische Zeitschrift; 2016; 91(1): 103–123

Abhandlung

Helle Vandkilde*

Bronzization: The Bronze Age as Pre-Modern Globalization

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A Brief History of Recycling

November 19, 2019

This guest blog is courtesy of American Disposal Services.

For those of you who think recycling is something that just came about within the last few decades, think again!

Ancient Recycling

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  Aug 23 2023
- NERC Embraces Re Recycling for Offic

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The Recycled Self: Consumers' Disposal Decisions of Identity-Linked Products

REMI TRUDEL
JENNIFER J. ARGO
MATTHEW D. MENG

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Ancient Recycling

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The analysis of Roman and Medieval copper alloys is one of the largest opportunities in UK archaeological science

Particularly in the context of the metal of later prehistory, it is surprising and complex, with the potential for delivering novel insights into society, economy, geography, and technology.

I have found metal character to be a far more powerful unifying concept than provenance –

Both as a way of studying the past
And more importantly as a way of bringing together archaeologists, and engaging with the public

Thank you to all our project partners and advisors

Thanks to:

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Aurélie Cuénod
John Koch
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Viktor Trifonov
Neil Jakeman
Chloe Duckworth
Stuart Needham
Nigel Blades
Justine Bayley

All our partners, analysts, and many more

Please contact us at:

remade@reading.ac.uk
research.reading.ac.uk/remade