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Assessing countermarks on a corroded silver *dachao tongbao*

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A temporary display devoted to Mongol coinage and entitled "Pax Mongolica (AD 1210-1350)" was recently organised at the Ashmolean Museum¹. The exhibition was an opportunity to display some rare and lesser known coins from the Islamic and East Asian collections. A rare and historically puzzling silver coin was therefore selected. The coin adopting the shape of Chinese coinage bears the inscription *dachao tongbao* 大朝通寶 ('Currency of the Great Dynasty') written using Chinese characters. No Chinese historical source mentions this coin, and archaeological evidence support an attribution to the beginning of the Mongol Yuan dynasty (AD 1271-1368)². As the exhibition was being prepared, a study of this coinage was being meanwhile published by V.A. Belyaev and S.V. Sidorovich³. They produced a typology based on the coins inscriptions and reverse countermarks. The corrosion on the Ashmolean coin made it difficult to read the obverse inscription and the presence of countermarks was unclear. The coin was treated during the summer 2015 by Stephanie Ward to prepare it for display. The following article will detail the treatment chosen with particular reference to the removal of a copper corrosion on this silver coin and the benefit for its study.

The *dachao tongbao* from the Ashmolean collection is a cash coin (round with a square hole in the middle) of 23 mm and weighing 3.3g, see fig. 1. Before any attempt to clean it, it was primordial to assess its metallic content. Different metallic versions of this coinage were discovered: silver, but also bronze and lead⁴. Although the overall appearance of the coin was consistent with that of a corroded bronze coin, closer visual inspection showed patches of silver beneath the green copper corrosion. Examination under a binocular microscope revealed this more clearly. The presence of copper corrosion is not unusual on buried silver coinage. Many 'silver' coins are actually silver alloys, copper commonly being the largest other constituent. When these types of coins are subjected to a corrosive environment (such as through burial), the copper element of the alloy will corrode preferentially to the silver. This is due to the difference in their reactivity (electrode potential) with copper being the more active (electronegative) with a stronger tendency for copper ions to leach out of the coin and react to form corrosion products. As with the Ashmolean specimen, these can then be deposited on the coin's surface and in some instances, can completely obscure the base metal.

The covering of copper corrosion made the examination of the coin inscription difficult. Initial investigation to clarify surface features was carried out using methods that did not require removal of any corrosion. Examination of the coin under raking light and using a binocular microscope was undertaken but did not reveal sufficient detail so it was then photographed using Reflectance Transformation Imaging (RTI), see fig. 2. RTI (also known as polynomial texture mapping) is a photographic method that captures a series of digital

¹ The exhibition was curated by Lyce Jankowski and Jerome Mairat with the assistance of Marie Favereau.

² LEI *et alii* 1989, p. 28-31 et NINGXIA WENHUAJU 1991.

³ BELYAEV *et alii* 2015. This article became known to the authors only late in the restoration process.

⁴ NIU 1999, p.17.

images of an object lit from different angles. These images are then processed to allow the viewer to re-light the object virtually and they can be manipulated and enhanced by the user to enable detailed examination of an object's surface on a screen. This method has proved a useful technique in the Ashmolean museum for highlighting surface topography. However, although more detail was revealed, the reverse of the coin was partially decipherable and other methods for retrieving information were explored. Conventional x-radiography and x-ray computed tomography (CT scanning) could have been used to penetrate the corrosion layers without the need to physically remove them, but these techniques were not available in the museum at the time of treatment⁵. Other 3-D scanning and imaging techniques are also available for revealing detailed surface topography but were outside the scope of this project⁶.

The decision was made to remove obscuring copper corrosion products on the coin. As it was to go on public display, it was important to show the silver nature of the coin to make its oddity more striking. Trials were undertaken to remove the corrosion mechanically using simple hand tools such as scalpel and wooden sate stick. In many cases, mechanical cleaning is preferable to chemical intervention as the removal of the corrosion is more easily controlled and a skilled conservator can identify different layers within the corrosion and remove only those unwanted products. Information from a coin's original surface can be held within certain corrosion layers and these need to be retained since the remaining metal core may have lost much of this detail. For the Ashmolean coin however, the tests indicated that mechanical cleaning alone would not be suitable for removing the green malachite corrosion from the coin surface. The hard nature of the corrosion crust overlying the softer silver beneath, together with limitations in the overall strength of the coin core, meant it was vulnerable to damage using this method. The addition of chemicals, to help soften the corrosion products before removal, produced an acceptable method. Formic acid was used as this is a relatively weak acid that does not attack silver. It was applied locally under a microscope allowing slow and controlled removal of the copper corrosion⁷. Care was taken to prevent unnecessary removal of copper from the coin body by limiting the time the acid was in place and using only a low concentration. Formic acid is volatile at room temperature so should not stay on the coin's surface. However, to ensure the time of acid exposure was correctly limited and excess acid was not held anywhere within the coin or corrosion (where it could carry on reacting) the coin was rinsed thoroughly and dried. Fig. 3 shows the cleaned coin. The coin was also lacquered to prevent further tarnishing. Finally, the coin was photographed again using RTI to further enhance the surface details revealed during treatment, see fig. 4.

⁵ For more details see SCHREINER 2004 and MILES 2011.

⁶ This is a rapidly developing field and detailed discussion of these methods is not possible in this document; some general information can be found in PAYNE 2013.

⁷ Diluted formic acid (15% volume/volume acid in distilled water) was applied locally on a cotton wool swab and gently rubbed over areas of copper corrosion. After approximately three minutes, the same areas were swabbed with distilled water to stop further reactions whilst hand tools were used to dislodge parts of the corrosion. This process was repeated until most of the corrosion was removed. The coin was rinsed under running tap water for half an hour before being immersed in distilled water and dried on a clean paper towel. It was air-dried for 24 hours before being lacquered with three layers of 5% (weight/volume) Paraloid B72™ (methyl methacrylate/ ethyl acrylate copolymer) in an approximate 70/30 ratio of acetone/IMS solvent applied with a brush.

Once cleaned, the obverse inscription became very clear. The calligraphic style of the three characters *da*, *tong* and *bao* is inspired by those of some *Da Ding tongbao* 大定通寶 ('Currency of the Da Ding era'), a coin issued under the Jürchen Jin dynasty between 1178 and 1190. The horizontal stroke of the character *da* is leaning down at the right end similarly to the Jin coinage. But the most interesting feature of this coin is the two countermarks that were revealed on its reverse. These were impossible to see beforehand. One is located next to the central hole at 10.00 o'clock. The other is near the external border placed at 4.00 o'clock.



First countermark



Second countermark⁸

BELYAEV ET ALII do not give any reading of these countermarks, but understand the first one to be a distorted Arabic word *khan* خان⁹. We can surmise that the second one is a slightly distorted version of the Chinese character *zhai* 債 meaning 'debt, loan, liabilities'. This meaning corresponds to the use of the countermark as an official tax payment proof, as argued in BELYAEV ET ALII.

The limited historical understanding of this coinage gives this coin a real importance. The careful cleaning of the coin done at the Ashmolean Museum removed any corrosion and made visible the distinctive features of the coin, enabling us to compare it to coins of the Jin dynasty, but also opening new possibility to compare it to others *dachao tongbao*. Most of the coins of this type available today are heavily corroded¹⁰. It is to be hoped that these coins may be cleaned to help further scholarly researches, and we hope that our case may be inspirational in limiting temptations of aggressive cleaning. The unveiling of the two countermarks was particularly rewarding and we are looking to publish more extensively on this subject in the near future.

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⁸ These are the countermarks images published in BELYAEV *et alii* 2015, p. 90.

⁹ BELYAEV *et alii* 2015. p. 91.

¹⁰ See for example the coins illustrated on the Zeno website (60 coins available on April 6th) - <http://www.zeno.ru/showgallery.php?cat=4428>

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