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Front cover: Obverse die and medallion of West Australian Newspaper Award (see article "Royal Australian Institute of Architects - WA Chapter award medals")

Contents

President's Report

Our seventh biennial international numismatic conference NAAC2017, which was held in Melbourne in October, was a great success. National Organiser Walter Bloom and the local Organizing Committee chaired by Darren Burgess put together an interesting program, one of the consequences of which was the marvellous selection of papers for this volume of the Journal.

This last year has seen the publication of Peter Lane's *The Coin Cabinet*, and the winning of the Paul Simon Memorial Award by Barrie Newman. Both Peter and Barrie are great contributors to the Association.

Our Vice-President, Darren Burgess, has advised that he won't be renominating at our coming AGM due to the pressure of work and the need to progress some NAV activities. I am grateful to Darren for all the work he puts into the NAA, in particular last year's biennial conference and the Facebook page, not to mention the steady stream of news items. In fact Darren is not completely off the hook as he has become the Victorian State Representative to the Association.

Stewart Wright of Status International has kindly offered us use of a room for the Association's AGM on Monday 16 April (commencing 1pm) at his new premises at 64 Parramatta Rd, Forest Lodge, close to the University of Sydney.

The NAA continues to enjoy sponsorship at a sustainable level, with Noble Numismatics (Gold), Coinworks, Downies (Silver), Drake Sterling, Sterling & Currency and Vintage Coins & Banknotes (Bronze) all contributing to ensure the Association's continued success. However expenses are rising and receipts are falling, even with the steady level of membership. On the positive side, many are taking out ten-year memberships.

I am appreciative of the support of Council and other NAA members throughout the year, and particularly our Secretary, Jonathan Cohen, and Treasurer, Lyn Bloom, who are pivotal in the running of the Association, and our Managing Editor, Gil Davis, for his work in producing this Volume 28 of JNAA.

Walter R Bloom
President, NAA
www.numismatics.org.au
March 2017

Editor's Note

The 28th volume of the journal is a bumper issue and my eighth as Managing Editor. There are eleven articles reflecting a remarkable range of numismatic interests. I am particularly pleased to see the balance of modern Australian and historical numismatic interests, and the excellent scholarship throughout. Many of the articles derive from presentations given at the wonderful NAA conference held in Melbourne from 21-22 October, 2017. I thank the presenters for being willing to quickly turn their talks into articles, despite the hard work this entailed, as well as the dedication of the other contributors.

This journal is the annual publication of the peak numismatic body in the country. As noted in the last volume, I have been working with the President and the Editorial Committee to ensure the standard of all articles we publish compares favourably with the best international numismatic journals. This includes a rigorous double-blind peer-review process. I thank the members of the Editorial Committee (listed below) and the two anonymous reviewers assigned to each article for their prompt and constructive help.

I also wish to express my thanks to the two key people who work quietly and efficiently behind the scenes to help me get this journal out: John O'Connor (Nobles) who proof-reads the articles, and Barrie Newman (Adelaide Mint) who carefully looks after the production process.

In this volume we have six articles on modern Australian topics. The articles by Paul Holland and Walter bloom are numismatic studies respectively of George V pennies and award medals struck by the Royal Australian Institute of Architects, WA chapter. Their treatments are exemplary demonstrations of the 'arcane art' of numismatic studies combining detailed knowledge with keen observation. These are foundational studies for others to follow. Vincent Verheyen uses his expertise in chemistry to analyse surface marks on predecimal proof coins made at the Melbourne branch of the Royal Mint. He successfully demonstrates that some of the marks result from production rather than careless handling, a finding that will have implications for collectors of proofs generally. Jeremy McEachern, Barrie Newman and David Rampling show another side of numismatics – how it can be used to inform our understanding of the past. Their entertaining articles range from illuminating the story of one of Australia's earliest dealers (Rampling on Isidore Kozminsky), to the sporting achievements of one of the country's celebrated early athletes (McEachern on Richmond 'Dick' Eve and the collection of his memorabilia in the National Sports Museum), and even the sorry tale of an 'official' fraudster who nonetheless got away with his misdeeds (Newman on a Ugandan High Commissioner).

The volume also contains five articles on matters historical. Three of them deal with iconography and make fascinating reading, especially when taken together. Bridget McClean looks at Tarentine civic coinage c. 470–450 BC. Charlotte Mann and Rachel Mansfield both deal with iconography under emperors of the Severan dynasty of Rome in the early third century AD. Charlotte deals with the imperial portraiture of Caracalla, while Rachel examines the civic coinage of the eastern city of Antipatris under Elagabalus. The results of their studies are illuminating about how important coins were for disseminating propaganda, and in turn, understanding what was important to the emperors and cities that commissioned them. Christian Cuello takes us to the world of the Visigoths, best known for sacking Rome, but also producers of coinage, some of which reside in the Australian Centre for Ancient Numismatic Studies collection at Macquarie University, which he catalogues and discusses. Finally, Frank Robinson provides a careful study of bank notes of the Empire of Brazil which will be of interest to aficionados of paper money.

There is something for everyone in this volume.

Dr Gil Davis
Managing Editor

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Articles must comprise original research on numismatic material including but not limited to Australasian numismatics (coins, tokens, medals, banknotes) or ancient or mediaeval numismatics. Manuscripts can be emailed to any member of the Editorial Board in your area of research, along with a copy to the Managing Editor.

A metallurgical origin for surface impairments found on Australia's larger silver Q-Alloy proof coins

T Vincent Verheyen

Abstract

This article outlines an alternative explanation for careless handling, which can account for minor but problematic, surface marks found on predecimal proof coins made at the Melbourne branch of the Royal Mint. The high relief areas on proof florins typically reveal many just visible cracks, flakes and pits unlikely to be post-strike damage. Scanning Electron Microscopy probed these surface imperfections on the Queen's shoulder and adjacent field areas and confirmed many could only result from manufacturing issues. They originate from metallurgical problems associated with their blanks (as known as planchets or flans) which comprise a relatively brittle inhomogeneous quaternary alloy overlaid by a thin silver layer. These properties result in uneven metal flow and fill during impact from the dies creating surface metal stress. This stress is relieved by irregular incuse cracks and exfoliation, which contribute to roughness observed on the effigy. A small number of the proof florins were relatively free of visible defects, suggesting proof coin quality control relaxed at the Melbourne Mint during its last years. This article presents new evidence to support the view that minor marks on these proof coins should not be judged too harshly as many result from production issues and not mishandling.

Introduction

Proof coins represent the best quality that money can buy, ensuring their ongoing demand with collectors and investors. In contrast to the perfection of modern proof coinage, Australia's predecimal proofs have a somewhat quirky appearance and aesthetic reflecting the available technology and minting skills of the period. Great care was apparently taken at the Melbourne Mint in their production,[1] so one may expect any marks would have been noticed during final inspections. The Melbourne Mint production of proof sets increased markedly from a steady 1500 sets in the early 1960's to 2016 sets in 1962 and then by a further 150% for the last sets dated 1963 (5042 sets).[2] High production placed additional pressure on the Mint's limited proof (primitive by today's standards) manufacturing capability. As the problematic marks were minor and ubiquitous, it may have led to a relaxation in quality standards.

1 Willam John Mullett. *Melbourne Mint Branch of the Royal Mint The Establishment*. 39-41, 44 (1992).

2 Greg McDonald. *Collecting and Investing In Australian Coins and Banknotes*. First edn, 125-126; 317 (Coin Corner Publishing and Investment, 1990).

The larger predecimal proof coins issued as part of the "collector series" (1955-63) often exhibit multiple surface marks on their highest points. Greg McDonald first described the problem in 1990 in his classic guide.[2] After examining a significant number of proofs, Greg noted that minor but visible marks were noticeable from 1957 onwards. However, in later years particularly 1962 -1963 most florins were prone to surface defects. This article will present new research that explains how pristine proofs can appear with minor surface impediments without having been subjected to any post-strike damage.

These marks, though only just visible to the naked eye, were described as numerous and concentrated on the florin's effigy around the base of the queen's neck and shoulder area.[2] The author's examination of many proofs, including curated examples from official Mint and Museum collections concurs with Greg's initial observations. The marks are also just visible on shillings albeit to a lesser extent. Furthermore, the metallurgical flaws described here are not found on the smaller 6d and 3d denominations. That their different sized blanks are all sourced from equivalent parent alloy ingots or bars, suggests the alloy in itself is not the only factor. The direct correlation between reducing coin size and prevalence of marks provides a clue. The greater metal flow required to produce more substantial changes in relief during the striking of the florin is a likely contributing factor requiring further investigation.

The accepted explanation for the visible marks on the effigy and design is that because they are raised and hence unprotected, this visible damage is post-strike and due to careless handling, for instance from impacts with metal surfaces or packaging. These scratches, scuffs and knocks are due to:

- drawer storage at Mint
- friction with the plastic case as supplied in 1962-3
- inappropriate handling and storage by owners

However, as these coins were sold at a premium and are valuable, most would have been carefully handled. More importantly, the potential sources of post-strike damage outlined above would not have discriminated between coins of different size, so a better explanation is necessary. Naturally, surface marks due to post-strike damage will be present to some extent on many of these coins making the assignment of marks problematic. A technique used here to discriminate between marks due to manufacturing problems and those imparted later, involves the combination of Optical with Scanning Electron Microscopy (SEM).

Figure 1 illustrates a typical 1963 proof florin, which at first glance has a "speckled" mirror surfaces revealing no major problems. The key areas of interest are the raised areas on both the kangaroo and emu's back and the shoulder area near the truncation on the obverse effigy.

In this project, the focus is on the florin obverse in two areas:

1. The Queen's shoulder which is the highest point on the coin directly above the truncation. This truncation is an angled slope comprising an approx. 1 mm height difference between field and shoulder and includes the designer Mary Gillick's incuse M.G. initials. During striking, metal pushes up and expands into recesses of the die to form the shoulder in relief. This area is where the surface imperfections are concentrated creating a rough surface visible to the naked eye.

2. Below this truncation is a flat region (field) above the legend letters GR of GRATIA where, during the impact from the die, the metal had an outwards flat flow trajectory either up into the effigy or out towards the edge forming smooth flat surface revealing negligible surface roughness.

Some background on the manufacture and composition of the Royal Mint silver coining alloys is warranted.

Sterling Silver

The Royal Mint used a binary alloy comprising a mixture of 92.5% by weight silver (Ag) and 7.5% copper (Cu) known as sterling silver, to manufacture coins over several hundred years.[3] Being a homogenous solid solution, it is very suited to coining being easy to strike yet reasonably hard wearing with no change in colour. However, comprising

3 Maurice Bull. *English Silver Coinage since 1649*. Sixth edn, 286, 654, (Spink, 2015).

almost pure silver its use became prohibitive when the cost of metal approached a coin's face value.

Silver Quaternary Alloy

The Mint had to produce coins that were cheap, white and not too brittle or hard to melt or strike (wearing out the dies) and wore evenly in colour, i.e. stayed white all over. A four constituent alloy, composition by weight: 50% Ag, 40% Cu, 5% zinc (Zn), 5% nickel (Ni); and by atom fraction 37% Ag, 50% Cu, 6% Ni and 7% Zn, was developed in the Royal Mint London. It was used for their 1927 proof set, and lessons learned led to a much improved 1937 proof issues.[3] A detailed comparison of the Melbourne proofs against those two earlier London Q-metal issues is beyond the scope of this article. However, despite design differences, the London 1937 GVI proof florin and larger half-crown and crown do not exhibit the surface irregularities seen on Melbourne coins. The alloy was a far from a perfect answer (refer below) to the Royal Mints problem of reducing the blank's silver content, and London abandoned the alloy in 1947 for cupro-nickel.

Returning to the quaternary alloy, silver was to remain the base or matrix metal which would act as a "solvent" for the other components. Copper was selected to be the major diluent, but the alloy needed to be silver-white in appearance. London experimented with 10% Nickel as the whitener, but the Ternary alloy still had significant segregation and oxidation problems.[4] Eventually in 1927, a fourth metal–zinc–a known silver antioxidant was included to form a Quaternary alloy (Q-metal) which was not too hard, stayed relatively white and wore well in circulation.[5] The Q-metal is challenging to manufacture due to blending and segregation issues. Metallurgists recommended its production via three separate meltings,[4,5] but the Royal Mint developed a two-stage process. The inclusion of zinc was necessary but particularly troublesome as it was extremely volatile (Melting Point (M.P) 419 & Boiling Point (B.P.) 907ºC) when in contact with molten silver (M.P. 961 & B.P. 2,162 ºC). The Melbourne Mint's own furnaces were not able to achieve the extremely high melting point temperature for pure nickel at 1455ºC.

Melbourne followed advice from London and prepared the alloy via a two-stage method wherein the zinc, nickel, and some of the copper was melted first by electric arc furnaces at the Department of Munitions into a preliminary base metal alloy.[1] Its composition was similar to "*German Silver*" at 50% copper, 25% nickel and 25% zinc. The coinage alloy was then completed at the Mint by sequentially charging in the required silver, additional copper and the base metal alloy. The next problem to overcome was to

4 Robert Pepping. *New Zealand History Coined–Coins of New Zealand (1933-1965)*. 1st edn, 34,52, (Robert Pepping, 2017).

5 G. P. Dyer and P. P. Gaspar, 'Reform, the New Technology and Tower Hill, 1700-1966', in *A New History of the Royal Mint*, edited by C. E. Challis, pages 492, 559-560 (Cambridge University Press, 1992).

minimise segregation of the constituent metals during cooling to prevent coloured patches due to selective enrichment of various components. The cooling regime was dependent on the size of the cast ingots or bars, which were smaller in Melbourne than London and proved difficult to replicate. After rolling and drawing to the required strip thickness, blanks were cut, annealed and blanched in a strongly oxidising acid (pickling in sulphuric acid/sodium dichromate mixture) to enrich their surface silver content by selectively solubilising the other three metals.

Experimental

Twenty Melbourne proof 1960-1963 sets were examined for surface marks and a typical florin chosen for detailed investigation. The coin was ultrasonically cleaned in hexane and dried before imaging. A modified Olympus Model MF metallurgical microscope fitted with a 2 megapixel USB digital camera created the optical images which were processed using MicroCapture software (Leuchtturm®). SEM images were acquired using a Tescan VEGA 3 LMU (tungsten filament) instrument fitted with a Thermo Scientific EDS package for elemental analysis.

Results and Discussion

The marks under consideration are not present in exactly the same position on each coin and therefore die issues are discounted. Likewise, lint marks caused by foreign material creating incuse curved lines and patches during striking are present at random positions on only a minimal number of coins. These marks occur on all denominations and could not produce the problematic surface roughness whose cause is investigated here.

<u>*Optical Analysis*</u>

Optical light enables colour which is absent from an electron beam. Light microscopy in Figure 2 confirms the problematic marks (examined later by SEM) are not flat as they catch the light. Many marks appear as irregular cracks, fissures and delaminations without the "smooth" incuse edges associated with scratches. Surface roughness is not readily discernable by SEM imaging as light to dark changes can have many causes.

Figure 2 Reveals the obverse shoulder and undamaged rim area of two proof 1963 florins and below at higher magnification are a strip of microphotographs under different lighting of the truncation area for the upper left coin. The two upper pictures reveal obvious scratches as per the red arrow were a scratch diagonally crosses over the tunic's seam. The green arrows highlight irregular surface marks, which are the focus of this article. The lower strip of 3 includes a tick shaped feature further investigated in Figure 7.

The picture on the upper right (Figure 2) highlights variations in surface reflectivity caused by factors including "cabinet friction" resulting in dullness on the exposed areas. Also, the fields of both coins are blotchy with uneven reflectivity and colour due to granularity, attributed here to microsegregation of the alloy. The three lower pictures confirm the roughness of features examined later by SEM as the same surface marks either are exaggerated or blend into the background depending on the lighting angle.

The top left picture in Figure 2 also reveals the raised "wire" on the coin's outer rim (deliberately the highest feature to offer protection to the design) is not damaged which would be the case if the coin rattled around in a steel drawer.

<u>*SEM Analysis*</u>

SEM technology provides a wealth of additional information to the numismatist, typically not at high magnification (as all coins appear extremely rough at 1000X plus magnification available with the technique!) rather the focus here being surface composition. A powerful electron beam is focused on the coin's surface, just penetrating it while interacting with its atomic structure and emitting various types of radiation. Here, the following two types of electrons and select x-rays emitted from the sample are collected and processed into images.

- Secondary Electrons (SE) are collected at an angle at the side of the chamber and are more sensitive to surface features and texture. Their imaging is most comparable to optical microscopy but with additional complexity from edge effects (e.g. edges of lettering) and charging due to non-conductive areas.
- Back Scattered Electrons (BSE) come from deeper in the coin and are more sensitive to elemental variation. Images reveal white through grey to black areas, which represent variation in electron intensity. Darker areas correspond to the detector receiving fewer electrons, here correlating with a reduction in silver (the heaviest element and rich producer of BSE)
- Energy-dispersive X-ray spectroscopy (EDX)–X-Rays characteristic of each coin element (similar to X-Ray Fluorescence (XRF) technology now becoming more common for rare coin validation) are emitted and processed into element maps. Mapping gives EDX the critical advantage over XRF of providing spatial information, i.e. changes in elemental composition with distance.

Many of the surface marks revealed by SE on the Queen's shoulder (Figure 3) are visualised by BSE as darker areas (with lower electron emission) indicating these marks have different (lighter) elemental compositions. The fields appear smooth by SE with darker areas around the lettering thought due to carbonaceous deposits not removable by ultrasonic cleaning. In contrast, BSE from these same field areas reveals multiple dark spots in accord with the blotches (granularity) observed in Figure 2. BSE imaging confirms that there is not a complete seal in the alloy's silver coating with spots and random darker grey (silver deficient) areas showing.

At higher magnification (Figure 4) the variation in elemental composition revealed by BSE is more apparent as different shades of grey across both the field and effigy regions. These differences result from the selective enrichment of non-silver alloy elements, in this case, copper – see later. Scratches and scuffs apparent in the SE image are not easily seen in the BSE version suggesting this post-strike damage does not always penetrate the Q-metal's silver surface layer. Figure 4 reveals that darker areas in the BSE are not always present as surface features (roughness) in SE but correspond to coloured blotches under optical microscopy (Figure 2).

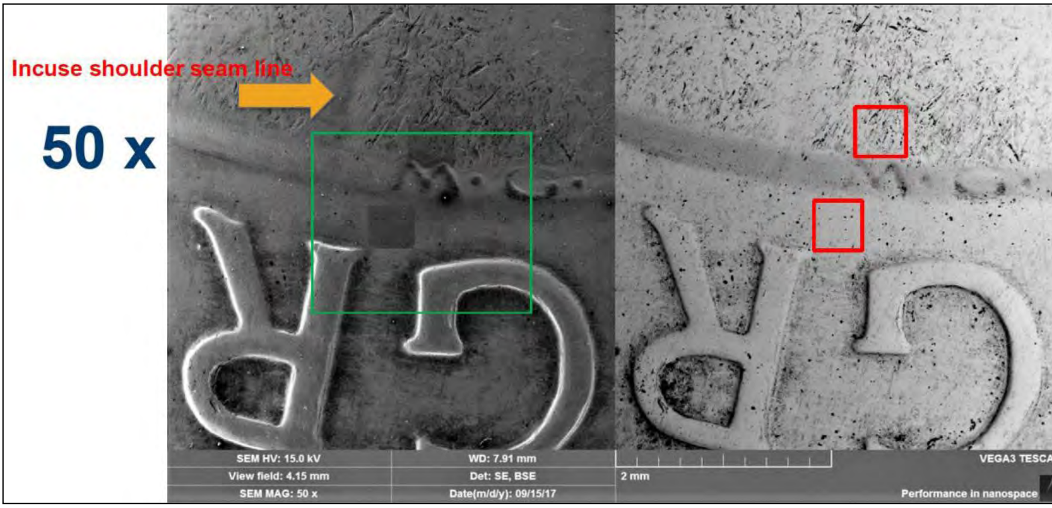

Figure 3 Presents low magnification (50X) and electron beam energy (15.0kV) SE and BSE images for the region on the 1963 proof Florin obverse presented optically in Figure 2. The green and red boxes indicate the image boundaries for Figures 4 and 5

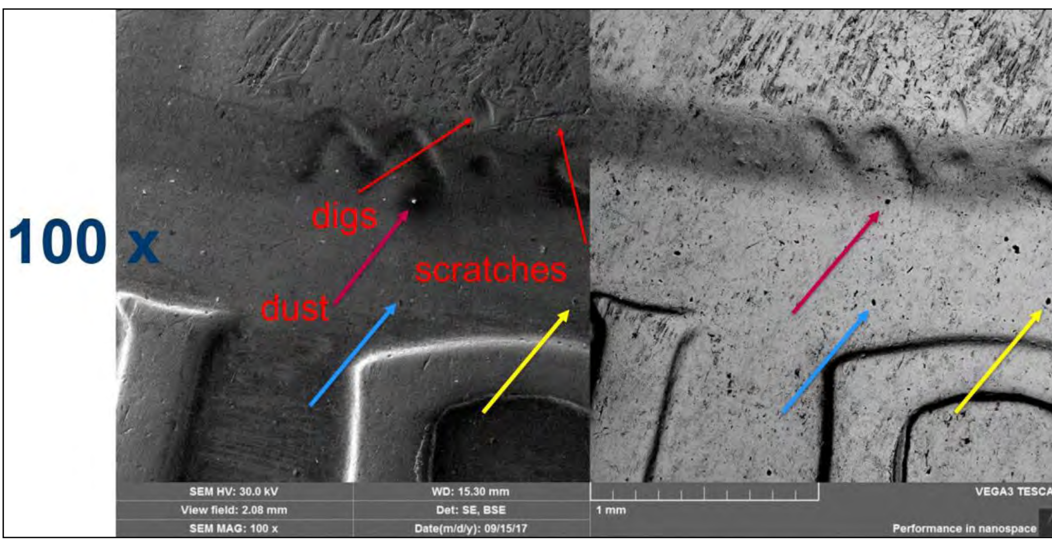

Figure 4 Reveals the green boxed region under higher 100X magnification also using a more penetrating 30KV electron beam. The different coloured arrows point to the same surface features on both images with the blue and yellow pointing to 0.1mm pits where silver is missing.

At 500X magnification, the surface roughness on the shoulder region (left images in Figure 5) is taking on a crystalline texture interspersed with irregular pitting and flakes, i.e. the alloy substrate granularity is being exposed. Fine scratches are also evident due to their clean straight edges. The surface in the field area (right images) is much smoother as expected but reveals several defects. A flake of metal in the top quarter obscures a surface crack or fracture running towards the right corner confirming this defect is not a post-strike scratch. The SE image also reveals just visible short raised metal flow lines running parallel to each other (at 15 degrees roughly top to bottom) which are responsible for the coins subtle lustre.

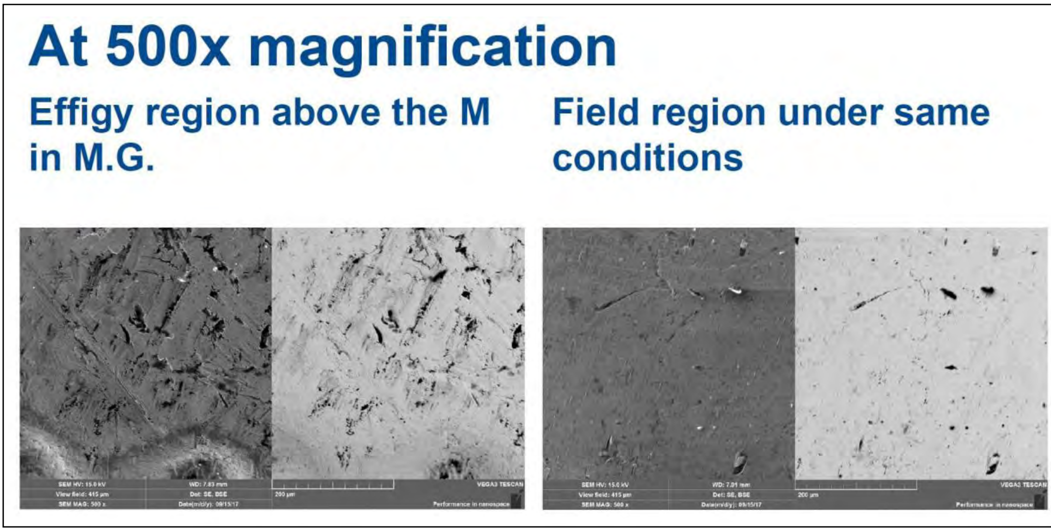

Figure 5 Presents 500X and 15kV SE and BSE images of the red boxed shoulder and field regions on the florin obverse defined previously in Figure 3.

Let us assume that before striking the blank had a homogenous distribution of alloy related surface defects (areas of differing elemental composition, fissures and delaminations). Comparing the shoulder and field BSE images (Figure 5) suggests that during striking a strong plastic deformation is occurring. The elemental surface distribution is differentially impacted in these two regions:

- by the vertical metal flow and expansion associated with forming the Queen's shoulder within the die's recess and
- compression followed by horizontal flow associated with the field area between the truncation and lettering.

Additional surface roughness in the shoulder region accentuates the same defect distribution also present in the field. Close examination of the field BSE reveals subtle changes in greyscale (electron backscatter intensity) along grain boundaries which become very obvious in the shoulder area.

EDX analysis provides a means to evaluate the changes in elemental distribution eluded to by the BSE imaging. Figure 6 reveals the Q-metal element maps of the shoulder and field regions presented in Figure 5. In accord with the blank's blanching to increase its surface silver concentration, both regions are rich in silver and surprisingly similar in the distribution of low silver (darker) areas which bear little relation to the surface texture revealed in the corresponding SE image at the top of each set (Figure 6). Copper, nickel and zinc are present in areas where silver is deficient with copper dominating these defects. This observation is in accord with alloy inhomogeneity, that is particles of base metal alloy did not wholly disperse, (dissolve) within the coinage alloy during its fabrication at the Mint.

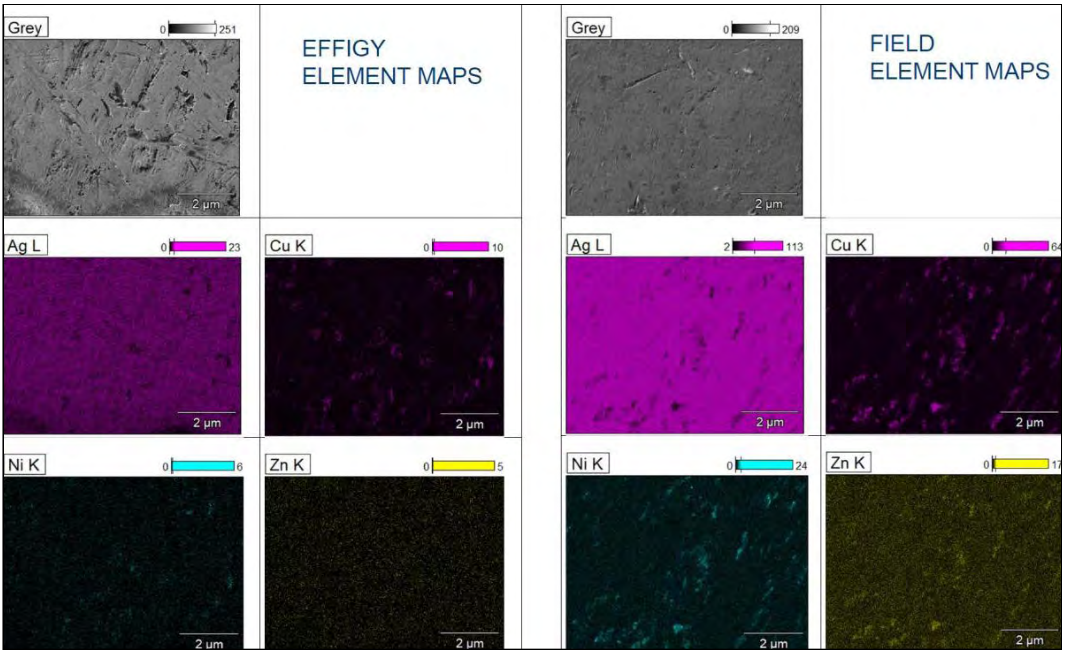

Figure 6 EDX Q-metal element maps for the shoulder and field regions shown in Figure 5. An increase in brightness reflects an increase in element concentration; however, absolute values should not be compared between the two regions due to acquisition differences.

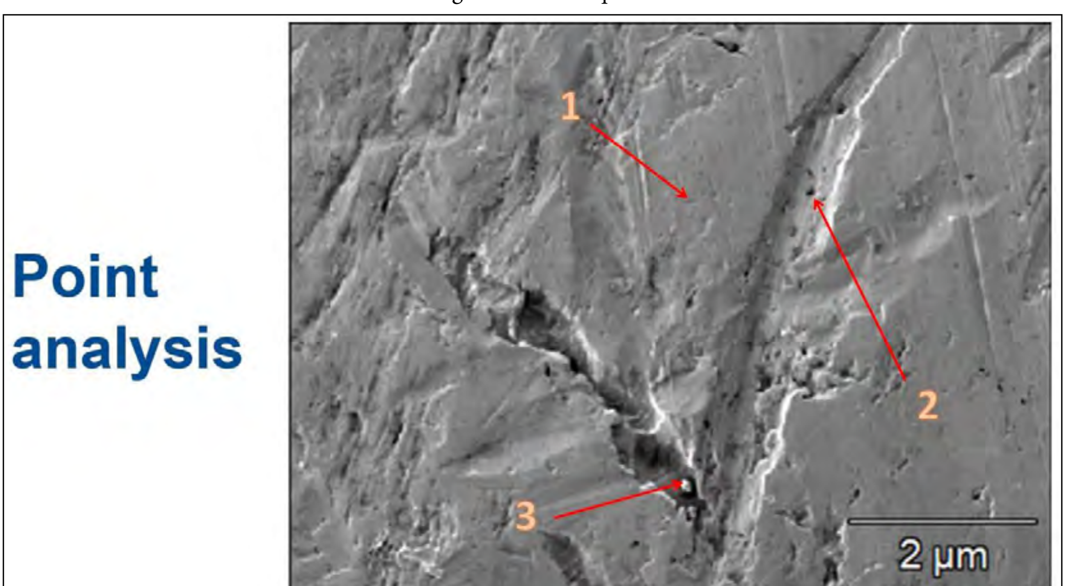

Figure 7 SEM image locations for EDX point analysis spectra, the numbered arrows point to features whose elemental composition are presented in spectral form in Figure 8. The image is of a tick shaped feature on the Queen's shoulder close to the truncation on the obverse first revealed in Figure 2.

The spectrum in Figure 8 for the smooth surface at position 1 reveals it is reasonably pure (95%) silver. The tick shaped incuse mark is a combination of a crack and scratch as revealed by their different edge and depth profiles. Embedded in the base of the scratch at position 2 is a grain of Q-metal alloy as revealed in the middle spectrum in Figure 8. This spectrum also reveals oxygen present indicating it is an oxidised granule, which may have hindered its dissolution in the melt.

Embedded within the crack or fissure at position 3 (Figure 7) is a particle whose spectrum in Figure 8 reveals it is silica, i.e. pure SiO_2. This 0.1 micron particle is likely a remnant of the polishing media applied to the proof blanks by the Mint.[1] If the crack was already present in the blank before the polishing, it is likely to have trapped the particle.

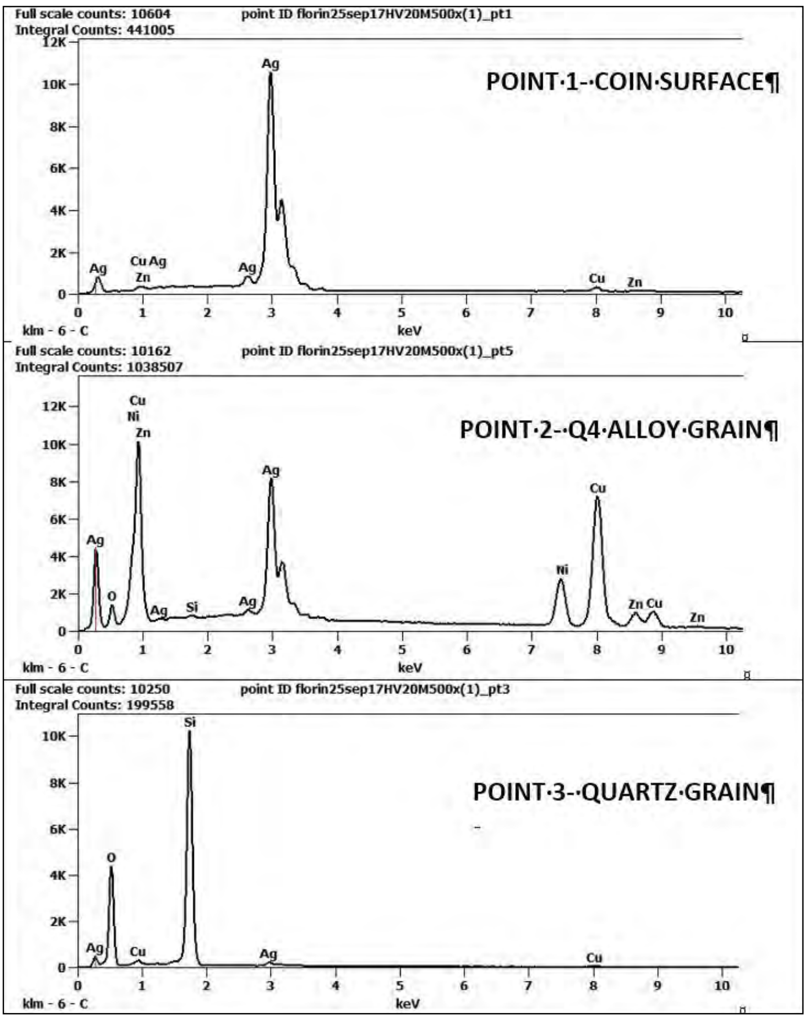

Figure 8 EDX point analysis spectra of the three image locations outlined in Figure 7. Their relative elemental compositions are presented as a spectrum with elements identified by their chemical symbols above their respective peaks. The areas of the peaks are indicative of the amount of that particular element present at that location.

The images presented here confirm a metallurgical origin for the problematic marks, as post-strike damage cannot satisfactorily account for all the features responsible for the surface roughness typically seen on these proof coins. However, any metallurgical explanation needs to account for the following:

Blanching (pickling) the alloy blanks should produce a near pure and even thickness surface film of silver providing the alloy is uniform.

Polishing the blanks would further obscure any defects in their silver surface.

Silver is very malleable and ductile. Providing this layer is sufficient, it would be unlikely that minor defects still present on the blanks would be visible on the struck coins.

Metallurgical Explanations

The following causes are presented in decreasing order of probability, and it is likely a combination of these were involved:

- Insufficient blanching treatment is leading to flaking of the surface silver layer on striking. The silver is too thin to cover the variation in metal flow properties caused by compositional irregularities in the alloy grain boundaries underneath.
- The blanks were not adequately annealed (to soften the alloy) and too hard; blows from the die could then force the blank's surface to "open up" within its recesses forming stress relieving micro cracks in the coin's raised areas.
- Alloy inhomogeneity creates grain boundaries as points of weakness were atypical alloy particles (enriched in some metals) are liberated from the alloy during striking creating incuse channels and pits.
- Foreign material such as minerals and gas bubbles incorporated during alloy and blank preparation create initial weak areas which then propagate defects from these point sources.

Conclusions

Problematic irregular shaped minor marks found in raised areas on the Melbourne Mint's larger proof coins are not just the result of post-strike damage nor due to die problems. Rather evidence presented here suggests that minor surface flakes, cracks, splits and pits primarily found on the highest regions of the larger coins are due to metallurgical issues. They originate during Q-metal alloy production and blank manufacture and are exacerbated during striking. Annealing, blanching and polishing will all affect blank surface quality. Due to their higher relief, surface stress increases in the larger coins because of more significant metal flow during contact with the dies. The thin, almost pure silver layer present on the blank's surface, despite its malleability, appears unable to compensate for the granularity and associated variable hardness underneath. Alloy inhomogeneity produces differential metal flow along grain boundaries resulting in the minor marks observed. Their minor nature and ubiquitous prevalence, along with the need to timely fill the large number ordered would explain why the Melbourne Mint released them for sale.

Acknowledgements

The assistance of staff at the Federation University, Carbon Technology Research Centre in enabling access to the SEM is gratefully acknowledged.

Author

Vincent Verheyen's numismatic research is focused on the specimen/proof coinage made available by the Royal Mint to collectors between 1826 and 1963. He is particularly interested in the special strikes of those regular coins that would have circulated in Australia.

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1920