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Project Gallery

State intervention in post-Qin bronze production in Sichuan: scientific insights from *mou* vessels

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Bronze *mou* vessels appear in Shu tombs in south-west China during the Eastern Zhou period (*c.* 771–256 BC). Examination of these vessels reveals major changes in the supply of metal and alloying technology in the Shu State, throwing new light on the social impact of the Qin conquest and later unification of China.

Key words: East Asia, Shu culture, bronze *mou*, archaeometallurgy, China unification

Introduction

Qin emerged as one of the most successful states in the late Warring States period (316–221 BC), exerting a profound impact on later Chinese history. One strategic step during the unification of China under the Qin was the occupation of the present-day Sichuan basin in south-west China, home of the Shu State (Figure 1). The Sichuan basin was one of the most resource-rich regions in Bronze Age China (e.g. Sanxingdui), with prosperous agriculture, established bronze production and a large population. Historical documents (e.g. *Records of History* (《史记》 司马迁)) record that the Qin conquest of Sichuan (316 BC) was likely resource driven. Following the conquest, a series of workshops was established in Sichuan by the Qin State, of which copper and copper alloys were the main products.

However, it remains uncertain to what extent these historical events affected local bronze production at Sichuan or contributed to unification. We argue that the Shu bronze production, especially objects made at local workshops, provides a unique angle to disentangle this issue. Our new scientific analyses show that although the casting technology remains similar to that of previous periods, alloying composition and the sources of copper and lead for bronze production changed after the conquest.

Nine bronze *mou (*鍪) unearthed from tombs in Guanghua Village and Metro Supermarket in Chengdu, dating from the late Warring States to Qin periods, were analysed. The presence of bronze *mou* (a typical Shu bronze vessel usually discovered in local elite tombs)

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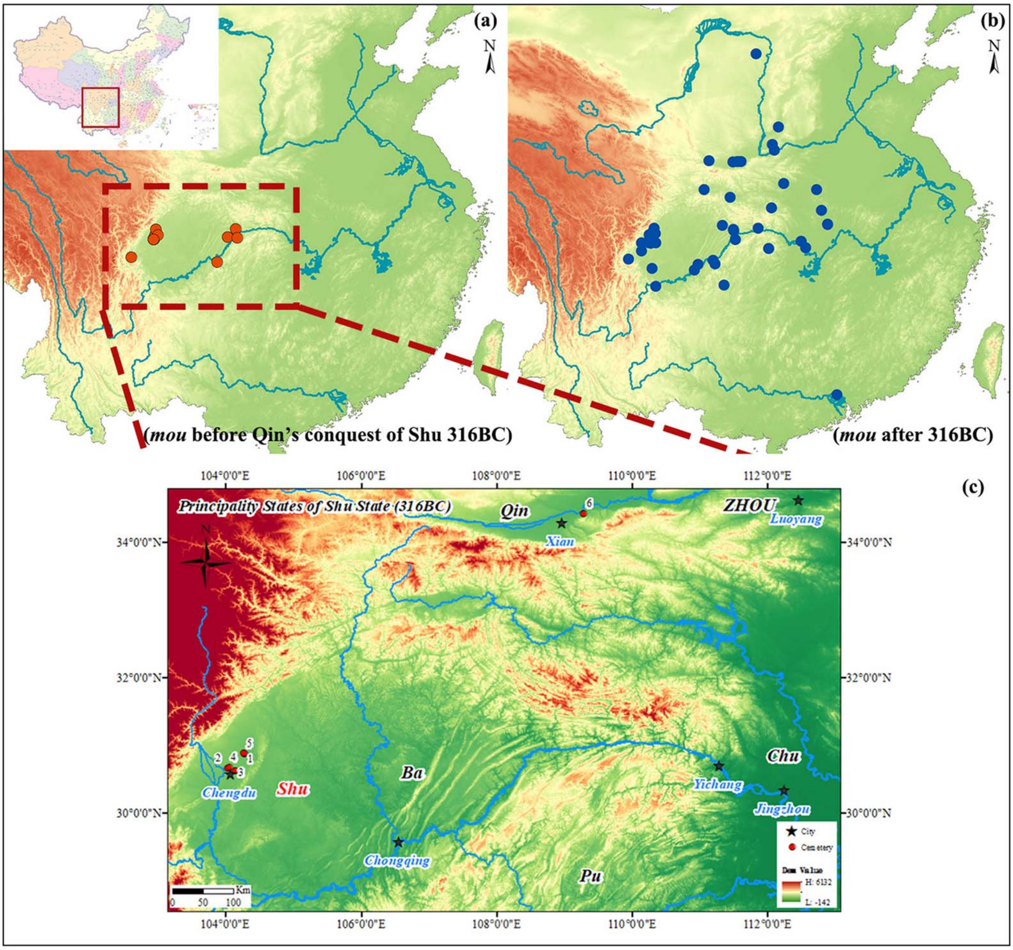

Figure 1. Distribution map of mou *(a & b) and major states and sites mentioned in this study: 1) Shuangyuan; 2) Guanghua; 3) Metro Supermarket; 4) Baishou Road; 5) Qingjiang Road; 6) Xinfeng (figure by authors).*

illustrates a fine typochronological sequence. The dispersal of this vessel shows an increasing connectivity between Sichuan and central China after the Qin conquest (Figure 1a & b).

Typochronology of *mou*

As illustrated in Figure 2, the earliest bronze *mou* have the largest handles (Type A). Around the middle Warring States period, *mou* are still characterised by the single handle, but it is smaller and attached to the lower part of the neck, with the broadest diameter on lower part of the body (Type B). The bellies of Type C vessels appear more bulging than Type B. The handle was subsequently moved from neck to shoulder and the maximum diameter of the body was pushed toward the middle, while the vessels were sometimes decorated by a raised line on the shoulder (Type D). Type E has two handles in different sizes (late stage of late Warring States to Qin). A combination of typology and excavation context shows that all

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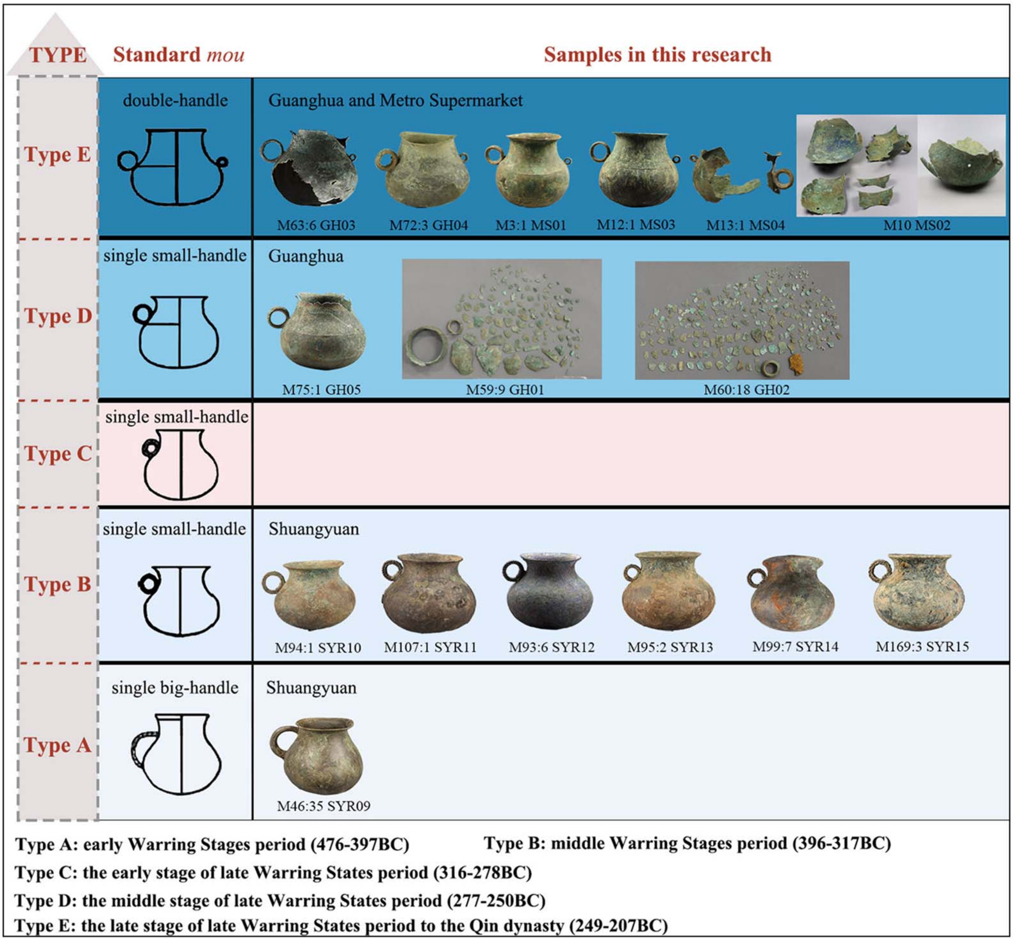

Figure 2. Typical bronze mou *samples (figure by authors).*

the bronze *mou* derived from Guanghua Village and Metro Supermarket were made after the Qin conquest of Shu (Types D & E).

Transformation of the Shu bronze industry

Scanning electron microscopy with energy dispersive x-ray spectroscopy (SEM-EDS), metallography, multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS) and inductively coupled plasma atomic emission spectroscopy (ICP-AES) are employed here. All samples are lead-tin bronze (Table 1), consistent with the prevailing alloying techniques in this and previous periods. Metallographic microstructures (Figure 3) exhibit casting structures, such as α dendrites with segregation and spherical lead inclusions, suggestive of room temperature casting and rapid cooling.

Figure 4a illustrates a reduction in the percentage of lead and tin in the *mou* from Guanghua Village and Metro Supermarket (late Warring States to Qin) compared to *mou* from

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Table 1. Chemical composition results of *mou* from Guanghua Village (GH) and Metro Supermarket (MS) (samples taken from the rim or handle of bronze *mous*).

		Major elements (SEM-EDS: Wt%)			Trace elements (ICP-AES: ppm)					
No.	**Tomb no.**	**Cu**	**Sn**	**Pb**	**Co**	**Ni**	**As**	**Sb**	**Te**	**Ag**
GH01	M59:9	76.6	14.2	8.1	175	840	2590	911	371	3856
GH02	M60:18	94.0	2.9	2.0	104	621	15407	1912	458	1079
GH03	M63:6	89.8	3.2	5.5	107	331	2188	654	434	1001
GH04	M72:3	88.6	2.0	5.4	335	851	2173	1315	515	710
GH05	M75:1	87.3	3.5	9.0	165	953	4969	1296	388	2332
MS01	M3:1	90.5	2.6	5.1	115	644	2405	4750	366	298
MS02	M10	90.7	2.4	4.5	122	459	2501	3460	267	357
MS03	M12:1	89.8	2.4	4.9	103	479	1245	1501	299	435
MS04	M13:1	88.9	4.0	4.4	20	208	1209	754	94	263

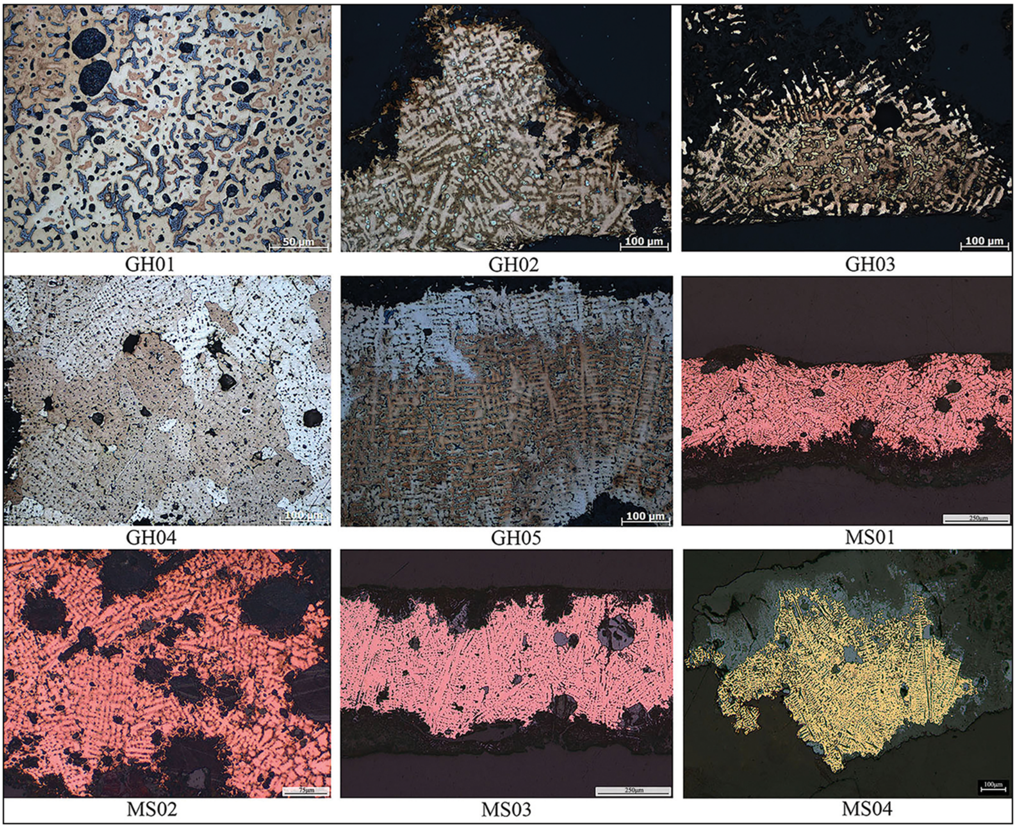

Figure 3. Metallographic images of the mou *samples from Guanghua (GH) and Metro Supermarket (MS) (figure by authors).*

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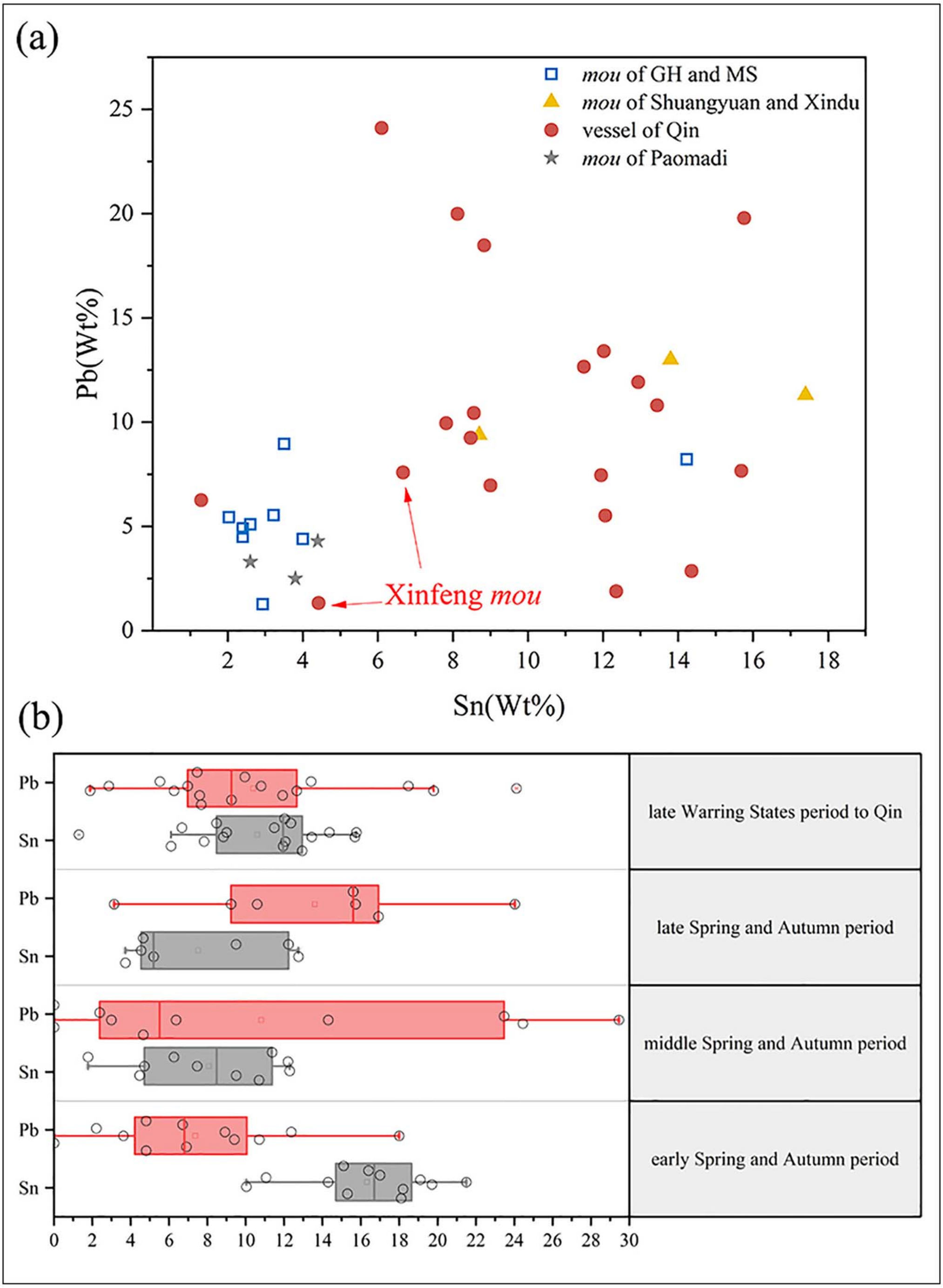

Figure 4. Differences in chemical composition between Shu and Qin vessels: a) Shu mou*, Qin vessels, and Paomadi* mou*; b) alloy composition data of bronze vessels unearthed from Qin tombs in Eastern Zhou (figure by authors).*

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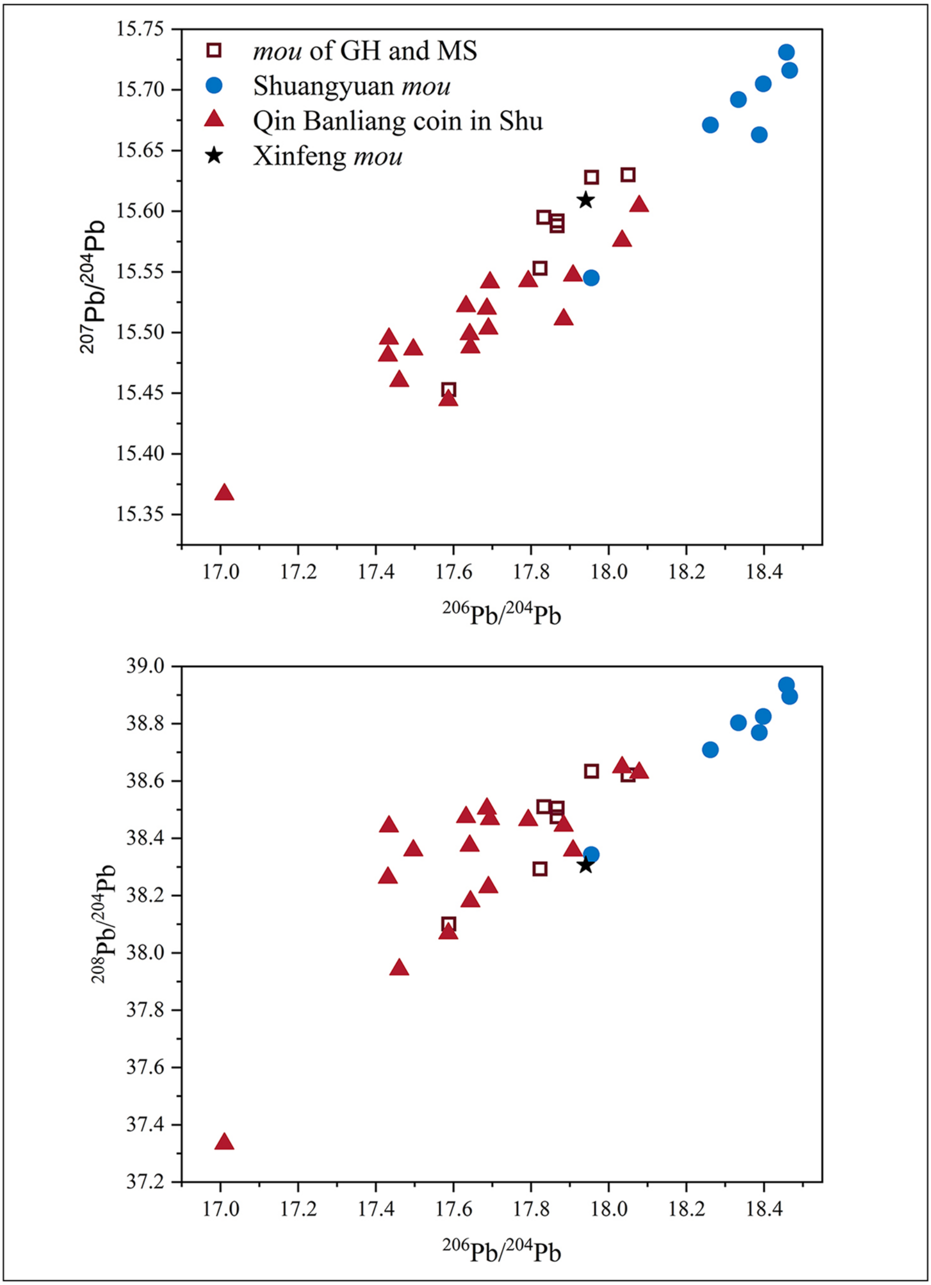

Figure 5. Comparison of lead isotope ratio of bronzes from Shu before and after the Qin conquest (figure by authors).

Xindu Majia and Shuangyuan cemeteries (mid Warring States) (Wang *et al.* 2024), probably due to strict administration post conquest. Similar low alloy percentages are also seen in the bronze *mou* from the Xinfeng Qin cemetery in Shaanxi (also dated to late Warring States) and from Paomadi M26 and M35 in Hubei (early Western Han, 206–141 BC) (Liu *et al.* 2018;

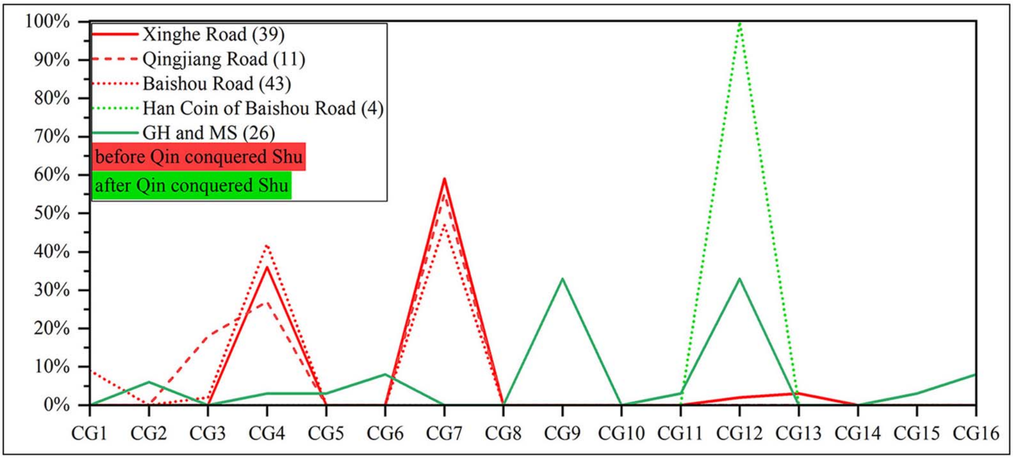

Figure 6. Statistical diagram of copper group percentage in Shu bronzes (figure by authors).

Zhang *et al.* 2019). Yet, on a broader scale, Qin vessels exhibit a higher average but wider variation in lead and tin content than Shu vessels (Figure 4a) also show an overall increase in tin content compared with earlier vessels from the mid-late Spring and Autumn periods (Figure 4b), raising questions about where Qin people obtained tin.

Lead isotope ratios of local bronzes decrease after the Qin conquest (compare Xinfeng, Guanghua Village and Metro Supermarket to Shuangyuan in Figure 5), indicative of a change in lead sources. Moreover, the isotopic consistency between the local *mou* and the Qin coinage recovered from the Shu region points to a shared supply of lead.

Impurity patterns illustrate the diachronic changes in copper resources used by the Shu culture during the Eastern Zhou period (770–221 BC) (after Pollard *et al.* 2017). The same type of copper, characterised by silver and antimony impurities (Copper Group (CG) 4 & 7), was used consistently prior to the Qin conquest (Li *et al.* 2020), but post-conquest copper sources are characterised by silver and arsenic impurities (CG9 & 12) (Figure 6).

Conclusion and future prospects

While the current dataset is admittedly small, it is possible to argue that the Qin conquest of Shu had a substantial impact on local bronze production; precipitating a reduction in the tin content of bronze *mous* and a shift in copper or lead sources. The Qin State benefited from the rich resources of Sichuan, sustaining their own bronze production (e.g. Qin standardised weapons) that supported the annexation of other states. Meanwhile, subsequent unification of China facilitated communication between the Sichuan basin and the Yangzi and Yellow Rivers, as reflected by the increased distribution of the *mou* vessels (Figure 1b). The Qin-Shu interaction undoubtedly played a role in the integration of the Qin State of China, and more compositional and lead isotopic analyses of bronze could provide more insights into this turbulent period.

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References

LI, H.C. *et al.*. 2020. Bronze production in the Ancient Chengdu Plains: a diachronic metallurgical perspective on a separate cultural region. *Journal of Cultural Heritage* 43: 26–36. https://doi.org/10.1016/j.culher.2019.11.005

LIU, JIAN-YU, MENG-YA XIAO, LU WANG, YING-CHEN WANG & YU LIU. 2018. Scientific study on bronzes unearthed from the Paomadi Cemetery in Yicheng, Hubei Province. *Sciences of Conservation and Archaeology* 30: 114–25 (in Chinese).

POLLARD, A., P. BRAY, P. HOMMEL, Y.-K. HSU, R. LIU & J. RAWSON. 2017. Bronze Age metal circulation in China. *Antiquity* 91: 674–87. https://doi.org/10.15184/aqy.2017.45

WANG, X.T., Y.D. YANG, T.Y. WANG & W.G. LUO. 2024. A feast: Indigenous production and interregional exchange reflected by the bronze vessels unearthed from Shuangyuan Village Cemetery in southwestern China. *Archaeometry* 66: 352–67. https://doi.org/10.1111/arcm.12910

ZHANG, JI, DAN WANG, HAN-QIN JIA & JIAN-LI CHEN. 2019. Analysis of bronzes of Spring and Autumn period unearthed from the Zhongxiang Huangtupo cemetery and research on related problems. *Cultural Relics in Southern China* 3: 104–13 (in Chinese).

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