

The Numismatic Studies
of
Lawrence Henry Cope JP, PhD, FIM, MWeldI, FRNS
A Chronology

Compiled by Martin Cope

Foreword

My father applied his skills as a professional research metallurgist to the study of the coinage alloys of the Roman Empire. Through 'wet chemical' analysis of over one thousand coins, his pioneering work established the true compositions of their alloys (compared to analysis by less accurate non-destructive methods) and linked the changes in these alloys to the monetary policies which led to the issue of the coins. His studies also provided evidence of the methods used in the fabrication of the coins and the metallurgical skills of the mint workers.

Following my father's death at the age of 54 in November 1978, my mother deposited his working papers, remaining coin samples and analysis results with the Department of Coins and Medals in the British Museum.

In 1997 the British Museum published Occasional Paper 120 *Metal Analyses of Roman Coins Minted under the Empire*, L.H. Cope[†], C.E. King, J.P. Northover and T. Clay, which tabulated his analysis results together with a commentary on his work and developments in this field since his death.

In 2002 I looked through some boxes of papers still in my mother's possession which contained mainly correspondence and publication drafts and produced a website summarising my father's publications: <http://www.regngo.com/lhcope/>

In 2016 I started to take a more thorough look at all the papers that my mother had not deposited with the British Museum and have used these to produce this summary of my father's work as revealed through his correspondence. This may not be the complete story as not all his correspondence may have survived and I have not attempted to access any which may be within the archive at the British Museum. Wherever possible I have quoted from the original documents and tried to avoid personal interpretation (though occasionally I have been able to clarify the context from my memories).

Martin Cope
October 2017

Beginnings

Lawrence Henry Cope was born in 1924 in Aldridge, South Staffordshire and in 1935 won a scholarship to Queen Mary's School, Walsall. Following his School Certificate exams in the summer of 1940 (being awarded a distinction in chemistry) he entered the Science and Mathematical sixth form with the idea of studying chemistry at university. He soon came to realise that this might be a difficult ambition during wartime and in January 1941 he left school and started work in the laboratory of Stewarts & Lloyds' iron and steel works at Bilston. In the evenings, he studied for City and Guilds qualifications in metallurgy at the County Technical College, Wednesbury.

In January 1947 he transferred to the department of research and technical development at Stewarts & Lloyds' steel works at Corby, Northamptonshire. In March 1949 he married Ione from the nearby village of Geddington and together they started a family. In November 1951 he joined Corby Technical College to teach metallurgy in a newly created department.

Towards the end of 1954 local newspapers carried reports of a hoard of Roman coins which had been found that summer at nearby Burton Latimer and recently presented to Northampton Museum. Lawrence's interest was aroused by the description of the coins as 'bronze with a silver wash' and he contacted the museum offering his department's facilities at Corby Technical College to determine how the coins were silvered.

ROMAN COINS FROM BURTON LATIMER

NORTHAMPTON Museum in Guildhall-road has been presented with its first hoard of coins. They are Roman ones dug up near Burton Latimer during the summer by Mr. W. D. Evans, of Hilly Farm, High-street, Burton Latimer.

The hoard is the first to be dug up in the County for a long time. Most of the coins are in a very good state of preservation. They were minted at London and Colchester, and the mint marks still show quite clearly on many of them.

The earliest of the coins is that bearing the head of Victorinus, who reigned from 265-267 A.D. It is thought that they were buried towards the end of the third century.

The coins are bronze with a silver wash, and the fact that many still have the silver on them adds extra value to the find.

It is most unusual to find coins with the silver still on them, as the wash, used to make production cheaper, was very thin.

An idea of their original value can be gained from the fact that 12½ of these coins would be the normal monthly pay of an ordinary Roman soldier.

The museum has a total of 108 coins.

MERCURY & HERALD THURSDAY, DECEMBER 23, 1954. 3

The museum curator wrote

it is too early yet to come to a definite decision regarding their detailed examination. If I can find a similar coin on which destructive tests can be carried out, I will get in touch with you.

Lawrence replied

I have been thinking of alternative ways by which we may discover how the silver wash was applied. The junction of the silver coating with the base metal is the point where the nature of the bond can be revealed by microscopic examination. It occurs to me that if a coin exists in which the silver wash is not complete (so that the bronze shows through), the junction of the dissimilar metals can be effectively examined without causing any damage.

Later in January 1955 the museum curator wrote

I have now been able to find a Roman coin on which we shall be pleased for you to carry out a microscopic examination and other non-destructive tests. I should be glad if you would be good enough to return it in due course and shall be interested in your findings.

Lawrence reported on his initial findings for this Gordian III coin in mid May and discovered that there was a new curator at the Museum, Mr Alan Warhurst, who gave him permission for destructive tests on the coin.

Mr Warhurst issued the coins from the Burton Latimer hoard (mostly minted during the reigns of Carausius and Allectus) to Lawrence in batches and he produced tabulations and histograms of their weights which led him to suggest that

... there was no precise weighing of the blank before coining but that the pieces of metal were cut approximately to the right size in appearance.

Measurement of the specific gravity of two of the coins hinted at the likely composition of the bronze, but he was denied the destructive analysis that would have revealed more.

A report of Lawrence's work was published in a local newspaper in November 1955 but this erroneously presented the destructive tests on the Gordian III coin as though these had been performed on one of the Burton Latimer hoard coins.

& Northamptonshire Advertiser, Friday, Nov. 4, 1955.



ROMANS FOUND A WAY TO DISGUISE COINS: SECRET IS DISCLOSED

EXPERTS were intrigued when they examined a hoard of 108 Roman coins found buried in a field at Burton Latimer last year. For some of the 1,600-year-old coins showed distinct traces of a thin silver wash on their surfaces.

How did the silver get there, since the Romans, for all their accomplishments, had no knowledge of electroplating?

In an attempt to find the answer Mr. L. H. Cope, a keen numismatist, has been enlisting the aid of some of the modern apparatus at Corby Technical College, where he is lecturer in metallurgy.

After a number of experiments he believes he may have hit upon the method used by the Romans.

He mixed silver ore with a strong brine. And he found that if a coin was dipped in, and at the same time given contact with an iron surface, an electrolytic cell was set up sufficient to produce a silver coating.

"So far I have managed to make only a soft coating that wears off quickly," he said. "But it is possible the Romans may have hit on something like this, since the materials necessary were easily obtainable at that time."

Mr. Cope, whose home is at "East View," New Road, Geddington, was elected a Fellow of the Royal Numismatic Society a fortnight ago, largely because of his research into ancient coins.

He was given permission to experiment with the Burton Latimer hoard—found on

the farm of Mr. W. D. Evans—by Mr. Alan Warhurst, curator of Northampton Museum.

First job was to get rid of the thick coating of verdigris. This he accomplished, after several experiments, by using ordinary household ammonia.

Before examination a coin was polished to a mirror finish, then etched with acids to show up the structure more clearly.

Microphoto

Finally Mr. Cope made use of the College's £1,000 photo-micrography equipment, used in advanced metallurgy studies, which is capable of giving up to 2,000 magnification.

The photographs that resulted showed the structure of the coin in minute detail and gave valuable clues about the methods used in minting.

To complete the examination Mr. Cope destroyed one of the coins to analyse it.

How were the coins made? Mr. Cope's research shows that the small pea-shaped blank was placed between two dies and hammered flat. This accounts for the fact that the coins are of different shapes and many different weights.

The head on the die was engraved. But each letter was punched in individually,

the process being repeated at regular intervals to keep the lettering clean.

"Thus each coin is virtually an individual one," says Mr. Cope. "Modern mass production methods do not lend themselves to the same fineness of detail."

Before starting on the Burton Latimer coins Mr. Cope examined, at the request of Northampton Museum, a "silver" coin of the reign of Gordian III.

Photo-micrography showed that the structure was bronze, deliberately coated by a process of mixing silver and mercury into a paste and placing it on the blank.

"It was an inflationary period at the time," he says. "And by this method they were able to produce silver coins at little more than the cost of bronze ones."



HERE are Mr. Cope's photographs of two of the Burton Latimer coins, magnified two and a half times. The head (top left) is that of Marcus Aurelius Valerius Carausius, a Belgian who was given a command in the Roman Army and later set himself up as "Emperor of Britain." Carausius was murdered by his admiral Allectus who succeeded him and continued to strike coins of which the one pictured above is an example.



MR. L. H. COPE, lecturer in metallurgy at Corby Technical College, examines an ancient coin with the aid of the college's valuable photo-micrograph equipment.

In May 1955 Lawrence applied to join the Royal Numismatic Society and in June he started correspondence with Dr CHV Sutherland at the Ashmolean Museum in Oxford regarding the silver wash on coins of the later years of the 3rd century AD and the early years of the 4th.

In November Dr Sutherland sent him eight coins from the period AD 295-305 from the Fyfield hoard with a view to investigating the silvery deposit on their surface in the light of the recent suggestion by HL Adelson in the American Numismatic Society publication *Museum Notes* that this deposit was not intentional but the result of a chemical reaction while the coins were in the ground. Dr Sutherland wrote

The whole set up of the Diocletianic coinage is so obscure that it is most necessary to decide just what was deliberately put into the token coinage as a preliminary to deciding what was the relationship between this and the coinage next highest in the scale, i.e. silver. For it remains true that even today,

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after nearly a century of enquiry, we do not know the precise denominational relationship between this token coinage and the silver! I am very glad to think that you are continuing to deal with this problem and I shall, as I say, be most interested to read your future results.

During 1955 Lawrence became concerned that his career was not progressing at Corby Technical College and he started to apply for alternative posts. After a lengthy vetting he joined the Reactor Division of the UK Atomic Energy Authority at its headquarters in Risley, South Lancashire in August 1956 and was transferred to the fast reactor development site at Dounreay, Caithness in June 1958. No longer having access to technical facilities for personal study the practical side of his investigations were suspended and he had

to content myself with a theoretical study of the development of Imperial bronze coinage alloys based on the existing published analyses only.

However, his work on the development of alloys for fast reactor fuel elements brought him into contact with a number of specialist engineering companies and university research departments which would later prove useful.

In August 1963 following the death of his father he secured a transfer back to Risley in order to be nearer to his mother while helping her with the administration of his father's estate.

In October 1963 Lawrence reached the highest level of his profession when he was elected a Fellow of the Institution of Metallurgists.

1965

In the autumn of 1965 Lawrence re-started his coinage research in earnest. He had formed the opinion that the minting of coinage and the composition of the alloys used during the Roman Empire would have been strictly regulated and that monetary reforms should therefore be visible as step changes in composition at specific dates. When he plotted a graph of the existing published analyses he felt that the fuller picture was being obscured by the wide scatter of assay results. This he attributed to poor pre-analysis sampling, a lack of precision in identification and dating, and poor analytical techniques (particularly prior to the standards set out by Professor ER Caley). It was these short-comings that he set out to improve on and with the addition of metallographic examination he hoped also to obtain a clearer picture of the evolution of coinage manufacturing practices and the mint-workers' understanding of metallurgy.

In October Lawrence approached the museums of Warrington and Chester with a request for suitable coins for destructive analysis.

In November Lawrence contacted the classics master at his old school seeking a translation of Codex Theodosianus IX,21,6 (mentioned in Adelson's paper) - an edict of AD 349 regarding the unofficial extraction of silver by mint workers from 'maiorinam pecuniam' being made a capital offence. The schoolmaster suggested that an expert in the late Roman Empire might be able to improve the translation he was providing and Lawrence then asked Professor AHM Jones of Cambridge University to review it. Professor Jones made a small revision to the final phrase and noted

maiorinam pecuniam should mean 'big copper coins' & probably refers to what numismatists call 'folles'

In December Lawrence arranged for six folles with the most obvious white metal wash (from the Fyfield hoard and received 10 years earlier from Dr Sutherland) to be examined at the British Steel Castings Research Association using spectrographic analysis to identify the white surface layer and the composition of the base metal.

1966

In January Lawrence reported the initial findings to Dr Sutherland that

the wash is identified as silver in every case. But there is not simply a superficial layer, silver is present in the base metal too. The percentage is now being determined, but we suspect that there are higher levels than can be accounted as natural impurity, and that the alloying of silver with the coinage bronze is deliberate.

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The silver in the bronze was obviously intended to be there (in the bigger coins) certainly at the time of Constantius II to warrant the edict of AD 349 warning those who removed it.

You will appreciate that this positive evidence of a silver 'wash' being upon a silver-bearing bronze base contrasts with my previous discovery of the Gordian III silver-clad bronze of which the base alloy is silver-free, and with the evidence of Hedges & Robins in the 1963 Numismatic Chronicle in which they assume and almost prove that the silver is only at the surface of the bronzes which they examined of a similar period.

My good friend Dr G Hume – Head of the Dept of Metallurgy at Wednesbury has now given me the opportunity to guide research projects for two students taking a Higher National Diploma. I have briefed them on further metallographic and analytical work which needs now to be done on the coins and on others of the period. I have also a good silvered bronze antoninianus of Salonina from Chester for examination. It seems that the time is now ripe for a systematic study to determine which issues contained silver, and how much; what evidence there is that some of it was removed (wholly or in part) by the illegal acts of the flaturarii; and which alloys are capable of being silvered, washed deliberately, or by natural corrosive environments. [NB: *Salonina coin was actually from Warrington - code W8.*]

In January Lawrence sent 11 of the coins received from Warrington and Chester museums to the County Technical College, Wednesbury for the two student research projects. The college offered support to Lawrence's research by performing wet chemical analyses of coins which would be carried out by Mr Harry Billingham over the next few years. They also provided a metallurgical microscope which Lawrence would use at home for the metallographic work.

In February Lawrence made contact with the Department of Coins and Medals at the British Museum with photographs of the Gordian III coin and received a reply from Mr Robert Carson (then Deputy Keeper) indicating that it was a forgery based both on Lawrence's 1955 analysis of the metal composition and the mismatch between the designs of the two sides of the coin. Lawrence then prepared a paper "A Silvered Bronze False Antoninianus Ascribed to the Roman Emperor Gordian III AD 238-244", which was reviewed by Professor FC Thompson of Manchester Museum in March, by Robert Carson in May and published in the January 1967 issue of *Metallurgia*.

Also in February Lawrence approached the museums of Birmingham and Colchester with a request for coins for destructive analysis and received batches of coins from both in April and May respectively.

Early in April Lawrence visited the British Museum for a first meeting with Robert Carson in which he explained his analytical interests as alloy classification and silvering. In his notes from the meeting Lawrence recorded

Carson would like to solve the XX-I problem. Italian paper suggested 5% silver in coin as a possibility but no analyses quoted to substantiate this.

P.M. [i.e. maiorinam pecuniam] not yet identified; not known which [coin type] contains the silver.

Following the meeting Lawrence wrote to Robert Carson

It was good to find a mutual desire to get to the bottom of the silvering and silver content of the antoniniani and folles. I believe this can be done over the next few years by a systematic approach to the subject, with analyses at strategic points of time and mints of issue.

There is a great dearth of analytical evidence between AD 305 and 350. This is where I hope to concentrate my own research ... especially of the all-important few years just before AD 349, which should throw more light on the edict of that date.

Again in late April Lawrence wrote to Robert Carson

I have had another critical look at the available analyses including neutron activation. I am growing more convinced that so far as the large folles of the AD 296 reform are concerned, the analysts have been recording total silver without distinguishing between the superficial coating and the silver in the alloy base. This may explain the results varying from 0% to 5% silver - depending on the degree of preservation or loss of the original coating. I assume for the moment that this coin series contains no silver in the base alloy; no analysis clearly shows otherwise. All the (admittedly slender) evidence points to a plain or leaded alpha bronze base coated originally with 5% silver. Metallography of the Fyfield folles which I have had completed this week shows such an alloy base with an extremely fine grain structure which might be expected of a coin struck from a heated flan. This would have speeded and cheapened production and lessened wear on the dies.

Another study of the bronze analyses into the 4th century reveals no 'wet chemical' analyses of the larger coins of the 346-349 period. From the literature it appears that several attempts have been made to explain the edict of 349 without any relevant analyses! Or it has been correlated with quite distant issues.

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By June some results of wet chemical analyses were starting to come through from Harry Billingham at Wednesbury Technical College, and Lawrence reported on the progress to the donors of the coins. In doing so, he also made them aware of the coins that he was seeking for the next stage of his research. In response Chester Museum donated a Galley type of FEL TEMP REPARATIO - coin code Ch18.

In late June Lawrence wrote to Robert Carson

I think I have evidence now, and some reasoning, to identify the 'centenionalis' - in conformity with its literal meaning. Mattingly considered it to be synonymous with the 'maiorina pecunia', but I think that there is a distinction. I believe it to be the AE2 'Fallen Horseman' type of the FEL TEMP REPARATIO series, of the same module as the 'Galley' variety which I identify as the true 'maiorina pecunia' of the edict of 349. If the earliest 'Fallen Horseman' issues can be shown to contain in the region of 1.4 to 1.5% of silver in the alloy, then I think we have the answer.

In mid July Lawrence started approaching more museums for suitable coins and received a positive reaction from about half of them - namely Bristol, Leicester, Lincoln, The National Museum of Wales and York. He wrote summarising his work so far and what he planned to do.

In particular I am investigating the problems of silver in, and on, the third and fourth century bronze coinage. So far, with coins donated by several museums, it has been possible to identify with reasonable certainty the 'maiorina pecunia' of the Codex Theodosianus edict of AD349; and to distinguish this from the 'centenionalis'.

I can also disprove one theory that XXI on some coins means 5% silver.

At the end of August Lawrence enquired about the possibility of publishing a paper in the *Bulletin of the Historical Metallurgy Group*. Writing to Dr RF Tylecote, the honorary editor, he stated

I have a paper in draft (written with the analyst) covering a dozen new complete analyses of important Roman coin types of the late third and early fourth centuries. It covers simply the numismatic details, the analyses, and the deductions from the results; and it is a fairly short paper. Nevertheless it could make a very significant addition to the recorded full analytical results - which only amount to about 180 over the whole of the last century of enquiry.

Dr Tylecote replied that he would be glad to have the paper but there would be little space available in the January issue and

I therefore feel that it would be best to defer it until the July 1967 Bulletin. This will give you more time for additional analyses.

In September Lawrence wrote to Prof Thompson at Manchester Museum to report that the analysis for coin M4

gives positive evidence of a substantial silver (addition) content within. It does not compare with the silver-free Alexandrian folles analysed by Brazener a long time ago, and it seems to refute Lewis's claim that (on the basis of analyses of some folles of Western Mints) the follis was essentially a plain silver-free bronze coin. Since those folles were near-contemporary with this analysis this suggests different practices between the E & W mints - and possibly different policies governing the coinage issues in extremities of the Empire.

Professor Thompson replied

Carry on the good work. With regard to your remarks regarding differences between mints in the boundaries of the Empire I am in whole-hearted agreement.

In late September Lawrence wrote to Robert Carson with the analysis for a 'Galley' coin - coin code BM17 - saying

We see again the now familiar heavily-leaded alpha-bronze alloy base. The silver content (2.17%) is close to those already reported for the Galley type in my previous results. The overall compositions of these coins appear to have been fairly well standardised.

A comment on the alloy type is that these heavily-leaded alpha-bronzes closely resemble what are used today as bearing metals in heavy duty diesel engines. The ease with which they can be cast ... and their anti-friction properties, would have enabled mass production of coins with minimal die wear.

The same day Lawrence wrote to Professor Thompson mentioning the same analysis results with

I believe I am getting nearer to confirming that this is the argentiiferous bronze 'pecunia maiorina' of the Edict of 349.

I have now some 300 or more Roman coins covering the 1st to 5th centuries but cannot progress the work faster than one analysis a week. Six years or more will be needed to do the survey of metallurgical alloy development which it is my ambition to achieve. I find I can get a commercial

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analyst in Liverpool to give an accurate complete analysis for £8 per coin. They are interested in the project, which could provide them with steady work to fill the gaps between their rush jobs - hence the reduced fees quoted. Can you advise how I might raise funds for some or all of this work?

In his reply Professor Thompson advised

I know of no national organisation from whom you would have any hope of help.

Would there not be much to recommend taking the work in small doses and getting a bit done and published. You would then have something concrete with which to ask for further help.

In mid October Lawrence wrote to Robert Carson with the analysis for coin code BM11 saying

Once again, the leaded alpha-bronze alloy with silver present. This time the silver content is almost half of that discovered in the Galley coins. This is the first 'Hut' variety I have had analysed.

A few days later he met with Carson at the British Museum to report on progress and discuss possible subjects for publications. With respect to folles he noted

Pattern emerging, need for more early folles other than Rome or Trier.

And with respect to the Fel Temp series

Alloy type such that it is difficult to believe they could be silvered by immersion in silver-rich alloy. Another method would have had to be used.

In November Lawrence wrote to Robert Carson with the analysis results for coins coded BM18, W3 and W5. For W5 he wrote

It is clear that no silver was intended in this coin. It is not even present as an impurity. Since this issue preceded the Fel Temp series it shows that silver in the latter issues was most likely the result of deliberate addition and it shows that silver could be excluded (or extracted) in the years before the evidence of 349AD.

In December Lawrence applied for a Research Award from the Leverhulme Trust in order to commission commercial analyses stating

18 new analyses [have been] completed in the last year

it now appears:

(i) that the follis of Diocletian's reform did have a silver addition to the base alloy as well as a silvered coating; that later the silvered coating was retained but the silver in the base alloy was reduced to zero.

(ii) that variations did exist in the metallurgical practices and the coinage materials used at mints remote from each other, and at the same time under the Eastern and Western administrations of what was seemingly one Empire.

(iii) that evidence can be produced now for the identification of the 'pecunia maiorina', the 'centenionalis' and the 'decargyrus' in metallurgical terms which conform with the literal (but hitherto puzzling) meanings of those terms in the ancient literature.

Robert Carson wrote a strong letter of support for the application, but an award was not forthcoming.

1967

In January Lawrence received the results for the silver content of the cores of the six folles from the Fyfield hoard, which was determined by chemical analysis using drillings taken from a fine hole drilled from the edge into the interior of the coin and found to range from 0.8% to 3.6%. Lawrence wrote to Dr Sutherland

I think now that Adelson (1954) was wrong. When there is a silvered surface it is almost certainly the consequence of a deliberate argentifising process.

In January Lawrence wrote to Mr GC Boon at the National Museum of Wales with the analysis result for the coin coded NMW1 saying

I am now pleased to report that this analysis helps to substantiate my theory that the FH types were the original 'centenionalis' - literally 'containing 100 parts' (grains of silver) per pound of coinage alloy. If the Roman Pound contained 7200 (wheat) grains, 100/7200ths would equal 1.39% silver: this is exactly the average of two determinations made on one half of this coin. Even on a wider assumption that 6912 wheat grains go to the Roman Pound (i.e. 24 to the scruple) the analysis is still very near to the resultant 1.45% theoretical.

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Mr Boon replied

I feel that your suggestion of the interpretation to be given to that vexatious term *centenionalis* carries conviction, and must at the very least lead one to re-examine the possibility that the XXI of the reform coins of Aurelian, etc. refers to the alloy, as Mickwitz and Bolin believed.

Naturally you must get hold of other early Fel Temps. All I can find here, that can be spared, are the enclosed two, both, I'm afraid of eastern mintage. I am wondering whether you might not write with advantage to the Director of Reading Museum, Mr TL Gwatkin, MA, mentioning my name.

Lawrence followed up this suggestion and received a batch of coins from Reading later in the year.

In February Lawrence wrote to Sir Mortimer Wheeler, secretary of the British Academy, outlining his work and asking

Is there the possibility that the British Academy would support the work in this neglected field of Roman numismatic studies?

Sir Mortimer replied enclosing the conditions under which the Academy gave contributions to research funds and said

If you care to send an application between now and the end of the year it will be considered for 1968.

Early in March Lawrence received 3 coins via Robert Carson which had been donated for analysis by RNS Fellow J I A Bromwich and Lawrence sent 2 of these coins coded Bromwich1 and Bromwich2 for commercial analysis by Alfred H Knight of Liverpool and when the results were returned three weeks later, Lawrence relayed them to Carson.

At the end of April Lawrence submitted the manuscript for "The compositions of 35 Roman bronze coins of the period AD 284-363" which was published in the July 1967 issue of the *Bulletin of the Historical Metallurgy Group*.

In May in a letter to Mr Boon, Lawrence wrote

My work on alloy standards does strengthen my belief that the XXI mark means 20:1 with reference to the silver content; but now I don't think it means '20 bronze to 1 silver' - i.e. 5% silver alloy as previous commentators have suggested. I think it is the other way round; i.e. 20 units (scruples, obols or some other weight units) of silver to 1 libra of bronze.

In June Lawrence submitted the manuscript for "Roman Imperial Silver Coinage Alloy Standards: The Evidence" which was published in *The Numismatic Chronicle* for 1967.

In June the two student research projects at the County Technical College, Wednesbury were completed. "An investigation into the production of silver-coated Roman Imperial coins of the 3rd century AD" by Mr RB Reed demonstrated the impracticability of coating coins by dipping in molten silver-rich alloy. "An investigation to determine how silver might have been illegally extracted from 4th century argentiferous tin bronze coinage alloy" by Mr WF Smith showed that the extraction of silver by melting with lead as described by Agricola in "De re metallica" in 1556 was effective independent of the quantity of tin in the bronze.

In July Lawrence approached more museums for suitable coins and again received a positive reaction from half of them - namely Carlisle and Hereford. He wrote a similar letter to that used in 1966 summarising his work so far and what he planned to do. This time he stated

In a paper, now accepted by the Royal Numismatic Society, I have provided evidence for the existence of definite alloy standards for the composition of the silver coinage. I have turned also to the solution of problems of the folles, and have evidence that this was originally a standard silver-bearing alloy containing 20 obols of silver to the libra of bronze, and that it was additionally coated with silver.

Towards the end of September Lawrence wrote to Robert Carson saying

I suspected evidence of a coinage policy change (with respect to fineness) somewhere between AD317 and 321, and this is starting to show up.

I intend to concentrate this autumn on the large folles of c.AD294 to AD306. If this period is done thoroughly it may be possible to produce a worth-while paper for NC 1968.

Around this time Lawrence submitted the manuscript for "The composition of 26 Roman Imperial silver and bronze coins minted between AD 206 and 360" which was published in the January 1968 issue of the *Bulletin of the Historical Metallurgy Group*.

In October Lawrence made arrangements to use facilities at Warrington Technical College to perform wet chemical analyses himself. For insurance purposes he had to sign on to an evening class course in

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chemistry and in a future year he was much amused when, as he was renewing his membership of the course, it was queried why he had not yet managed to pass the exam!

In December Lawrence submitted the manuscript for “The argentiferous bronze alloys of the large tetrarchic folles of AD 294-307” which was published in *The Numismatic Chronicle* for 1968.

In December Lawrence again applied for a Research Award from the Leverhulme Trust to commission commercial analyses stating

I have already made a little progress towards the main objectives by the completion and assessment of 61 new complete analyses and associated microscopical studies.

Again, an award was not forthcoming.

Also in December Lawrence made an application for a Research Award from the British Academy of £480 to commission commercial analyses for “60 coins of the silver series”

commencing with the initial series of deliberate debasements which are believed to have commenced in the reign of Nero and to have continued for just over two centuries before there was any serious attempt at restoration.

In May 1968 Lawrence received an award of £250 and used this to purchase analyses for 30 coins.

1968

On 1st March Lawrence delivered a lecture entitled “Metallurgical aspects of Roman Imperial coinage: the Silver and the Bronze” at Wolverhampton to a joint meeting of the West Midlands branch of the Institution of Metallurgists and the Wolverhampton Applied Science Society.

In mid April Lawrence wrote to Mr GC Boon at the National Museum of Wales stating

I am planning now to cover the issues of reduced folles - through the stages of reduction - from AD307 to 319. This will be for a paper in NC1969. The material I have is a bit ‘gappy’, so I could do with anything which you may have to spare.

Today I was with RAG Carson for a short while. He has filled a number of lacunae.

I have also written to CHV Sutherland. The greatest needs are for Maxentian folles, Divo Constantius, Balkan and Eastern early reduced folles, and Sol and Iovi types. Analysis results to date show the Maxentian coinage to be the most variable in composition.

Constantine’s Sol coinage appears, now, to have been made to at least 2 different silver standards either side of c.310. Licinius seems to have had a separate policy for coinage alloys and their finenesses, as does Maximinus before him. An interesting feature of one of your coins (NMW12, with 1.07% silver) is that it shows a precipitate change whereby the 6.5g folles are related in intrinsic worth to their larger predecessors in the proportions of 10 to 3. Some inflation! An Alexandrian coin of slightly later date (with the same weight std) confirms this. The value of this work is that it is becoming possible to put some facts and figures into numismatic concepts which have been a bit too conjectural hitherto.

Mr Boon replied

Thank you for another splendid note & how much I look forward to your papers in NC. Now I have scraped the barrel for you, and send what I can - no DIV.CONST. I’m afraid, a few Maxentian & Sol & Jovi pieces of Constantine and Licinius.

In May Lawrence submitted the manuscript for “Chemical analyses of 31 large Roman bronze coins minted between AD 294 and 307” which was published in July 1968 issue of the *Bulletin of the Historical Metallurgy Group*.

In May Dr Tylecote who had been closely involved with the excavation of ancient copper mines and processing sites at Timna in Israel wrote

I enclose herewith 4 pieces of copper-base alloy from Israel (Timna II) for you to analyse. I should like to know most the As content, which I suspect will be appreciable.

Lawrence arranged for X-ray fluorescent, X-ray diffraction and mass spectrographic analyses of these samples at the BSA Group Research Centre through his close friendship with Donald Oliver, the Director of Research. The results were conveyed to Dr Tylecote in September.

In July Lawrence visited the University of Surrey to see Professor Malcolm Waldren (previously a colleague at UKAEA) to review a student final year project “An investigation into the metals and fabrication processes used in the production of Roman Imperial coins, from a metallurgical aspect” by

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Mr P Pedley. Further student research projects would follow at the University of Surrey each year from 1969 to 1972.

Between August and December Lawrence received the results of the analyses for 30 coins purchased by means of the grant from the British Academy.

In October Professor Patrick Bruun, replied to a letter from Lawrence saying

I'm very interested in your research programme, which, I'm sure, will cover some of the gaps in my RIC volume. When I was preparing my book it was desperately difficult to find people with a real interest in the metallic composition of the coins.

I was very glad to see your first instalment published in NC 1967, and I'm very much looking forward to reading the continuation.

Correct identification of coins was vital to Lawrence's research and he regularly cross-checked the identifications from donors and from his own examination after careful cleaning with Robert Carson.

On quite a few occasions this process turned up a coin of known type for which the British Museum had no example and arrangements were then made for the coin to be added to the BM collection. Exceptionally, coins were found that were of a previously unrecorded type. A Siscian denarius argenteus of Maximian, (NWM46 from a batch of coins donated in August by the National Museum of Wales) was found to have a unique variation of its mint mark and was returned to the NWM; and a quinarius of Allectus (CJO22 from a batch of coins donated anonymously in May) was found to have a previously unrecorded obverse inscription and was added to the BM collection. These finds were reported in November in the *Warrington Guardian* under the headline "Rare Roman coins in museum 'rubbish' " and the story was then picked up by national newspapers including *The Guardian* and *The Daily Telegraph*.



In December Lawrence submitted the manuscript for "Chemical analyses of some weight-reduced Roman folles minted between AD 307 and 318" which was published in the January 1969 issue of the *Bulletin of the Historical Metallurgy Group*.

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In January Lawrence wrote to the British Academy regarding the analyses purchased with the grant saying

I believe that there are important new findings, based on much more accurate and complete metal assays than have been available hitherto, which will be worthy of a paper to the Royal Numismatic Society. I propose to submit a summary report to the British Academy later this month - together with an application for a further grant in 1969 to explore some of the issues indicated by the present work.

In his application to the British Academy for a grant of £620 to commission 62 analyses, Lawrence said

The new work proposed emerges from what has now been learned of the composition of the coinage alloys of the earlier Imperial era. There are 30 antoniniani of the 3rd century available for assay to cover the period of the most severe steps in debasement and the apparent developments of modified alloys between AD 240 and 296. Another 32 selected antoniniani will enable the first reliable comparison to be made of the standard alloys in vogue for the contemporaneous issues of Gallienus and the Gallic Emperor Postumus, and a study of the coinage of the British Emperors Carausius and Allectus which has never been undertaken before. My exploratory analyses suggest that there are distinctive features which mark independent alloy-selection policies on the part of the Roman, Gallic and British Emperors.

In May 1969 Lawrence received an award of £300 from the British Academy's Albert Reckitt Archaeological Fund and used this to purchase analyses concentrated on the antoniniani of Postumus.

In February Dr Sutherland wrote

your last contribution to the 'Bulletin of the Historical Metallurgy Group' together with your immensely interesting article in the newly published *Numismatic Chronicle* have now got me to the

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point of writing to say how much I admire the results which you are now producing in such abundance. In respect of the article in the Chronicle, this has taught me a very great deal indeed, for it has produced the factual evidence for changes in the monetary system round about AD 300 and just after which I seemed to perceive on other grounds but for which I had no independent hard evidence. What you are in fact doing, and doing in such a full and admirable way, is to write a scientific appendix, with historical implications, to what was included in my volume.

Following Lawrence's reply, Dr Sutherland wrote

I note with pleasure that you are advancing systematically, and that you have done thirty complete assays of the coinage from Vespasian to Constantus, and I do hope that a renewed British Academy grant will materialise so that you can go ahead still further. In all ways, the programme which you have set yourself is one of extreme interest and, of course, I do so greatly admire the fact that you are not simply on the look out for the percentage content of a major metal but that you are equally interested in the representation of so many of the minor alloy-metals as well.

At some point it had been suggested to Lawrence that the research he was doing might be worthy of a Masters degree or Doctorate and in February he took the first steps to explore this with the Council for National Academic Awards. Initial approaches to colleges for enrolment for a CNAA higher degree where rebuffed largely because the subject was unusual and potentially straddled both science and arts disciplines. With persistence Lawrence found support at Liverpool Regional College of Technology (in 1970 this became a part of the newly created Liverpool Polytechnic which is today known as Liverpool John Moores University) and was formally registered with the CNAA as a candidate for a degree of Master of Philosophy (with possibility of transfer to PhD) early in September 1969. The aim of the research was

To produce an authoritative work on the composition of the metals and alloys of the Roman Imperial silver and aes coinage, as they varied during five centuries of changing monetary policies, mineral resource exploitations, and coinage alloy developments.

Lawrence's supervisors were Robert Carson plus Dr MA Zammitt from the college with Professor Patrick M Bruun, University of Turku, Finland (author of *Roman Imperial Coinage* volume VII) and Professor ER Caley, Ohio State University, USA as additional advisors.

In March Lawrence repeated his lecture entitled "Metallurgical aspects of Roman Imperial coinage: The silver and the bronze" to the Metallurgical Society at Lanchester College of Technology at Coventry.

In March Lawrence visited the University of Surrey to discuss a student final-year project which he would supervise and which would investigate the methods of fabrication of early 4th century coinage. The outcome of the project was referenced later in Lawrence's paper "Die-module measurements, and the sequence of Constantine's reformed folles issues of Spring AD 310 and of early AD 313".

In April Lawrence submitted the corrected proofs for "The sequence of issues in the long T/F series of Constantinian folles minted at Trier, AD 309-315" which was then published in the August 1969 issue of *Schweizer Münzblätter*.

In April Professor E R Caley wrote

I have read with considerable interest your paper on the composition of tetrarchic folles which appeared in the last volume of the Numismatic Chronicle. It is my opinion this is a very important contribution to our knowledge of this group of coins.

In April Lawrence submitted the manuscript for "The chemical composition of the bronze coinage of Maxentius, AD 306 - 312" which was published in the July 1969 issue of the *Bulletin of the Historical Metallurgy Group*.

In April Robert Carson wrote to say that one of his students had just returned from Yugoslavia with a message from Dr A Jeločnik at the Narodni Muzej in Ljubljana that he was very interested in investigation of the folles of the Maxentian mints and would be happy to provide material for destructive analysis. Lawrence exchanged correspondence with Dr Jeločnik who then sent 10 coins (NML1-10) via the British Museum in May. The coins were analysed by Harry Billingham at Wednesbury and the results conveyed to Dr Jeločnik in September. In November Lawrence carried out confirmatory analyses of the two most heavily leaded coins (NML6 & 7) and wrote to Dr Jeločnik

The new results confirm my suspicion that the segregation of the insoluble lead-phase does affect the alloy distribution within the coins and the slightly higher silver proportions in the larger samples support my interpretation of the alloy fineness standard as one of 4 scrupula per libra.

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This work was the subject of “Further analyses of the bronze coinage of the Roman Emperor Maxentius, AD 306-312” which was published in the January 1971 issue of the *Bulletin of the Historical Metallurgy Group*.

In May Robert Carson wrote

I am planning the RNS programme for next session and wonder whether you would like to give us a paper: perhaps something on the rôle of metallurgy in numismatic research, methods of analysis, and a more detailed exposé of the application to one specific question and the results.

Lawrence agreed and was booked to speak to the RNS meeting on 21st April 1970.

In May Lawrence wrote to Patrick Bruun

Mr RAG Carson will already have written to you asking for your views on a matter which I have raised as a result of chemical analyses of some folles. It is that the eastern folles dated AD 317 to 320 in RIC VII might well be the higher of two denominations - of which the other is the XIII^r-marked piece, of smaller dimensions, which you list as being of AD 321-324. The ones with the J1 bust are richer in silver content, and we might regard them as 25d pieces. The Imperial Inscriptions would, I think, allow both groups to be dated AD 317-324.

Now, another matter arises out of my studies of the dimensions of the reduced folles. I find that the earliest issues of Arelate are in fact of larger diameter (of the die circle) than the last issues of Ostia, and that there are very few of the early Ostian issues with the larger of the dimensions of the folles of Rome of Oct 312 to early 313. The implications are; that Constantine did not begin to use Ostia as a mint immediately after its capture, but just before he effected a coinage size-reduction at Rome - from 22 to 19 mm; that the mint of Arelate commenced operation with the larger of the sizes, and before Ostia closed. The transfer of mint-personnel appears to have occurred during the second series of PARL issues which include the Providentiae Augg and Utilitas Publica issues (of 19 mm dia.) normally associated with the transfer.

In June Patrick Bruun replied

Thank you very much for your highly interesting letter ... I'm absolutely thrilled by the prospect of your metallurgical findings establishing a link which seems to approach the character of absolute proof between Ostia and Arelate. The earlier link suggested by me and others was based on resemblances of type and on probabilities. Now, it seems to me, we - or rather, you, - are approaching the truth. As a matter of principle, I do not stake my reputation on the correctness of my assumptions: I'm only too happy if the tentative arrangements of RIC vii can be substituted by something really solid.

I'm keenly looking forward to hear more about your findings about the AE (so called) denominations for the period AD 317-324, and to checking them against the material and, particularly, the hoards. Nobody has so far, despite the abounding dates in the papyri, been able to describe and analyse the economic policy of Constantine, particularly in relation to the measures taken by Licinius and we cannot overlook the fact that the Empire all the time must have been an economic entity.

In June Lawrence returned the proofs to Robert Carson for “The nadir of the Imperial antoninianus in the reign of Claudius II Gothicus, AD 268-270” for inclusion in the 1969 volume of *The Numismatic Chronicle*. In his response Robert Carson agreed to a suggestion made by Lawrence with

Dear Lawrence, I fully agree that we have worked together so long that it is rather ridiculous to maintain formality, even for a dour Scot!

In July Professor FC Thompson wrote

I am very pleased to hear of your increased grant from the Academy. It will I know be well spent.

You were good enough to offer to assist my work on the Channel Islands hoard. Two things would be of real assistance. In the first place a couple of complete analyses would round off the first stage, though in view of your own needs I should not dream of this, and I can do without them.

Lawrence did agree to analyse two coins and gave these codes M10 and M11 when he received them in September. He reported the analyses to Professor Thompson early in 1970 and these were included in “The Manufacture of Celtic Coins from the La Marquanderie Hoard” by FC Thompson and MJ Nasir in the 1972 volume of *The Numismatic Chronicle*.

In September Lawrence gave a talk about his research to the Rotary Club of Leigh, Lancashire and this was reported in the *Leigh Journal*.

In September Lawrence submitted the manuscript for “Die-module measurements, and the sequence of Constantine's reformed folles issues of Spring AD 310 and of early AD 313” for publication in *Schweizer Münzblätter*. In early October the editor, Dr Kapossy, wrote apologising for the delay in acknowledging receipt of the manuscript and said that he was surprised that it made no reference to a

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book published earlier in the year by P Bastien and H Huvelin - "Trouvaille de folles de la période Constantinienne (307-317)" and added

Your last paper has stirred up a lot of dust here. A not very friendly response from P Bastien appears in the coming issue.

Within a week Lawrence had obtained a copy of Bastien and Huvelin's book via Robert Carson (who also said that Patrick Bruun was reviewing it for *The Numismatic Chronicle*) and he then wrote to Robert Carson

I find considerable common ground - in both principle and detail - reached by our independent researches.

The main disagreement would seem to be the question of the dating of the 1/96 reform.

The advantage of my use of the BM collection for my data is that I have measured some key items which are not in the hoard which B&H publish - especially for the mints of Rome and Ostia. The hoard is not so complete.

In late October Lawrence wrote to Dr Kapossy

Yesterday I saw both Professor Bruun and Mr RAG Carson after they had both had the opportunity to compare the copy of my recent manuscript with the work of Bastien and Huvelin. Both have remarked that they see no reason for any changes in the text of my work, particularly since it establishes new points, of major importance, which Bastien and Huvelin have failed to discern. They have checked the die-measurements of the Ostian and Arelate folles which I mention, and confirm that I have established without doubt that Arelate commenced operations before Ostia closed and that both Arelate and Ostia issued coinage of 1/72- and 1/96-libra in the 21mm and 19mm sizes.

I await the text of Bastien's letter concerning my first paper, so that I can reply.

In November Patrick Bruun wrote

I was very glad for the opportunity of meeting you in London. I found our talks very rewarding, indeed, and remained very impressed by the results you have arrived at. I was particularly thrilled by your discovery of the denominational pattern of the Constantinian coinage. As far as I can see, and I have given the matter a great deal of thought during the last week, this necessitates a rearrangement of the Constantinian coinage, particularly of the VICTORIAE LAETAE, which obviously started in c.312 and went on with VIRTUS EXERCIT until new silver denominations were created at Sirmium c.322. Thus it ran alongside the Sol coinage.

With the publication of the November 1969 issue of *Schweizer Münzblätter*, it was in mid-December that Lawrence saw the full extent of Bastien's criticism of his previous paper. "A propos de l'article de Lawrence H Cope" was nearly as long as the original paper. Lawrence consulted Robert Carson on how best to respond and together they devised a plan. Accordingly, Lawrence wrote to Dr Kapossy

To reply in detail to each of Bastien's points - although possible - would be tedious and, I think, unnecessary. ... What I would like to suggest is that I take up with Bastien himself those matters which involve opinions, where there is obvious uncertainty of interpretation until more facts become available. I would then deal with the most important and fundamental matters in an introduction prefacing the second article which you are prepared to consider for publication. This second article does deal with some of the main points which Bastien raises. I will ensure that the text is further modified to cover his particular points of important principle.

In January 1970 Lawrence submitted a revised manuscript which was published in the May 1970 issue of *Schweizer Münzblätter*.

In his review of Bastien and Huvelin's book published in *The Numismatic Chronicle* for 1970, Patrick Bruun made a number of references to Lawrence's work including

In view of the large-scale analyses of the folles recently carried out by Mr. Cope and his collaborators, I think that these sections of the publication are less successful than the others. Mr. Cope is drawing an entirely new picture of the true character of the so-called bronze coinage of Constantine which seems to necessitate a revision of arrangements and dates of many coin series.

In December Lawrence sent a progress report to his research degree supervisors mentioning

Dr Robert H Brill, of The Corning Museum of Glass, New York, visited me on 9 Dec. to deliver and discuss lead-isotope analyses which he had obtained for me from Dr William Shields of the National Bureau of Standards, Washington, USA. I sent the samples in response to a general request for lead-bearing materials of ancient known provenance, just two years ago. I have now given Dr Brill further samples of some lead sulphate extracted from coins currently being analysed.

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As recently as 1965 Drs Brill and Wampler suggested that the differences in isotopic compositions of lead in galena ores should be sufficient to allow one to distinguish between leads mined in Greece, England, and Spain. ... The present work commenced when I added the suggestion that the lead in coin alloys might be used to determine whether Roman mints used local lead to make up alloys, or whether lead was transported much greater distances - either as metal or in the form of pre-prepared alloys. I submitted 13 samples of the remains of coins analysed for my paper in NC 1968.

None of my samples shows the low isotopic ratios which are typical of much earlier Greek pieces. Instead, a Heracleian FH3 has a Syrian lead in its alloy; the Antiochene and Alexandrian folles contain lead of local origin; a Milanese antoninianus of Aurelian contains typical Italian lead. The two rather exciting results, however, are: i) a suspected contemporaneous forgery of a Maxentian follis, supposedly minted in Rome, contains lead which is of a European source other than Italian - which could be Spanish. ... ii) an early follis of London - containing Gallic (not British) lead. This appears to be the first scientific evidence for the unmarked coins having been minted in Gaul in readiness for use in Britain.

Lawrence wrote an article "Roman Imperial Propaganda" which was published in the Christmas 1969 edition of *Culcheth Chronicle* - the staff magazine for the UKAEA Reactor Materials Laboratory (his place of work).

1970

In February Lawrence received a letter from Mr DF Allen stating

The Council of the Royal Numismatic Society is proposing to arrange a three-day Symposium on the Composition and Analysis of Coins between 9th and 11th December 1970.

Knowing that you have undertaken important research in this field, the Council has asked me to write to you now, before the Symposium is announced, to ask if you would be willing to be one of the speakers at it.

Lawrence wrote back

I count this as an honour, and I wish to accept.

He copied the invitation to his management at UKAEA asking

This is an honour which I ought not to decline. Do I need to take leave, or can it be treated as official?

Mr RW Nichols responded

I think that, (provided it says somewhere that you come from REML, UKAEA & so we share your honour) this should come out of official time. Please proceed on this basis.

In February Lawrence sent a progress report to his research degree supervisors mentioning

Full facilities are now available in the new Warrington Technical College for my use in performing wet-chemical assay of the nine elements which usually comprise a 'complete' analysis.

At present my studies are concentrated upon the Gallienic coinage - possible to separate this into its three metallurgical classifications and to discern some more positive chronological order than that which is currently available.

Pending the expected availability of pieces which will permit a thoroughly systematic study of the imperial era coinage I have made progress with isolated exploratory assays for periods for which there is little or no previous knowledge of the coinage alloys. My full chemical assays make useful comparison with electron-probe estimates made on the same coins at the University of Surrey. This year two more projects will be performed in the summer term and Professor Waldron has again appointed me as the Projects' Supervisor. One project will extend the fabrication studies which were used so successfully last year to demonstrate a feasible route for the minting of large folles. This time an attempt will be made to reproduce the metallurgical condition, size and weight, of typical more-highly leaded argentiferous-bronze weight-reduced folles of the '19mm, 1/96 libra' category of AD313. The other project will take the electron-probe analyses a stage further in their development; chemical assays of the bulk material will provide the norm.

I am presently reserving all extracted lead precipitates in anticipation of some use for lead-isotope analyses. Dr RH Brill has been approached for technical details and standards, in the hope that we can get similar studies made in the UK, with similar high precision. Dr P Bastien has sent me five 'unmarked' large folles. When they are positively identified I will proceed with conventional chemical analysis and then seek lead-isotope ratios. There is the hope that we can distinguish between coin alloys made in Gaul and in Britain. Some late Lugdenese antoniniani will also be compared, to look for a continuity of metallurgical practice.

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I propose a more limited publication of early results in the future so as to retain the more valuable original work for the thesis. In any event my principal concerns in the immediate future will be; the preparation of an introduction to the thesis; and the paper which is to be presented to the Royal Numismatic Society on 21 April.

At a meeting of the Royal Numismatic Society on 21st April 1970 Lawrence read a paper entitled "The Metallurgical investigation of Roman coinage". A summary of this paper appeared in *The Numismatic Chronicle* for 1970. A copy of the full text survives.

In May Lawrence sent a progress report to his research degree supervisors mentioning

Dr Gilmore now kindly provides neutron-activation assays, of gold, arsenic, and antimony, in the insoluble residues from the coin-dissolution stage. This saves much elaborate work and allows the determination of proportions too small for wet-analysis.

Some interesting results are emerging. Two of the 'moneys' asses of c. 22 BC possess over 0.5% silver, and exceptionally high nickel impurity levels (0.37 and 0.62%). The raw coppers must be of quite different origin from those of later Augustan pieces which are of higher purity. Vespasian's asses (the Cyprian copper mentioned by Pliny) are found to be of high purity but containing oxide laminations. An as of Hadrian is definitely a bronze - with 2.80% tin. A brass dupondius of Antonia Augusta is found to contain an unprecedented amount (6.35%) of lead, and the zinc content (13%) is the lowest yet recorded for pre-Neronian orichalcum.

Assays of Gallienic antoniniani provide increasing evidence of some sort of reform during the sole reign. A VIRTUS EXERCIT coin, at 2.78% Ag confirms that the issue can be grouped with the VICTORIAE LAETAE PRINC PERP issues. The SARMATIA DEVICTA coinage of London, RIC vii 290, with 1.67% Ag is definitely of the same fineness as the previous BEAT TRANQUILITAS issues.

Lead isotope ratios. Dr Brill hopes to obtain about 20 further results for me this summer. In the meantime Dr Zammitt is obtaining some results via SRC arrangements with Harwell.

In June Lawrence submitted the manuscript for "Further analyses of the bronze coinage of the Roman Emperor Maxentius, AD 306 - 312" which was published in the January 1971 issue of the *Bulletin of the Historical Metallurgy Group*.

In July Lawrence received a copy of the thesis of a student final-year project he had supervised at the University of Surrey which further investigated the methods of fabrication of early 4th century coinage (similar to coin CJO4). He wrote

I think it is a good piece of work. Of particular value is the confirmation it gives of a probable fabrication route which results in almost identical metallurgical structures to those of the genuine coinage, and similar weight distributions.

In July Lawrence provided a progress report on his degree work to the CNAA with an application to transfer to a PhD. He said

All the known literature relevant to the proposed plan of work has been scanned, including the most recent publications as they have emerged. In consequence, a systematic survey of the reliable coin analyses pertaining to the entire Roman Imperial era has been made and the lacunae have been positively identified. Material has been obtained to permit a more even chronological coverage than has ever been achieved before; this is with respect to the coinage issues in silver, brass and bronze, and copper.

Nearly 30 new coin analyses have been completed in the first academic year, covering periods for which there was little or no previous knowledge of coinage alloy composition.

The emergent results have been transmitted (either in personal discussion or by correspondence) to other leading numismatists in the UK and abroad - whence some of the material has come for analysis. Major critical problems have thus been identified, and the work is now orientated towards their solution within the scope of the general chronological survey of the material of the coinage.

In September the CNAA approved Lawrence's application for his registration to be transferred from MPhil to PhD.

In August Dr Sutherland wrote

Please accept my very best thanks for the kind gift of your important offprint from the Gazette Numismatique Suisse on Die-module measurements. This is a new angle of study which is plainly going to be of great value. Like all other simple things which are extremely practical, one wonders why people had not got on to this two or three decades ago as a proper criterion. However, the study is in good hands, and with you and Bastien working away on these lines, whether in parallel or not (!), we are bound to go ahead well.

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In September Lawrence reported the results of the analysis which Robert Carson had requested for a cast forgery from the Leysdown hoard. The full details of Lawrence's study of this coin (coded Ma 1B) were included in Carson's paper "Leysdown (Kent) Hoard of Early Roman Imperial Bronzes" published in *The Numismatic Chronicle* for 1971.

On 10th December Lawrence presented his paper to the RNS 'Symposium to discuss the various methods of analysing the metal contents of ancient and medieval coins'. The programme stated

Mr LH Cope, Principal Scientific Officer at the Risley Engineering and Materials Laboratory, UKAEA, Warrington, will present the results of a series of analyses of weight-reduced Roman folles, using destructive wet chemical analysis, and will discuss them with particular reference to the problem of sampling.

In December Lawrence sent a progress report to his research degree supervisors mentioning

The discovery of a highly zinc-rich orichalcum dupondius of Vespasian has opened up the possibility of further work in the neglected field of the Lugdenese issues, and Mr Carson has recently provided a disposable duplicate (BM200), and a sestertius of Galba (for whose coinage no analysis is recorded) for analysis.

Also in December Lawrence made another application for a Research Award from the British Academy for £300 to commission commercial analyses for "A study of the metallic composition of the coinage of the Roman Emperor Gallienus". Robert Carson wrote in support

In the past few years Mr Cope's systematic programme of such analyses has increased many-fold the amount of secure data available for this facet of the study of Roman Imperial coinage.

His current investigations aim to produce a series of analyses of the antoninianus of the third century and most specifically of the years AD 260-270, the decade in which this denomination suffered a rapid and increasing debasement. Most of the coinage of this period presents no overt evidence of dating and a series of metallurgical analyses which will reveal the stages of debasement will provide objective evidence for the arrangement of this coinage in proper chronological sequence.

Mr Cope has already produced a series of analyses of antoniniani of Postumus, but it is essential to secure a parallel series of figures for the coinage of Gallienus both to complete the evidence for the decade AD 260-270 and also to provide evidence which may solve the problem of the apparent disparity of acceptance of the coinage of Gallienus and Postumus as indicated by hoards of this period.

In May 1971 Lawrence received an award of £300.

1971

In January Lawrence gave an illustrated talk about his research to the Women's Institute in his home village of Culcheth, Lancashire.

In February Lawrence received analysis results for seven 1st and 2nd century coins from Liverpool Polytechnic which illustrated the change in composition over this period. The results of a further 17 coins were received from Liverpool Polytechnic in August 1971.

In February Lawrence sent a progress report to his research degree supervisors mentioning

In connexion with the follis reform I visited the John Rylands Library earlier this month to see the Alexandrian papyrus (P.Ryl.GK.607) and to discuss my approach to its more precise dating by analysis of coins issued contemporaneously. Tentatively, I date the papyrus to the early Spring of AD 294, on the basis of internal evidence and the arguments for the date of the follis reform which have appeared in more recent years and are summarised in RIC vi. Coin assays will provide evidence on an intrinsic worth basis which should match the known facts and my interpretation. It will be a useful gem to build into the thesis.

An interesting assay of an URBS ROMA 'medallion' of AD 327-333, RIC vii Rome 315, shows it to contain silver at a level which seems to equate with that of the GLORIA 'Two standards' items also assayed. This strengthens the opinion that this piece was really a large coin and not a true medallion. If its standard were 1/12 libra in weight it would have been equal intrinsically, to 12 GLORIA pieces (of 1/144 libra) - and perhaps also denominationally.

NC Fenner has recalculated all the former Pb-isotope ratios done via Liverpool Polytechnic, and has sent the results to me. These now match closely those obtained by Shields and reported by Brill and Shields at the RNS Symposium.

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Dr Daniell (Univ of Surrey) has approached me again about a project on coin-alloy fabrication; this year a degree student will attempt to simulate the fabrication of an alloy typical of Gratian's AE2 reform of AD 378-383, on the same lines as previous studies at Surrey.

The substance of the late Imperial AE2 coinage has always been in some doubt. I have commenced the analysis of three key pieces this month: a coin of Gratian (LRBC II, 376) contains silver in only impurity quantity, so the reform did not involve a return to previous standards for debased 'silver'; a REPARTIO REIPUB of Valentine II (LRBC II, 1065), issued just before the rival coinage of Theodosius, contains only traces of silver; a VIRTUS EXERCITI of Theodosius, (LRBC II, 2565) - the rival coinage - AD383-388, also contains negligible silver. These coins are all leaded coppers.

In March Lawrence enlisted the assistance of his younger son, Stephen, to carry out a statistical analysis of the weights of coins from the Domqueur hoard as recorded in 1965 by P Bastien and F Vasselle. Stephen went on to extend his computer programs to plot weight-distribution histograms and was jointly awarded the Parkes Weber Prize by the RNS in December 1972 for an essay on "Statistical Methods in Numismatics".

In March Lawrence delivered a lecture entitled "Chemical and Metallurgical Investigation of Roman Coinage" to the Liverpool and North Western section of the Royal Institute of Chemistry at the Technical College, Warrington. He was then interviewed by a local paper - the *Golborne Reporter & Star* - which published an article on his numismatic work two weeks later.

In April Lawrence read a review of the Exhalograph oxygen analyser made by Balzers of Lichenstein and intended for analysing steel samples. He enquired whether this equipment would be "suited for the determination of oxygen in Roman copper and debased silver coins" and was delighted when Balzers confirmed this and offered to analyse 20 samples free of charge. Lawrence received the results in July and in August submitted an article "Oxygen in Roman coinage metals and alloys" which was published in the November 1971 issue of *Spink's Numismatic Circular*.

In April Lawrence sent a progress report to his research degree supervisors mentioning

A start has been made with the NA and Chemical assays of the four gold coin samples submitted by the BM Research Laboratory; several analyses which have to be finished for the RNS Symposium paper have been progressed further; the finenesses of some late 4th cent. issues have been determined; and assays have been commenced on pre-reform radiates and tetradrachms.

No deliberately added silver has yet been found in any of the common leaded-copper issues of the reigns of Valentinian or Theodosius. Samples of some of the rarer and earliest large pieces are still being sought.

A remarkable discovery is the absence of silver in a Maximinian tetradrachm of year 2 compared with its presence (at, apparently, the XXI standard) in Antiochene and Lugdenese antoniniani minted close to the reform of c. 294. The denominational relationship of these pieces must now be questioned, and further assays of tetradrachms minted nearer to the reform will have to be undertaken when the material becomes available.

Lawrence's mother was diagnosed with stomach cancer in March and died at the end of June. Dealing with her estate meant that he had less time to devote to numismatic research for a number of months.

In July Lawrence received the results of spectrographic analysis for 7 trace elements performed at Liverpool Polytechnic on a batch of 23 coins. Lawrence noted

More impurity creeps into the 'British' coins over the chronological period of interest; esp. after the reconquest of c. AD297. As & Ni especially.

Morley's spectrographic results for folles alloys somewhat inconclusive; there do not appear to be any distinctive impurities in proportions which clearly characterise either the Lugdunum, Treveran or London or unmarked folles in the critical chronological period.

In October Lawrence sent a progress report to his research degree supervisors mentioning

Dr JPC Kent has provided a large volume of disposable late fourth-century material for analysis. From this I have sorted many pieces (46) of the Fel.Temp.Reparatio series. Time will not permit full analyses to be completed for the thesis, so I propose to determine silver only (on one half-coin sample) as being the most important constituent of the alloys from a numismatic point of view. Then at key points I will analyse fully, to determine mint preferences for base alloys. I intend to feed these results into the dual outlets of thesis and the unpublished volume of RIC viii (where Dr Kent feels that he might make good use of the data to support his work).

The Valentinianic coinage is being studied in the same way. Thus far it gives little cause for excitement; but occasional levels of silver (~0.3%) in the leaded coppers require explanation in comparison with issues before and after.

The Numismatic Studies of Lawrence H Cope

In December Robert Carson sent a coin (which Lawrence coded as KJJE1) writing

Sorry if your visit on Wednesday was a fiasco. John [Kent] was unexpectedly stricken. Enclosed is a consolation, donated by Elks and at your complete disposal for analysis. We've been looking for one of these for some time.

1972

In February Lawrence gave a lecture to the Chester Archaeological Society which was based on the paper he had previously presented to the RNS in April 1970. He also presented a seminar "The chemistry and metallurgy of Roman coins" in the Department of Chemistry at Liverpool Polytechnic.

In March Lawrence presented a paper "The place of wet-chemical metallurgical analysis in archaeological research" to the Symposium on Archaeometry and Archaeological Prospection at Oxford. Lawrence was unable to attend, so he recorded it to tape and a member of his staff at UKAEA who had prepared the photomicrographs went along to play it back and operate the slide projector. This paper included an example analysis using the coin coded KJJE1 donated in December and was published in *Archaeometry* vol. 15, part 2 in 1973 under the title "The metallurgical examination of a debased silver coin of Maximinus Daza issued by Constantine I".

During 1972 the RNS published its *Special Publication No. 8 Methods of Chemical and Metallurgical Investigation of Ancient Coinage* which carried papers presented at the RNS Symposium held in December 1970. Lawrence's paper "The metallurgical analysis of Roman imperial silver and aes coinage" occupied prime position as the first in the volume. Authors had been encouraged to make good use of the publishing opportunity and a further three contributions from Lawrence were included - "Surface-silvered ancient coins", "A comparison of electron-probe microanalysis with other methods for determining the bulk alloy compositions of ancient coins" co-authored with Richard Warren from the University of Surrey (which built on a student project which Lawrence had supervised in 1968) and "Report on the wet-chemical analysis of parts of coins" as an appendix to "A comparative analysis of some gold coins" by WA Oddy and F Schweizer.

In October Lawrence was appointed a Justice of the Peace. He was allowed up to 18 days special leave of absence per year by the UKAEA in order to perform duty in Warrington Magistrates' Court and on occasion in one of the nearby Crown Courts.

In December Lawrence gave an illustrated talk on "The Roman Imperial Coinage - recent research" to Leigh Literary Society and this was reported in the *Leigh Journal*.

1973

In January David Burge wrote

Many thanks indeed for the offprint of your most interesting article on Roman coin analysis. ... I would also like to congratulate your son on his winning the Parkes Weber Award. Thank you both for your help and advice with the Bourton Hoard report. But for you, I doubt whether it would have got more than a brief mention in the Numismatic Chronicle.

Lawrence determined the silver content of two coins (coded BoW1 & 2) from the Bourton-on-the-Water hoard and his son, Stephen, produced weight-distribution statistics and histograms for inclusion in Burge's report "Bourton-on-the-Water (Gloucestershire) Hoard of Constantinian Folles" published in *The Numismatic Chronicle* for 1973.

In March Lawrence presented a paper "Metallurgical segregation. Its influence on coin analyses" to the Symposium on Archaeometry and Archaeological Prospection at Oxford. Dr Gordon Gilmore of the Universities Research Reactor, Risley also presented a paper "Indium in Roman coinage alloys" which related to work he was doing for Lawrence on the use of neutron activation measurements of trace elements in attempting to characterise coinage metal ore sources.

In March Lawrence received an enquiry from Cathy King, who was doing research at the Ashmolean,

By the way, how do you measure coin diameters? Is the device you use difficult to come by? I thought I'd best inquire as I'm about to move forward to the period post-305 when this sort of thing becomes a necessity.

The Numismatic Studies of Lawrence H Cope

Lawrence lent his gauge which he had made himself and in June she wrote

I am in the process of having your measuring gauge copied, having finally discovered some university photographers who will do it, the Ashmolean people being unable to for reasons best known to themselves.

In June Lawrence visited Robert Carson at the British Museum who mentioned how he was using Lawrence's results, which showed that bronze coins had an intentional silver content, to argue that finds of these coins should be considered as treasure trove. The first success had been a hoard found at Scatterdells Wood, Chipperfield, Hertfordshire which had been declared treasure trove by the coroner at Hemel Hempstead on 6th July 1972.

In July Robert Carson sought information from Lawrence on the finenesses of the coins in the recently discovered Warsop hoard and this was included in his paper "Warsop (Notts.) Treasure Trove of Constantinian Folles" published in *The Numismatic Chronicle* for 1974.

At the end of July Cathy King wrote

I leave Oxford on the 8th for France, Austria & Italy hoping my research grant will be adequate to cover basic needs in view of the dwindling pound.

Many thanks for all your help & discussion this year - thanks to you I have a much finer appreciation of the techniques of producing ancient coins which does help a great deal in understanding how the monetary system worked as a whole.

A copy of the gauge will accompany me on my travels.

In September Dr Zammitt wrote to say that the CNAA had approved the appointment of Dr Tylecote of the University of Newcastle upon Tyne as the external examiner for Lawrence's PhD thesis.

In October Michael Metcalf wrote

I've been thinking for some time that I ought to ask you whether you would allow me to ask the [RNS] Council to appoint you to the Editorial Committee of the Numismatic Chronicle - a formalization of an existing position, since your advice has been freely sought on scientific aspects of MS, and the trend is unlikely to be reversed!

A few days later Robert Carson wrote

It has been suggested by Michael Metcalf that, as you so kindly advise, or obtain expert advice, on 'technical' articles submitted to NC, you should appear amongst the names of the editorial committee. I fully agree - and should have thought of this myself. If you have no objection, I propose to incorporate your name in NC 1973, if I have the opportunity on the final stage of proofs of this volume.

Lawrence agreed and his name duly appeared on the title page of *The Numismatic Chronicle* from 1973.

1974

Early in March Lawrence completed his PhD thesis "The metallurgical development of the Roman Imperial coinage during the first five centuries AD" and 2nd May was soon agreed upon as the date for the 'viva' with the external examiner (Dr Tylecote) and assessors (Robert Carson and Dr Zammitt).

In March Lawrence was approached by Dr DH Tarling from Newcastle University who was seeking to borrow Roman coins to test his theory that while being hot-struck between dies they might have become magnetised in line with the earth's field and that this could be detected and indicate the latitude at which they were minted. Dr Tarling had originally approached the British Museum and Robert Carson had directed him to Lawrence. Lawrence lent him three coins which were returned in April along with the results in an enthusiastic letter from Dr Tarling.

In March Lawrence and Gordon Gilmore co-presented a paper "Neutron activation analysis of precipitates extracted from Roman coins" to the Symposium on Archaeometry and Archaeological Prospection at Oxford. A few days later Cathy King wrote

I am so sorry we had no real time to talk, since your thesis & the information which it contains is so valuable & interesting both in its own right and in view of what I've been reading and doing. I want to thank you again for the accessibility of your findings, the offprints etc. I begin to get the feeling we can actually recreate the money system and be reasonably certain we're right - and that's exciting.

The Numismatic Studies of Lawrence H Cope

On 3rd May, the day after Lawrence's PhD 'viva', Robert Carson wrote

Dear Lawrence, I am not sure what the protocol of CNA A procedure is, but I see no harm in letting you know, in advance of any official communication, that your examiner and assessors had no hesitation in recommending your thesis as satisfying the requirements.

Now that this satisfactory stage has been reached I should like to voice my admiration for the sheer amount of work and industry that provided the basic material for the thesis, and my appreciation of the application of its results to such a range of numismatic problems. Inevitably the advances you have been able to make in several areas have pointed out other problems which now require resolution; but that is for the future. With warmest congratulations, yours, Robert

In June Lawrence received official notification from CNA A that they had "resolved to confer on you the degree of Doctor of Philosophy with effect from 6th June 1974". Bound copies of his thesis were provided to the CNA A, Liverpool Polytechnic and the British Museum.

In July Lawrence responded to a request from Dr Tarling and lent seven more coins followed in August by a batch of 40 coins all minted at Lyons so that the consistency of magnetisation could be checked.

In September Lawrence gave an unbound copy of his thesis to the Ashmolean Museum and Michael Metcalf wrote

I've taken a little look at the text, and must say I'm very impressed! Really this ought to be published. Are you going to go on filling in gaps for a while, or do you feel that you have reached a pausing-point?

In October Michael Metcalf wrote that he and Robert Carson were exploring the possibility of the RNS publishing Lawrence's thesis. In the meantime he had asked Cathy King to review it for *The Numismatic Chronicle* for 1975. She wrote:

Michael Metcalf let me have a look at your thesis and I have in fact read it at a gulp. It's a good and very sound piece of work & will be invaluable to me since it incorporates so much information hitherto unavailable. I do think you write clearly on scientific subjects - which is a blessing for those of us who are non-specialists but need to have some idea of techniques etc.

On 8th November Lawrence attended Liverpool Polytechnic's CNA A Degree and Diploma Ceremony at the James Parsons Hall, Byrom Street, Liverpool for the formal presentation of his doctorate.

In December Lawrence made another application for a Research Award from the British Academy for £300 to commission commercial analyses. In his application he wrote

The 1971 Award of the British Academy led to thirty-six new coin analyses being added to more than thirty others performed by the applicant. When these were discussed with experts (at the British Museum) it became obvious that they compel so radical a reform of the existing coin arrangements of the coinage of Gallienus in the standard works of reference that a substantial number of additional analyses of the coinages of that emperor and of the contemporaneous issues of the Gallic usurpers will be necessary to follow the sequence of rapid monetary reforms at Rome and parallel minting policies in Asia and Gaul.

Similarly, the applicant's recent discovery of the abandonment of the time-honoured intrinsic-worth relationship between the imperial coinage and the Alexandrian tetradrachm, within the reign of Probus, necessitates the closer dating of this previously unknown and undocumented event with assays of date-marked Alexandrian coins and of the contemporaneous imperial issues. The metallurgical independence of the subsequent British Empire, under Carausius and Allectus, is also adumbrated by exploratory analyses of the coinage, and needs deeper investigation in parallel with the Diocletianic issues.

This time an award was not forthcoming.

1975

In January Lawrence submitted corrections to the proofs for "The chemical composition of a tetradrachm of Probus with a reverse type illustrating Codex Theodosianus XII, vii, I" which was published in *The Numismatic Chronicle* for 1975.

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In February Lawrence received a letter from Dr Tarling commenting on his magnetisation measurements

only certain coins seem to be really suitable if you are looking for precise magnetic directions - which we would be for dating or latitude purposes. Stable coins have well defined directions, but agreement between different coins of the same age is not really good enough for practical purposes.

In February Lawrence visited Malta for a holiday which gave him the opportunity, with introductions from Robert Carson, to visit the National Museum in Valetta and the Cathedral Museum in Mdina with a view to obtaining disposable coins for analysis. He was seeking coins

particularly of Central and Eastern mintage.

I have reached the stage where I have exhausted the material which the British Museum and a few others in Britain can provide, yet there are a few tantalising problems to solve - especially with issues of the more eastern mints than Gaul.

In July he received 31 coins, which he had selected during his visit to the Cathedral Museum, following approval by the Chapter.

In March Robert Carson wrote

As you know, I am trying to produce for Methuens the imperial volume for their 'Roman Coins'. At the moment I am trying to put together a section on the various successive monetary systems, and in this I am finding your thesis of very great use.

In March Lawrence presented a seminar "The Chemistry and Metallurgy of Imperial Roman Coinage" to final year students in the Department of Chemistry at Liverpool Polytechnic.

In March Lawrence presented two papers "Complete analyses of Timna coppers from the 13th - 12th century BC: extraction site 2" and "Mass spectrometric analyses of the Roman copper coinage of the early empire" to the Symposium on Archaeometry and Archaeological Prospection at Oxford. He also co-presented two papers with Dr Gilmore "Arsenic and Indium in Roman copper coinage alloys" and "Analyses of some late Byzantine copper scyphate coinages of the thirteenth century AD, and the analysis of counterfeit dirhems from Susa (Persia)".

In March Lawrence was asked if he would review Marta Giaccherio's "Edictum Diocletiani et Collegarum de Pretiis Rerum Venalium" for *The Numismatic Chronicle*. Lawrence agreed and submitted a typescript in September and this was published as "Diocletian's Price Edict and Second Coinage Reform in the light of Recent Discoveries" in *The Numismatic Chronicle* for 1977.

In March Robert Carson wrote

RNS finds itself in the happy position of having accumulated once again a viable amount in the Special Publications fund, and the SP Committee is favourably disposed to the possibility of publishing your thesis in this series.

I have found, and continue to find so much of use in the thesis, that I should be happy to see both the matter and the method more widely available.

In June Lawrence and Dr Gilmore published "Gold, Antimony, Arsenic and Indium in the Copper-based Roman Imperial Coinage Alloys" as Universities Research Reactor Report URR-5. This brought together the contents of their neutron activation analysis paper to the Oxford symposium in 1974 and their follow-on paper to the symposium in 1975. Originally a paper based on the first symposium had been submitted in September 1974 to *Archaeometry* who intended to publish a shortened version in 1975 but then in March advised that publication would be delayed into 1976.

In August Lawrence returned the corrected proofs for "Mass-spectrometric analyses of the Roman copper coinage of the early empire" which was published in the October issue of *Spink's Numismatic Circular*. This was based on one of the papers he had presented in March at the Oxford symposium.

In September Professor Caley wrote

I thank you very much for sending me a copy of your excellent report on the determination of gold, antimony, arsenic and indium in Roman coinage alloys. You have demonstrated very clearly that neutron activation analysis is a very powerful tool for the determination of these minor components of ancient coinage alloys. In my opinion, your combination of this method of analysis with wet chemical methods is superior to any other analytical scheme for the complete analysis of such alloys. I was pleased to learn that your results for arsenic in your Group I coins are in good agreement with the results I obtained earlier on similar coins.

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In September Lawrence lent Dr Tarling “17 roman coins of a narrow range of dates of issue from the period beyond that in which silvering was done externally or any silver was included in the alloy itself” in case the process of surface silvering could have resulted in a change in magnetisation.

In November Lawrence made another application for a Research Award from the British Academy for £300 to commission commercial analyses. This was identical to the unsuccessful application made the previous year. In June 1976 Lawrence received an award for the full £300 - this was his fourth award from the British Academy.

Early in December Lawrence visited Robert Carson at the British Museum during which he raised the thoughts he had for the RNS to set up a research committee. A few days later he wrote to the Honorary Secretary

Last Thursday I mentioned, briefly, to Mr RAG Carson a matter which I would like you to place on the Agenda for the next Council meeting of the Royal Numismatic Society.

The Society's Symposium in 1970 succeeded in drawing the experts in the different fields and disciplines together, and it was an important landmark in our history; but I think that there remains the need for a continuity of liaison, and for planned objectives, as well as to expand the work in the most numismatically profitable directions possible for the future. I think that this is beyond the scope of one person, but I think it could be achieved by the Society by the creation of a 'Chemical and Metallurgical Research Committee'.

In December Patrick Bruun wrote

I was in London in November and presented a paper to the Society. I had hoped to be able to see you there, but was sorely disappointed. Instead I worked in Robert's office with your thesis under my eyes; what an impressive volume. I'm indeed looking forward to seeing it in print.

In early November we celebrated the centennial anniversary of our Historical society with papers illustrating various aspects of the progress of historical research. I took the liberty of presenting some of your results and showing some of the illustrations in the Symposium publications. People were quite impressed.

1976

In January Lawrence proof-read a draft by Dr Tarling for a brief talk he was presenting at a symposium on archaeomagnetism at Newcastle and afterwards he received a letter from Dr Tarling saying

the talk aroused some interest although I tried to play down the dating side of things for the time being

I thought I would re-vamp the manuscript in the next couple of weeks or so

I would now like to give some priority to getting this work completed as we could then make a good introductory paper

[Dr Tarling eventually published a paper on this work with “Archaeomagnetic properties of coins” in *Archaeometry* 24,1 (1982) in which he wrote

Most of the numismatic comments are based on either the written or verbal comments of the late Dr Lawrence Cope. This preliminary study could not have been carried out without his assistance and I wish to acknowledge my very sincere debt to him.]

In February Robert Carson wrote concerning “Tyler's booklet” (*The Persian Wars of the 3rd Century AD and Roman Imperial Monetary Policy, AD 253-68* by Philip Tyler) and asked

Would you consider doing a review for NC?

Lawrence submitted a typescript in May which was published as “The fineness and sequence of the Gallienic Antoniniani, AD 259-68” in *The Numismatic Chronicle* for 1977.

In March Robert Carson wrote

RNS Council discussed on Tuesday your suggestion for a Chem. & Metal. Research Committee. The idea finds approval in principle, with a possible extension to include other scientific aspects of numismatic investigation. It was decided that the best means of progress was to appoint a small ad hoc committee to discuss the idea and formulate proposals for Council on constituents of a research committee, area and range of activity, methods of procedure, etc. Council would be grateful if you would serve on this preliminary committee together with Andrew Oddy and David Sellwood. It was suggested that the committee might be able to produce something for the Council meeting in May.

The Numismatic Studies of Lawrence H Cope

In April Lawrence wrote a paper using statistics he had developed from his review of Marta Giaccherio's work which he submitted to *Schweizer Münzblätter*. It was published as "Diocletian's Price Edict and its associated coinage denominations" in the February 1977 issue.

In May Lawrence was unable to attend the RNS Council meeting and Andrew Oddy wrote

The Council took the decision in principle to establish a Scientific Research Committee, but did not have time to discuss it fully ... the topic will be raised again next month.

In May Robert Carson wrote

Thank you for your suggestions about the Coleby coins. This T.T. [treasure trove] is the pigeon of the Duchy of Lancaster ... I am passing the gist of it on to Wheeler at the Duchy office to use if he wishes

[This large hoard of over 15,000 coins had been declared treasure trove in August 1975. The decision was being contended by the owner of the find site and in 1981 the Court of Appeal ruled that the hoard was not treasure trove, and also removed the basis on which Robert Carson had argued successfully for treasure trove status for a number of coin hoards since 1972.]

In September Robert Carson wrote

It would be most interesting and informative to have the kind of information you suggest obtaining on the new Lincoln hoard [Waddington] coins. I have set aside a batch of 100 for you to pick up on 8 September when we can talk further on this. Howes has started to clean the bulk and would welcome a few minutes discussion with you.

In October Robert Carson wrote

The bulk of the hoard have now been cleaned and a start made on identification. It will be interesting to have your data on the pre- and post-cleaning characteristics of this group.

I am glad that your next visit to Slough will make it possible for you to take in the November meeting of RNS and Cathy King's paper. I hope that it may be possible for you to get down in sufficient time to attend part at least of Council meeting to give us the benefit of your advice on the matter of the Research Committee.

The minutes from the RNS Council meeting on 16th November 1976 recorded

Scientific Research Committee. The President outlined the previous history of this project and Dr Cope discussed his view of the proposed Committee's role. It was agreed to set up a committee of some 5-7 Fellows under the Chairmanship of Dr Cope with the object of 1) collecting and collating information, including bibliographical and 2) to promote scientific research in all branches of numismatics. The committee would be fully responsible to Council and would submit regular reports to it. Mr Oddy and Mr Sellwood also agreed to serve on the Committee and further members would be added later. It was further agreed that the Committee should submit to the March meeting of Council its proposals for 1) the machinery required for the collection and dissemination of the various kinds of information and 2) an active research programme on weight statistics. The president thanked Dr Cope, Mr Oddy and Mr Sellwood for their valuable work on this project.

1977

On 24th January Lawrence chaired the first meeting of the RNS Scientific Research Committee.

In February Cathy King wrote

I am deeply involved at the moment in analysing mid-4th century Constantinian bronzes (330-341) from the Woodeaton hoard using the isoprobe. None of the standards in Oxford has a lead, tin, copper, silver composition and I wondered whether you had kept unanalysed halves of coins and if I could borrow them. I should very much like to see what a genuine ancient alloy of known composition looks like compared to the results I am getting.

Lawrence replied

I have no standards to provide for you, because the low weight of the coins of this period means that one needs almost all the sample one can recover, after cleaning, for a full analysis. But I enclose two half coins left, which pertain to an earlier series of closely similar analysis.

Since the thesis, I have assayed almost as many coins again of the 331-348 era. There are differences in silver standards at the various mints, particularly after 335. The western mints descended to zero with some issues; and the Gloria 1-std. coinage from the western mints was reduced much in silver as the smaller issues came in. Die size correlation with silver is, therefore, important. The eastern mints, however, seem to have kept their standards up until 341.

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On 17th May Lawrence chaired the second meeting of the RNS Scientific Research Committee.

In July Cathy King wrote

I have been to the Paris Conference and returned and they wish to publish our respective papers. In the circumstances since I have quoted you extensively and used your results for comparative purposes I'd be very grateful if you'd read this rather brief paper and make any corrections, comments etc. which may be necessary.

It seemed unfair to quote your actual silver contents before you published them so I incorporated them into a graph & hope that you won't object to my using them in this manner.

In September Lawrence was invited to contribute a paper at a conference scheduled for 7th February 1978 on "Materials in Archaeology" to be organised by the Materials Science Club and the City University, London.

In September Lawrence gave a talk on "Alloy developments 3000 BC to AD 1977" to colleagues at UKAEA. He opened with

When I was invited to speak on the subject of alloy development - which has chanced to be my lot, on and off, over the twenty-one years that I have been with the Authority - I was hesitant, because most of the Projects on which I have been engaged have borne rather high military or commercial classifications which have severely restricted what can be said, even years after the event.

Indeed, to satisfy that yearning which lies in the breast of every scientist or technologist to make his discoveries known, I have had to turn to private metallurgical researches which fall entirely out of the reach of the Official Secrets Acts of modern times, and for which time itself has placed me beyond the tentacles of the criminal laws of Imperial Rome - some of which I break with no less frequency than impunity.

A summary of this talk was published in the Risley Nuclear Power Development Laboratories *Bulletin* for October.

In September Lawrence responded to a request from Dr Bastien with

Yes; I have made a number of assays of the coinage of Maxentius and Decentius since those published in the Bulletin with which you are familiar. These have not yet reached open publication but are contained in my Doctoral thesis which the Royal Numismatic Society will issue as a Special Publication in the future.

I am quite happy, however, to send these to you in the hope that they will help you in your own researches; and I have no objection to your using them in any publication which you are preparing. I enclose a copy of the appropriate pages which include my own views on the nature of the coinage.

In November Lawrence sent a detailed report to the British Academy on how he had used the award of £300 received in June 1976 to purchase the analyses for thirty coins. Lawrence intended "Metallurgical analyses of late third-century Roman Imperial coinages" to be "a summary report pending the open publication of these and some available supplementary results in the numismatic literature" but further publication would be prevented by his illness and death.

In November Lawrence made another application for a Research Award from the British Academy for £300 to commission commercial analyses "to determine the metallic composition of twenty late third-century AD tetradrachms".

Lawrence was unable to attend the 3rd meeting of the RNS Scientific Research Committee on 20th December.

1978

On 7th February Lawrence presented his paper "The development of the Roman Imperial coinage alloys during 3rd century AD" at the Materials in Archaeology conference held at the City University, London.

In February Lawrence was approached by *New Scientist* to write an article about his work on the chemical analysis of Roman coins.

In February Lawrence started correspondence with Mr TS Pattie of the Department of Manuscripts at The British Library concerning the dating of P. Oxy 1411 - an Egyptian papyrus which addresses the closure of banks because of their reluctance to exchange the latest coins and compels them to re-open and accept the coins of the emperors. Lawrence argued that the date of AD 260 applied by Grenfell

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and Hunt in 1916 did not fit well with the emerging knowledge of coinage reforms and that AD 262 would make better sense. Pattie examined photographs of the papyrus and agreed that the difficult-to-read date could be interpreted in a manner that indicated AD 262.

In February Cathy King wrote

I've been playing with the Riby Hoard and discover that the weight & diameter distributions confirm your findings in re the fineness - in other words there are visible signs of debasement in almost every issue which suggests the Voetter classification system is more-or-less useless.

On 21st February Lawrence chaired the 4th meeting of the RNS Scientific Research Committee and on 22nd March Michael Metcalf wrote

The Council of the Society had the minutes of our 4th meeting and went through them with considerable interest & approval.

On 6th May following a series of tests over the preceding few days Lawrence was told that he had kidney cancer.

In early May Lawrence informed the editor of *New Scientist* that he was ill and was told

There is no urgency at all about your article. If you feel like working on it, we would be delighted to have it, but if not, please leave it until you are fully recovered.

Lawrence was unable to attend the 5th meeting of the RNS Scientific Research Committee on 16th May and another committee member, David Sellwood, wrote

The other members of the SRC were as distressed as I was to hear of your impending kidney operation. They join me in sending every good wish for your speedy and complete recovery.

The formation and functioning of the Committee, as well as its support by the RNS as a whole, owe much to your initiatives and, however our meetings are run, they will inevitably be the poorer for your absence, short as we hope this will be.

On 19th May an operation to remove Lawrence's cancerous right kidney was abandoned due to problems with anaesthesia. The operation was completed successfully on 2nd June.

In June Lawrence was granted a fifth award from the British Academy - receiving the full £300 for which he had applied and began preparing samples for submission to the commercial analysts. Due to his illness, none were submitted and the award was repaid to the British Academy following his death.

In June Lawrence drafted a paper "The dating of P. Oxy 1411" which Mr Pattie approved and returned as a typescript. Lawrence died before arrangements could be made for its publication.

On 25th July Lawrence commenced a series of plasmapheresis sessions at the Christie Hospital in Manchester.

On 3rd August Robert Carson who had recently been appointed Keeper of the Department of Coins and Medals wrote

Thank you for the news of your progress, and I am happy to learn that in some respects things are working out satisfactory, though not so well in others.

We naturally are anxious to relieve you of additional burdens at this time, and I agree with your suggestion that we ask David Sellwood to take on the Chairmanship of RNS Scientific Research Council [sic]; but the Society remains grateful to you for your initiative in this.

On 18th August, three days after his sixth plasmapheresis session, Lawrence suffered a stroke and on 31st August Robert Carson wrote

I am so sorry to learn your news that the necessary steps to combat one trouble have resulted in promoting another. I am glad, however, that you can report that the paralysis is likely to be only temporary.

I can imagine how trying it is to suffer this set-back when things seemed to be going well, but I must say again how admirable I find your philosophic acceptance of your trouble.

On 19th September Marion Archibald, Hon. Secretary of the RNS Scientific Research Committee wrote

The arrangements for the Colloquium on Computers in Numismatics are going well.

I've just written to ask the Director to chair one session ... another is of course yourself, whom I'd like very much to chair the first session. I'd like to have your name in the programme and if unfortunately you don't feel fit enough on the day we can easily get Robert to continue as Chairman for the rest of the first session.

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On 20th October Robert Carson wrote

I am sure you would like to know that the question of the chairmanship of the SRC came before Council of RNS this week. In accordance with your wishes Council accepted that you resign the chairmanship, and has appointed David Sellwood in your stead.

I am asked by Council in the first place to express its appreciation of your initiative which led to the creation of our SRC, and of all the work you did in launching the work of the committee, and in the second place to convey Council's best wishes for recovery.

Again, very best wishes for continued progress from all your friends here and especially from me.

In October Pierre Bastien wrote

I am writing my third volume on the Lyons' mint, for the period 294 - 316. I shall bring in this work 16 new analyses, in addition to those already published. But, I suppose that, in your thesis, you provided another analysis of folles from the Lyons' mint and unmarked folles from the continental mint. Could you give me your results, as you did so kindly last year for my article on Magnentius.

On 2nd November Lawrence dictated a reply to Bastien.

Please forgive my writing via my wife but I am extremely weak, in consequence of anaemia following hyper-nephroma & a stroke in August, from which I am not yet recovered. To cover such an eventuality I completed the basic analyses at each time and deposited them with Mr Carson at the British Museum, to prevent their loss in my own records, in the event of my being unable to write them up. My Thesis contains, so far as I can see, only three of the issues you mention, i.e. Table XXII on page 198, BM260, BM257, LHC110. The remainder for the period 296 - 316 have not been published but are included in the information sent to Mr Carson post thesis, in a sporadic manner & require to be culled. They do not go very far to AD 316 but you are at liberty to publish for them on my behalf. Best wishes for a magnificent third work.

Lawrence died in the early hours of 7th November 1978.

Epilogue

Lawrence's death was recorded in the RNS President's Address published in *The Numismatic Chronicle* for 1979

Dr L. H. Cope had been a Fellow since 1955. By profession he was a metallurgist of considerable distinction, and the application of his specialist knowledge, particularly to the field of Roman coinage of which he had acquired a wide knowledge, resulted in a series of publications, both in our own *Numismatic Chronicle* and in a range of numismatic periodicals abroad, as well as in specialist metallurgical journals. These all advanced our understanding not only of the metallic composition of Roman coins, but also, as a consequence, of the complex questions of debasement, and successive coinage reforms. His doctoral thesis, *The Metallurgical Development of the Roman Imperial Coinage during the first five centuries AD* (1974) is an invaluable source for this aspect of the long range of this coinage. Shortly before his death Dr. Cope was engaged in revising and amplifying this thesis which it was planned to publish as one of the Society's Special Publications. It is hoped that his work can still be edited for publication so as to make his contribution to our subject widely available.

Lawrence is mentioned three times in 'A History of the Royal Numismatic Society 1836-1986' by R. A. G. Carson

Section 4 1936-1976 page 38. The most recent new activity has been the setting up of a Scientific Research Committee, following the suggestion by our Fellow Dr. L. H. Cope. The function of this committee, in broad terms, is the assembly of information on work done on any scientific aspect concerned with coinage, the execution of a number of scientific projects related to coinage, and the publication from time to time of a volume concerned with these topics.

Section 4 1936-1976 page 41. The metallurgy of the Roman coinage has been investigated by L. H. Cope in such contributions as 'The Roman imperial silver coinage alloy standards' in NC 1967, and 'The nadir of the imperial antoninianus in the reign of Claudius II' in NC 1969.

Section 5 1976-1986 page 45. The Scientific Research Committee suffered a sad loss through the premature death of L. H. Cope, the initiator of the concept and the first chairman of the committee, but it continued its work, first under D. G. Sellwood and subsequently with W. A. Oddy as chairman. Special Publication No. 13 on Metallurgy in Numismatics represented only one facet of the committee's work. In November 1978, in conjunction with the Research Laboratory of the British Museum, it organized a colloquium on Computers in Numismatics. In general terms it has continued to

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initiate and encourage the application of scientific techniques to numismatic study, and to collate and record the results of such activities.

In 1997 the British Museum published Occasional Paper 120 'Metal Analyses of Roman Coins Minted under the Empire' by L.H. Cope[†], C.E. King, J.P. Northover and T. Clay, which drew together Lawrence's analysis results for 993 coins. The preface stated

After his death, his papers and analysis results came to the Department of Coins and Medals in the British Museum who hoped to publish them in due course. It soon became clear that only Dr Cope could have produced a revision of his thesis which would have reflected his particular application of analysis results and metallurgical techniques to rebarbitive numismatic problems.

Naturally it omitted a number of analyses that Lawrence carried out on coins outside of the Roman Empire.

Analysis results for a further 18 coins (all sestertii and dupondii) were found amongst the papers studied for this chronology, making a grand total of over 1,000 analyses.

Coin Codes

The following list of coin codes is more complete than the list given in Occasional Paper 120.

Code	Source / Comment
A	Ashmolean Museum, Oxford. Contact: Dr C.H.V. Sutherland
AEM	A.E. Martin
AHB	A.H. Baldwin & Sons Ltd, London. Contact: Simon Bendall
AJHG	Antony J.H. Gunstone
ANS	American Numismatic Society
B	City Museum and Art Gallery, Birmingham. Contact: Asst Keeper, Antony J.H. Gunstone
BM	British Museum. Contact: Robert A.G. Carson & Dr J.P.C. Kent
BoW	Bourton-on-the-Water hoard. Assays for D. Burge
Br	City Museum, Bristol. Contact: Curator, L.V. Grinsell
Brom	J.I'A. Bromwich
Ca	City Museum and Art Gallery, Carlisle. Contact: Curator, Robert Hogg
Ch	Grosvenor Museum, Chester. Contact: Curator, D.F. Petch
CJO	Anonymous donor via A.J.H. Gunstone
CMM	Cathedral Museum, Malta. Contact: Prof. E. Coleiro
Co	Colchester and Essex Museum. Contact: Curator, David T-D. Clarke
DW	Devizes Museum, Wiltshire. Contact: Paul Robinson
EHR	E.H. Redfern
Ex	Rougement House Museum, Exeter. Contact: Curator, Miss Susan M. Pearce
H	Hereford City Museum. Contact: Asst Curator, Monica Naldrett
HDG	Col H.D. Gallwey
JC	John Casey, University of Durham
KJJE	K.J.J. Elks
L	City and County Museum, Lincoln. Contact: Keeper, J.B. Whitwell
LHC	Lawrence H. Cope (many from a source brokered by A.J.H. Gunstone)
Ls	City of Leicester Museums and Art Gallery. Contact: Keeper, J.F.L. Norwood
M	Manchester Museum. Contact: Prof. F.C. Thompson
Ma	Leysdown hoard. Assay of a cast forgery for R.A.G. Carson
MAZ	Dr M.A. Zammitt
Mo	Assays for A.H. Morton of Iranian (non Roman) forgeries.
NML	Narodni Muzej, Ljubljana. Contact: Dr A. Jeločnik
NMW	National Museum of Wales, Cardiff. Contact: Asst Keeper, George C. Boon
PB	Dr P. Bastien
PMB	Prof. Patrick M. Bruun, Finland
R	Reading Museum and Art Gallery. Contact: Asst Archaeologist, Jillian A. Thomas
S	Archives et Bibliothèque de la Ville de Strasbourg
SGF	Unknown
SL	Schweizerisches Landesmuseum, Zurich. Contact: Dr H.-U. Geiger
UoS	University of Surrey. Provided by Prof. F.C. Thompson of Manchester Museum for student project work.
W	Municipal Museum, Warrington. Contact: Director, J.R. Rimmer
Y	Yorkshire Museum, York. Contact: Keeper, G.F. Willmot