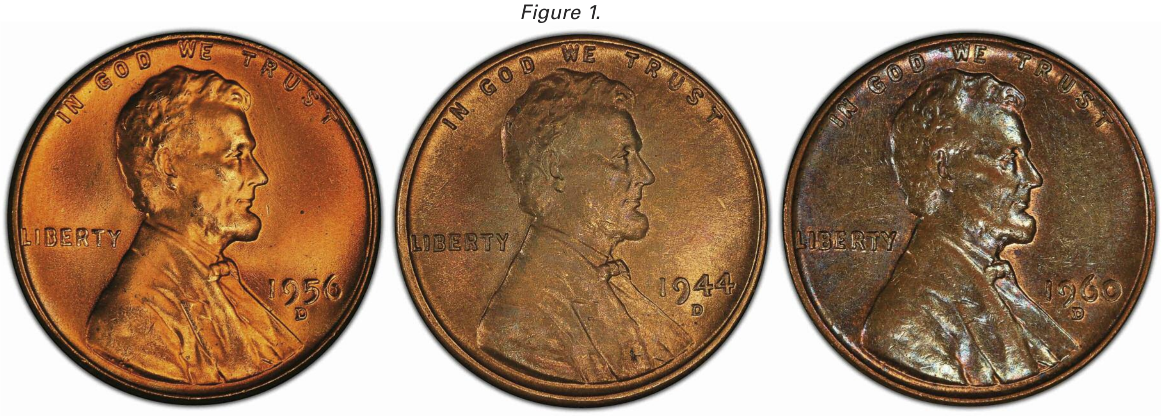
Australian Bronze Pre-Decimal Towards a New Understanding

ONE of my bugbears in numismatics is the PCGS classification of "Genuine - Questionable Color". On its website, PCGS states of this grade that "Copper coins are sometimes stripped of their colour to simulate their original, red appearance. In most cases, these treatments result in unnatural colors that the experts at PCGS will reject." Fair enough. However, anyone with any experience collecting Australian bronze knows to question "what is mint red?" The kaleidoscope of colours that befall Australian bronze coins leads one to ask what alloy is being used? How does one grade those colours? Those were the questions in my head as I set out to write this article.

Figure 1.



Red (RD) Red Brown (RB) Brown (BN)

Colour plays an important role in PCGS grading, with associated values determined by whether the coin is designated red, red-brown or brown. Looking at the American pennies copied from the PCGS registry (figure 1), the colour designation fits nicely. I'm not sure if American grading companies then attempted to impose a 'one size fits all' to designating foreign bronze colours or they naively accepted the guidebook definition of Australian bronze. I for one am thankful that necessity has proven the mother of invention, so that Australian coins are a real mixed bag of various alloys. Otherwise, Australian pre-decimal bronze would not be an area of interest to me. The reasons for the variations are another story.

Determining the factors that create the colour we call bronze was a significant endeavour in my search for answers. I found my first clue in a piece of French research[1] reproducing the bronze manufacturing of antiquity. The author cast ingots with varying levels of copper, tin and lead. The following passage caught my attention - "the percentage of tin in the alloys influences the colour changes". It took me some weeks to find an authoritative website blogging on planchet alloy errors[2]. In one of the articles on that site, the author mentioned that too much zinc in the mix can also give a brassy colour.

To better understand the processes, terminology and technology of the period, I've also sought out papers and publications on metallurgy. Digitised technical information from the early century is scant. However, Project Gutenberg has digitised the work of a lecturer from the University of Birmingham[3]. The publication is useful in that it was printed in 1912, which makes the understanding of this lecturer relevant to early 20th Century metallurgy and numismatics. The author notes the following:

Uses of Copper Alloys — Between 20 and 30 per cent of the copper produced is employed in the form of alloys. The more important of these are:

- **Brasses**; alloys of copper and zinc.
- **Bronzes**; chiefly alloys of copper and tin.
- **Coinage Alloys**; of gold and silver with copper.
- **German Silver**; alloys of copper, nickel, and zinc.
- **Special Bronzes**; alloys of copper with such metals as aluminium and manganese.

So, from this publication and further reading of metal manufacturing websites, my understanding is that a yellowish metal is not necessarily brass. Zinc (Zn) alloyed with copper (Cu) makes brass. High levels of tin (Sn - Latin origin *Stannum*) also produce yellow coins, but they are an alloy of bronze. So, for anyone who has wondered about those strangely coloured post-war Australian pennies and half pennies, wonder no more. The long wait for an x-ray fluorescent scanner from Olympus was finally met with regulatory approval from NT Health. I have put that alloy analyser straight to work. It didn't disappoint. Below left (figure 2) PCGS MS64RB #25177490 carrying the Borg pedigree. Below right, PCGS Questionable Color - UNC detail #37361426. It has a metal composition of 96.55% copper (Cu), 3.26% tin (Sn) and nominal amounts of P, Zn, Fe and Pb.

Figure 2.

Geoff Heidemann of Cockatoo Coins has cautioned me that in his experience, XRF technology is a clumsy tool compared to fire assay, so I have ignored the trace elements and focused on the primary metals. If you're now thinking "hang on, the guidebook says bronze is 97.5% Cu, 2% Zn and .5% Sn", you'd be right. The guidebooks do indeed say that. However, the exceptions are frequent enough to suggest that they're almost the norm. The reasons for this would make for interesting research. A comparative analysis of colour suggests that yes, the 1950 half penny above is correct.

Having no experience in doctoring coins I spent a great deal of time reading online about colour for this article. A recurring theme in those articles is that a dipped coin tends to have colours that are flat and lifeless. That certainly appears to be the case here. But there are also other errors possible. The alloys may not have been mixed correctly during manufacturing. Incorrect annealing can separate alloys back into their base metal groups. I am purchasing base metals from Ebay to better understand their respective colours - tin is a silvery metal. It's possible that we are observing streaks of concentrated tin on the obverse. However, the evidence below suggests otherwise.

Figure 3.

Figure 3 is of four 1943M half pennies - 3 of them are in PCGS's population registry and are all given the colour designation red. I have placed the coins in order of colour changes, starting from yellow to red. The fourth coin I have compared with (black background) is PCGS Questionable color #37361424. I've placed it 3rd in the row as it doesn't display a red copper intensity like coin number 4. The alloy in my coin is 96.7% Cu, 3.2% Zn. It's easier to understand with a comparative colour sample like those above that reducing the Cu levels reduces the rose/red colouring of what I now understand is copper-rich bronze. I'm less concerned with issues of doctoring in this example as it retains attractive colour, detail and lustre. If the coin was doctored, it was a much better job than the 1950 half penny.

The other 1943M's that were analysed in my small group of 'questionable colors' (not illustrated here) came in at 3.0% and 2.8% Zn - remaining was Cu. That's nearly half a percent difference in Zinc levels in just the 3 examples I've tested. I suspect a larger survey should confirm alloy changes to be one variable in the colour of our coins. To suggest the designation red meaning original mint colour is arguably pushing the boundaries of utility. I understand PCGS's reasoning – I've added a useful PCGS reference in the bibliography [6]. However, given the variations in Australian bronze alloys it arguably does not serve collectors. I am thinking through an alternative colour designation that would prove more realistic for the market down under.

Figure 4,

Above left (figure 4) is an example in the PCGS registry, given the colour designation red. To the right, Questionable Color #35621562. A pair of odd looking coins; unsurprising given the XRF analysis. This alloy reads as 95.05% Cu and 4.56% Sn with residual trace metals including phosphor and nickel. The XRF algorithm labelled this metal Phosphor Bronze. Such metal was used in maritime armaments like ships and submarines. What little information that I've been able to find on the internet suggests that India's foundries were a *massive* contributor to the Allied war machine in both world wars[7]. One can speculate that this huge manufacturing expansion in WWI would have come with an enormous learning curve and the potential for numerous errors.

So, this alloy could be a mistake in the total run of bronze produced by Bombay or a question of expediency in efforts to maintain material output for the war. Testing of much larger samples will improve and validate this understanding or otherwise send me back to the drawing board with more questions. That the coin may be – in the eyes of a PCGS grader – doctored, doesn't concern me in the slightest. From the PCGS example above left, I can see that coins were being minted with a colour that approximates my example. I now have a better understanding of why this is the case. In the case of the above penny, the heavy die brush striations running across both sides of the coin suggest it may be specimen example or early die state business strike.

Figure 5.

From the site of American error specialists (2) comes this important illustration of alloy errors (figure 5). A normal copper-alloy cent of this period is 95% copper, with the remaining 5% tin and zinc. However, the attractive UNC example imaged by PCGS on the left is tempered by silvery globules of Zn or Sn (2nd obverse), incorrect alloy mixing creating brassy bands of yellow colour (3rd image). My favourite error, which until now I had thought was toning, is the classic wood grain finish (4th image), so prevalent amongst early 20th Century UK pennies. According to the author, these are planchet alloy mix errors. Elsewhere, the author has received written confirmation of another interesting error from the US Mint itself. It's worth a quick read[2].

What's interesting is that this 95/5% mix Cu/Zn-Sn creates an attractive red copper looking coin in the PCGS image. Yet a very similar alloy ratio in the 1916 Bombay example previously illustrated looks closer to the obverse number 3 above. This suggests the possibility of an alloy mixing error. It could also be the chemistry of the metal that creates these subtle differences. Answering these questions will take time. I begin to accumulate a collection of error coins and base metals, to help me understand the subtle variances in colours. Nonetheless, from this initial inquiry it appears that impurities and alloy mixing errors play a role in colour. Let's look at a couple of more examples.

Figure 6.

I found out that the UK Government controlled copper prices (by controlling the London Metals Exchange) from the beginning of WWII until 1953 (7). Subsequently, the Royal Mint manufactured 1951PL bronze (figure 6) with an eclectic range of alloys like 96.32/3.49/.19 Cu/Sn/P on the left and and 94.34/3.89/1.5 Cu/Sn/Zn on the right. One could imagine the Cold War in Europe and the Korean conflict giving weight to other priorities for copper besides Australian coins. At least the UK Government didn't send us brass razoos! Note the wood-grain appearance of the half penny, indicative of an alloy mix error.

Figure 7.

This 1948 Melbourne Penny (figure 7) caught my eye when I was purchasing a penny collection years ago, although I didn't understand what I was looking at. The Small Arms Ammunition Factory No.2 at Footscray was still reportedly manufacturing planchets for the Melbourne mint post-war. This example is an alloy of 96.87% Cu, 2.94% Sn, .19% P with traces of Zn, Pb & Fe. I'm wondering which of those four latter metals were intended or are impurities. The reasons for this could be varied and access to departmental archives would be useful for more information. Collectors may or may not be familiar with the yellow hues of these two aforementioned dates. A quick look through comparative offerings of the date on eBay suggests this example is another potential alloy mixing error.

Figure 8.

Shiny pennies always get my attention. Again, as a stranger to coin doctoring, I thought a bunch of mint red, late period Perth half pennies worth checking out. This Perth half penny (figure 8) cemented my understanding of how some scammers live. It also appears an indication that some Americans don't know the Australian market very well.

The combined eBay and import costs exchanged into Australian dollars are a definite barrier to purchasing such an unimportant denomination and date. Did someone naively thought that stripping a cheap Aussie coin back to red would make it more valuable? Because it is Perth Mint, that made the coin an ugly anomaly compared to the colourful comparison below. While the Ebay seller was careful to show one nice example of the garbage he was selling, by purchasing a group of coins I was able to clearly understand the doctored nature of the work. A few of the coins should recover their patina with time. However, the fingerprint on the two examples illustrated in this article is highly suggestive of tampering with some (if not all) of the half pennies I have purchased.

Figure 9.

Nonetheless, without having gone through the process of researching and writing this essay, I would not have been able to approach my next article. It is a tentative answer to the question of why Perth pennies are so highly coloured. This colourful 1964 penny (figure 9) offers a couple of clues to this subject. The streaks indicate a potential alloy mixing error, with varying levels of oxidation. Some areas of the reverse are already dark, yet other areas are showing thin film oxidation on the colour spectrum according to patina depth - i.e., the various alloys appear to oxidise at different rates. Note the lamination peel behind the kangaroo's legs. The alloy mixing error may be contributing to this issue. More on this in the next article.

This article started out questioning PCGS's "Questionable Color". The use of this no grade designation is useful in understanding some of the coins I've acquired. Thumbprints and flat, dull surfaces certainly validate rejection. Yet some of the coins in my collection suggest that the grading may have an element of subjective opinion. Let's face it, all coin grading is subjective opinion. I know from experience that PCGS grade with an admirable level of consistency. Yet the colour designations are problematic, as is the rejection of certain coins over 'questionable colour'. The XRF scanner I've acquired begins to elucidate on this subject, as will hopefully the inquiry into alloy mixing errors. More on this subject to follow.

If you have constructive feedback and further information that will be freely credited to its author in future articles, please email Leslie Robinson at topendcoins@gmail.com.au

References

The Colour Palette of Antique Bronzes: An Experimental Archaeology Project: https://exarc.net/issue-2017-2/ea/colour-palette-antique-bronzes-experimental-archaeology-project

Planchet Errors: Improper Alloy Mix: https://www.error-ref.com/improper-alloy-mix/

Modern Copper Smelting: https://www.gutenberg.org/files/59328/59328-h/59328-h.htm

What Do RD, RB & BN Grading Designations Mean on Copper Coins?: https://www.pcgs.com/news/rd-rb-bn-grading-designations-on-copper-coins

The Little Known Story of How Jamshedpur Played an Active Role in Both the World Wars: https://www.thebetterindia.com/77957/jamshedpur-tatanagar-tata-steel-world-wars/

Copper Bottomed Booms and Busts: https://www.winton.com/longer-view/copper-bottomed-booms-and-busts

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