Journal of Powder Metallurgy & Mining

Merkel, J Powder Metall Min 2022, 11:9

Review Article

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Evidence of the Early Islamic Period's Widespread Usage of Dry Silver Ore and Its Significance for the Development of Silver Metallurgy

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Abstract

Silver production has had a long-standing relationship with lead metallurgy. It is generally acknowledged that galena, a lead sulphide, was the main source of silver during the early Middle Ages. Galena can occasionally contain up to 0.5% silver, which suggests that tonnes of lead must have undergone rigorous processing in order to extract kilogrammes of silver. This study has discovered evidence that extraordinarily rich silver ores must have played a vital role in one of the major silver-using polities in the 8th and 9th centuries AD: the Early Islamic Caliphate. While all physical evidence from mines, slag, and the metal itself point to this being true. 26 coins were metallographically analysed, and matte inclusions (silver-copper remarkably pure silver [1-5].This silver cannot have been manufactured exclusively from lead ore or through the use of lead, as the matte preserved in the coins could not withstand the highly oxidising refining procedure necessary to separate lead from silver. It is necessary to adopt a new paradigm in order to comprehend early mediaeval extractive metallurgy. The Early Islamic silver supply greatly benefited from the processing of "dry" silver ore, which was composed of practically pure silver minerals. The findings of this study challenge long-held notions about the development of silver metallurgy and have significant technological and economic ramifications. They also have significant ramifications for provenance investigations and the interpretation of data from lead and elemental isotopes.

There are three factors that connect the production of lead and silver Lead and silver minerals frequently coexist, 2. During the ore's smelting, lead traps and safeguards the silver, and 3. Cupellation is a method for separating silver from lead. Critical to the process is cupellation [6-7].Two immiscible liquids, an oxide liquid (PbO) and a metallic liquid containing silver and other oxidation-resistant metals, are created when lead is selectively oxidised above 900 °C. Silver can be refined to extremely high purity and recovered with little loss with this procedure. Even though cupellation has ancient roots, by the Greco-Roman era at the latest, lead and cupellation were widely regarded as essential to the creation of silver across the Classical World.

Introduction

More than a century has passed since the first attempts at reconstructing the historical development of silver metallurgy. Perspectives adopted from contemporary extractive metallurgy were crucial to its development from the start, especially given that for the most of its existence, silver was extracted from lead-based ore. Engineers and metallurgists like W. Gowland had a significant impact on establishing the research trajectory that can be followed into the twenty-first century.This focus on silver ore based on lead is Galena, a lead sulphide that can be associated with silver typically in quantities of 0.1-0.5%, is widely accepted as the primary ore basis for silver production in research on the early Middle Ages, where it is particularly prominent [8-15]. The galena ore at Melle, the famed mine in western France that has been linked to the Merovingians' adoption of the silver standard and the most important silver mine of the Carolingians is typical of silver concentrations in this range. Based on the fundamental qualities of Islamic silver, specifically a sudden.

Two dirhams aroused concerns due to their abnormal nickel-rich compositions in a thorough investigation of the elemental and lead isotope analysis of 8th and 9th century Islamic dirhams.This led to additional investigations, which resulted in a 26 dirham metallographic research. The purpose of the study is to provide an explanation for the "how" and "from what" of historical silver production. In order to answer these concerns, it is important to understand which elements and phases survive the cupellation process and which do not, especially with relation to sulphur. The results challenge the established notion for silver production primarily based on lead ore and the universality of cupellation, and instead point to the exploitation of top-grade silver ores without the use of lead. The present study combines metallography quantitative elemental analysis and experimentation to examine this issue from an alternative angle and proposes a new paradigm for the understanding of early medieval extractive metallurgy of silver.

Subjective Heading

Two dirhams aroused concerns due to their abnormal nickel-rich compositions in a thorough investigation of the elemental and lead isotope analysis of 8th and 9th century Islamic dirhams. This led to additional investigations, which resulted in a 26 dirham metallographic research. The purpose of the study is to provide an explanation for the "how" and "from what" of historical silver production. In order to answer these concerns, it is important to understand which elements and phases survive the cupellation process and which do not, especially with relation to sulphur. the ore For the early stages of silver use, it is suggested that native silver and "dry" silver ore were used. The El-Argar civilization of Bronze Age Spain created silver items without the use of

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Received: 05-Sep-2022, Manuscript No: jpmm-22-74096, **Editor assigned:** 07-Sep -2022, Pre QC No: jpmm-22-74096 (PQ), **Reviewed:** 20- Sep -2022, QC No: jpmm-22-74096, **Revised:** 22- Sep -2022, Manuscript No: jpmm-22-74096 (R), **Published:** 28- Sep -2022, DOI: 10.4172/2168-9806.1000324

Citation: Merkel SW (2022) Evidence of the Early Islamic Period's Widespread Usage of Dry Silver Ore and Its Significance for the Development of Silver Metallurgy. J Powder Metall Min 6: 324.

lead-based metallurgical techniques, as has been demonstrated .Some claim that the Moche people of the New World utilised 'dry' silver ores like cerargyrite in the Andes (Patterson 1971, 311–312). Meyers (2003) makes the case that "dry" ores were used when silver was first used in Western and Central Asia during the Chalcolithic and Early Bronze Age. Similar metallurgical techniques to those used to extract copper from ore, such as reduction or roast-reduction smelting, would have been used to process these "dry" silver ores.

Cupellation was a significant technical advancement that was created in the Old World around the fourth millennium BC. According to Meyers (2003), lead ores replaced rich lead-free ores as the primary source of silver production by the third millennium BC. Cupellation was initially developed to extract silver from rich lead-free ores. Meyers confidently suggests a change to silver production with a predominate lead-ore base sometime in the third millennium, although it's not obvious where he gets this date from. It is crucial to emphasise that, despite the fact that there is strong evidence for a lengthy history of cupellation, its use does not indicate that silver was made from lead ores.

Discussion

It is virtually universally acknowledged that the extraction of silver from lead-based ores like galena was essential to the supply of silver by the time of Classical Antiquity Pliny and Strabo, two classical authors, confirm that lead is used to extract silver from ore and that lead-based silver ore is used (Forbes 1940). Supplies were dependent on production in the eastern Roman provinces and by the Persians in Late Antiquity after the collapse of Roman silver mining in Spain Edmondson .Given that early mediaeval technology was essentially the same as that of the Romans, Due to the Roman mines' exhaustion, mediaeval cultures were forced to rely on progressively less abundant and labor-intensive mineral sources. It's likely that later mining was restricted to lead ore deposits that were even poorer or harder to access since the Romans were extracting silver from argentiferous galena. According to this viewpoint, the Early Islamic Caliphate's and early mediaeval Melle's reliance on galena-based ores for silver production is consistent with the research narrative of silver metallurgy.

However, this common view becomes unviable when one moves beyond the early Middle Ages. Late mediaeval and Renaissance writings about Central Europe categorically refute the notion that silver was produced there using galena, which typically contains 0.1-0.5% silver, prior to the advent of explosives. The processing of "dry" silver ores almost leaves no trace, which has ramifications for the larger history of silver and suggests that our understanding of earlier metallurgy may be biassed by the fact that lead-based silver metallurgy leaves traces that are discovered by archaeologists. The Bartels makes a case for the relevance of a variety of high-grade silver minerals, secondary ore enrichment techniques, and "bonanzas" for the silver industry that dates back to early modern mineralogy and the Middle Ages. The discrepancy between the two study cultures reveals a gap between early modern history and archaeology.

The Arabs entered the world of silver currency use with the invasion of Sasanian Mesopotamia and Iran in the middle of the 7th century. The Umayyads (661–750 AD) adopted the technique of minting silver and combined the three Mesopotamian monetary systems already in operation into one .Following the same alloy standards as earlier Sasanian and Arab-Sasanian coinage at first Wasit, the most productive mint and chief garrison for Iraq and Iran, started to strike silver dirhams of exceptional purity around 100-104 A H (718-722 AD). This practise spread throughout the Caliphate and continued more or less unaltered for two centuries.The metal had to be newly manufactured or purified in order to reach the quality found in Early Islamic dirhams, which was frequently as high as 97 weight percent silver. As long as the silver was purified to meet the extraordinarily high purity level, this metal need not have just been mined; instead, it might have come from recycled old metal. However, there are several arguments against widespread recycling during this time. A strict increase in the production of high-purity coinage, as seen particularly in the Early Abbasid period during the final third of the eighth century AD .is only possible with an increase in the available metal supply which suggests new mining and metal production. Based Peninsula and Central Asia, but this has yet to be confirmed by scientific methods. Using historical sources, Shatzmiller argues that an increase in the access to coinage, together with changes in monetary policy, fuelled large-scale economic growth over much of the Islamic world.

In the second half of the eighth century, the Abbasids oversaw one of the largest increases in Early Islamic dirham minting .The foundation of the trans-Eurasian silver trade, which linked the majority of Eastern and Northern Europe to the Islamic World, was made possible in large part by the widespread export of dirhams. This surge in dirham production, which is archaeologically documented by dirham hoards from the ninth and tenth centuries found in Russia and the Baltic states, is crucial to understanding the cultural and economic history of Eurasia.

Understanding the resource basis that sustained this expansion is necessary to look into the circumstances surrounding how and why this happened. Meyers (2003) found a lack of silver and a significant reduction in ore grade in relation to the issue of Early Islamic mining. These are definitely not the circumstances one would predict in conjunction with an increase in silver output and export. But up to this time, there hasn't been a second line of physical evidence to confirm or disprove Meyer's theory

The 26 deaccessioned dirhams from the Ashmolean Museum that are currently kept in the School of Oriental Studies at the University of Oxford served as the basis for this metallographic investigation. Twenty of them are Abbasid dirhams (768–913 AD), with an emphasis on Baghdad (Madinat al–Salam), the most active Early Abbasid mint. They come from mints in Iraq, Iran, and Central Asia. Six of them, who struck Wasit, are Umayyad (704–740 AD). The dirhams from the eastern Islamic territories are found in the mints. Muhammadiya (in Tehran, Iran), Zaranj (in western Afghanistan), Balkh (in northern Afghanistan), and Bukhara. produced (in Uzbekistan). The dirhams were chosen to bridge the gaps in time between the Umayyad and early Abbasid dynasties that had been previously recognized.

After being sliced from the coins, the 10–20 mg silver samples were manually cleaned by abrasion to remove corrosion. The silver samples were divided into two parts, each weighing between 5 and 10 mg, and then evaluated by portable X-ray fluorescence. To figure out the silver and lead concentrations in the first batch of silver, it was first broken down with mild nitric acid, dried, and then dissolved in a 2% HNO_3 solution. After being digested in diluted HNO_3, the second batch was dried. Next, aqua regia was added, and both batches were heated to 105 °C for 12 hours before being dried and redissolved in a 5% HCl solution. Every other measured element's concentration was estimated using the digestion of aqua regia. School of Geography at the University of Oxford, the ESI prepFASTTM sample introduction system, and the BTM ICP Mass Spectrometer were used to quantify the element concentrations. Using multi-element standard solutions traceable to NIST SRMs (Merck, Darmstadt, Germany), elements of silver reference materials MBH 133X-AGA1 and AGA3 were measured alongside the instrument's calibration to demonstrate accuracy and precision. Repeat blank analyses were carried out to establish internal detection limits and prove that there was no contamination. Low sample quality was caused by an error with the 100x dilution in the ESI prepFASTTM sample introduction device. Recovery (usually 40–80%), it was challenging to identify silver accurately. After manually diluting the HNO3 solutions 100 times, silver was tested individually. The 100-fold dilution was a source of mistake, and it appears that the settling was difficult recuperation. The silver content displayed in Table S1 has been changed to 100%, and the measured analytical totals are also given. Except for Cr, Fe, Se, and Pd, which exhibit larger variability, replicate analyses of several digestions of the reference materials AGA1 and AGA3 vary typically less than 15% (2RSD) for the majority of elements and are all 20% (2RSD). In contrast to the MBH reference values, the Oxford ICPQMS analyses are usually within ±15% for most elements, and for gold and copper they are ±5% or better.

Conclusion

Matte inclusions are a common occurrence in Early Islamic silver that cannot be explained by the current theories regarding the evolution of silver metallurgy. Numerous dirhams still contain sulphides, which suggests that silver was frequently recovered from ore without the use of metallic lead or cupellation. Rich silver ore made comprised of native silver, cerargyrite, and acanthite must have been accessible in sufficient quantities during the study period to justify an unknown extractive metallurgical process that was crucial to the production of silver as a whole. Although the widely accepted account of the history of silver metallurgy is a vital Oversimplification, it skews and narrows the spectrum of ores towards poor ores, partly because of the early 20th century's significant effect on certain viewpoints and partly because rich ore is invisible and there is a (over) abundance of waste associated with the lowest ore grades. The current paradigm of cupellation's universality and silver production from lead ore dictates how silver research is conducted and what questions are judged important to examine.

Acknowledgement

I would like to thank my Professor for his support and encouragement.

Conflict of Interest

The authors declare that there are no conflicts of interest.

References

1. Al-Saa'd Z (1999) Chemical analysis of some Umayyad dirhems minted at Wasit. J Econ Soc Hist Orient 4: 351-363.
2. Artioli G, Canovaro C (2020) LIA of prehistoric metals in the Central Mediterranean area: a review. Archaeometry 62: 53-85.
3. Bachmann HB (1993) The archaeometallurgy of silver R. Francovich Archeologia delle Attività Estrattive Metallurgiche. All Insegna del Giglio Florence: 487-495.
4. Bartelheim M, Contreras Cortés F (2014) The silver of the Southern Iberian El Argar Culture a first look at production and distribution. Trab Prehist 69: 293-309.
5. Bartels C (1992) Vom frühneuzeitlichen Montanwesen zur Bergbauindustrie. Erzbergbau im Oberharz 1635: 1866.
6. Butche K, Ponting M (2009) The silver coinage of roman Syria under the julio-claudian.emperors Levant 41: 59-78.
7. Ceyhan N (2009) Lead Isotope Geochemistry of Pb-Zn Deposits from the Eastern Taurides.MSc Thesis Middle East Technical University Turkey.
8. Edmondson JC (1989) Mining in the later Roman Empire and beyond continuity or disruption. J Rom Stud 79: 84-102.
9. Elam CF (1931) An investigation of the microstructures of fifteen silver Greek coins and some forgeries. J Inst Met 57-69.
10. Eniosova NV (2006) Tracing the routes of silver procurement to the early urban centre Gnezdovo. 10th/early 11th centuries.
11. Bendeguz T (2006) Die Archäologie der frühen Ungarn Chronologie Technologie und Methodik RGZM. Mainz 261-276.
12. Forbes RJ (1940) Technologie in de Oudheid silver and lead in antiquity Jaarbericht van het Vooraziatisch Egyptisch Gezelschap. Ex Oriente Lux 489-524.
13. Gondonneau A, Guerr M (2002) The circulation of precious metals in the Arab Empire the case of the Near and Middle East. Archaeometry 44: 573-599.
14. Gordus AA (1972) Neutron activation analysis of coins and coin-streaks.Royal Numismatic Society London 127-148.
15. Gowland W (1918) VI silver in roman and earlier times: I. Pre-historic and proto-historic times Archaeologia or Miscellaneous.Society of Antiquaries Oxford 121-160.