

Electronic Supplementary Material (ESM)

Metallurgical strategies at Sanxingdui: bronze production and resource reuse in Late Shang, China

Archaeological and Anthropological Sciences

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1. Samples and methods.

This research is based on recent typological studies and analysis of bronze artefacts unearthed from the Sanxingdui site. A total of 79 samples were collected for this study, which were sampled from 50 bronzes recovered from Pits No.1 and No.2. In some cases, more than one sample was taken from the same bronze object to compare with different parts of the artefact (Supplementary Table S2).

Alloy compositional analyses: The samples were mounted, ground and polished according to standard metallographic preparation procedures. After carbon coating, major elemental compositions were determined using a Tescan Vega III XMU scanning electron microscope (SEM) equipped with a Bruker XFlash® 6|10 energy-dispersive X-ray spectrometer (EDS) at the Laboratory (Institute for the History of Science and Cultural Heritage, University of Science and Technology Beijing, USTB). Analyses were performed in standardless semi-quantitative mode. The operating conditions were set as follows: an accelerating voltage of 20 kV, a working distance of 15 mm, and a live acquisition time of 60 s, maintaining a stable count rate of approximately 1.6 kcps. All analytical results were normalized and are expressed in weight percent (wt%). To minimize the influence of corrosion, uncorroded metal cores or areas with minimal corrosion were targeted for area scanning.

Lead isotope ratio analyses: Pb isotope analyses were measured in Beijing Kehui

Testing Technology Co., Ltd. All chemical preparations were conducted on class 100 work benches within a 1000 clean laboratory. About 150mg of sample powder was weighted into a 15mL SavillexTM PFA screw-top beaker. Concentrated HNO₃ and HF (1mL and 2mL) were added to the samples and the sealed beakers were heated on a hotplate at 150 °C for one week. After digestion, acids were evaporated on the hotplate and residues were dissolved in 1 mL of concentrated HCl. This procedure was then repeated three times. Finally, the samples were dissolved in 1.5mL of 3.5M HNO₃. Pb was separated and purified from samples using Sr-Spec (Triskem, 100-150 µm) resin. Isotopic compositions of Pb analyses were undertaken using a Thermo Fisher Scientific Neptune Plus MC-ICP-MS. Before testing, the Pb concentration in sample was measured and then the sample was diluted into a solution with Pb concentration of 200ng/mL. Tl standard solution was added to make Pb:Tl=1:1. Pb isotope ratio were corrected for instrumental mass fractionation using the exponential fractionation law and assuming $^{203}\text{Tl}/^{205}\text{Tl} = 0.418922$.

Table S1. The general chronological framework of Chinese archaeology involved in this paper (Xia Shang Zhou duan dai gong cheng zhuan jia zu 2022).

Archaeological cultures (dynastic periods)				Date
Erlitou	Erlitou I-IV			c. 1780-1510 BC
Shang Dynasty	Early Shang	Lower Erligang I-II		c. 1540-1400 BC
		Upper Erligang I		
	Middle Shang	Upper Erligang II		c. 1400-1300 BC
		Early Huanbei Huayuanzhuang		
		Late Huanbei Huayuanzhuang		
	Late Shang	Yinxu I		c. 1320-1240 BC
		Yinxu II		c. 1260-1200 BC
		Yinxu III		c. 1200-1080 BC
		Yinxu IV		c. 1090-1040 BC
Zhou Dynasty	Western Zhou	Early Western Zhou		1046-950 BC
		Middle-Late Western Zhou		950-771 BC
	Eastern Zhou	Spring and Autumn period	Early Spring and Autumn	770-660 BC
			Middle Spring and Autumn	660-560 BC
			Late Spring and Autumn	560-453 BC
		Warring States period	Early Warring States	453-380 BC
			Middle-Late Warring States	380-221 BC

Table S2. Information of the Bronze Samples Analyzed from Sanxingdui.

Archaeological number	Name	Description	Sample ID	Categories
K2	Connection point on the bronze	Fragment	SXD:1	Non-vessel
K2	Bronze belly	Fragment	SXD:2	Non-vessel
K2	Eye-shaped bronze	Fragment	SXD:3	Non-vessel
K2	Bronze	Fragment	SXD:4	Non-vessel
			SXD:5	Non-vessel
-	Sun-shaped bronze	Strip	SXD:7	Non-vessel
		Disc	SXD:8	Non-vessel
-	Bronze tree	Fragment	SXD:10	Non-vessel
			SXD:11	Non-vessel
K2(3):142	Sun-shaped bronze	Disc (long)	SXD:12	Non-vessel
		Disc (short)	SXD:13	Non-vessel
		Cast joint part	SXD:14	Non-vessel
K2(3):323	Eye-shaped bronze	Fragment	SXD:15	Non-vessel
K2(3):58	Bronze human head	Left ear	SXD:16	Non-vessel
		Fragment	SXD:17	Non-vessel
		Repair casting part	SXD:18	Non-vessel
K2	Bronze human head	Fragment	SXD:20	Non-vessel
K2(3):22	Bird-beak-shaped bronze	Fragment	SXD:26	Non-vessel
K2(3):232	Bronze fragment	Fragment	SXD:27	Non-vessel
		Fragment	SXD:28	Non-vessel
		Fragment	SXD:29	Non-vessel
		Repair casting part	SXD:30	Non-vessel
		Repair casting part	SXD:31	Non-vessel
-	Bronze fragment	Bronze fragment	SXD:34	Non-vessel
K2(2):194	Bronze tree	Fragment	SXD:35	Non-vessel
		Base	SXD:36	Non-vessel
-	Bronze bird	Belly of the bird (near wings)	SXD:43	Non-vessel
		Belly of the bird (near belly)	SXD:44	Non-vessel
K2(3):267	Bronze tree	Branch	SXD:51	Non-vessel
		Core rod	SXD:52	Non-vessel
K2	Bronze human head	Fragment	SXD:53	Non-vessel
K2	Bronze animal	Foot	SXD:54	Non-vessel

Archaeological number	Name	Description	Sample ID	Categories
K2	Bronze bird	Foot	SXD:55	Non-vessel
K2(2):229	Eye-shaped bronze	Fragment	SXD:56	Non-vessel
-	Bronze ring	Fragment	SXD:59	Non-vessel
K2(2):155	Bird-beak-shaped bronze	Fragment	SXD:60	Non-vessel
K2(2):9	Bronze fragment	Fragment	SXD:65	Non-vessel
		Fragment	SXD:66	Non-vessel
		Fragment	SXD:67	Non-vessel
		Fragment	SXD:68	Non-vessel
		Fragment	SXD:69	Non-vessel
-	Bronze tree	Cast joint part	SXD:70	Non-vessel
		Cast joint part	SXD:71	Non-vessel
		Base	SXD:72	Non-vessel
-	Bronze bird	Belly of the bird (near neck)	SXD:73	Non-vessel
-	Bronze component	Fragment	SXD:76	Non-vessel
-	Bronze snake	Fragment	SXD:77	Non-vessel
		Repair casting part	SXD:78	Non-vessel
K2 (2) :103	Bronze vessel (<i>Zun/Lei</i>)	Foot of a vessel	SXD:6	Vessel
		Lip of a vessel	SXD:39	Vessel
		Belly of a vessel	SXD:41	Vessel
K2 (2) :8	Bronze <i>Zun</i>	Lip of a bronze <i>Zun</i>	SXD:9	Vessel
		Fragment	SXD:23	Vessel
K1:59	Bronze <i>Zun</i>	Foot of a bronze <i>Zun</i>	SXD:19	Vessel
-	Bronze vessel	Belly of a vessel	SXD:21	Vessel
		Animal head on the shoulder of a vessel	SXD:22	Vessel
K1:17?	Bronze vessel	Fragment	SXD:24	Vessel
K2 (3) :23	Bronze vessel	Fragment	SXD:25	Vessel
K1:53	Bronze <i>Pan</i>	Foot of a bronze <i>Pan</i>	SXD:32	Vessel
K1: 163	Bronze vessel	Lip of a vessel	SXD:33	Vessel
K2 (2) :39	Bronze vessel	Animal head on the shoulder of a vessel	SXD:37	Vessel
K2 (2) :39-1	Bronze vessel	Fragment	SXD:79	Vessel
K1:26	Bronze <i>Zun</i>	Lip of a bronze <i>Zun</i>	SXD:38	Vessel
K2 (2) :252	Bronze <i>Zun</i>	Belly of a bronze <i>Zun</i>	SXD:40	Vessel
-	Bronze square <i>Lei</i>	Shoulder of a bronze square <i>Lei</i>	SXD:42	Vessel
-	Bronze vessel (<i>Zun/Lei</i>)	Animal head on the shoulder of a vessel (small one)	SXD:45	Vessel

Archaeological number	Name	Description	Sample ID	Categories
		Animal head on the shoulder of a vessel (big one)	SXD:46	Vessel
-	Bronze <i>Zun</i>	Lip of a bronze <i>Zun</i> (repair casting part)	SXD:47	Vessel
		Lip of a bronze <i>Zun</i>	SXD:48	Vessel
-	Bronze vessel	Belly of a vessel	SXD:49	Vessel
-	Bronze vessel	Fragment	SXD:50	Vessel
K2 (2) :109	Bronze <i>Zun</i>	Foot of a bronze <i>Zun</i>	SXD:57	Vessel
		Foot of a bronze <i>Zun</i> (repair casting part)	SXD:58	Vessel
K2 (2) :184	Bronze square <i>Zun</i>	Shoulder of a bronze square <i>Zun</i>	SXD:61	Vessel
K2 (2) :117	Bronze <i>Lei</i>	Shoulder of a bronze <i>Lei</i>	SXD:62	Vessel
		Shoulder of a bronze <i>Lei</i> (repair casting part)	SXD:63	Vessel
K2 (3) :263	Bronze <i>Zun</i>	Lip of a bronze <i>Zun</i>	SXD:64	Vessel
无号	Bronze vessel (<i>Zun/Lei</i>)	Lip of a bronze vessel	SXD:74	Vessel
K1:158	Bronze vessel	Fragment	SXD:75	Vessel

Table S3. Alloy composition and isotope ratio data of Sanxingdui Bronzes: data from this study.

Sample ID	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb
SXD:1	76.87	7.30	15.83	22.9701	16.2789	43.5879
SXD:2	78.61	8.24	13.15	22.9361	16.2679	43.4220
SXD:3	85.60	5.11	9.30	21.5659	16.0642	42.3920
SXD:4	76.25	7.83	15.92	23.2344	16.3466	43.8464
SXD:5	83.95	6.37	9.67	23.2308	16.3457	43.8410
SXD:6	64.20	9.25	26.55	23.2780	16.3815	43.7055
SXD:7	80.68	5.16	14.16	23.1282	16.3383	43.7269
SXD:8	83.23	4.12	12.65	23.0418	16.3215	43.6463
SXD:9	80.53	4.34	15.13	23.0531	16.3099	43.8177
SXD:10	98.17	1.83	0.00	23.2554	16.3371	44.0884
SXD:11	89.64	3.07	7.30	23.4224	16.3718	44.2343
SXD:12	86.18	4.74	9.09	23.3235	16.4054	43.1863
SXD:13	92.81	3.39	3.80	23.3287	16.4067	43.1877
SXD:14	85.76	4.60	9.64	22.9903	16.3126	43.5734
SXD:15	82.72	3.78	13.49	23.1436	16.3251	43.8596
SXD:16	84.73	5.96	9.31	21.5315	16.0656	42.1548
SXD:17	82.72	9.03	8.26	23.3362	16.3412	43.9949
SXD:18	83.52	0.56	15.92	23.0794	16.3427	43.5002
SXD:19	79.85	2.64	17.51	23.7485	16.4615	44.3340
SXD:20	75.63	12.16	12.22	23.0822	16.3187	43.8300
SXD:21	71.74	9.07	19.19	23.2796	16.3821	43.7071
SXD:22	81.98	0.55	17.47	23.4219	16.4019	44.1036
SXD:23	74.47	7.58	17.95	22.8875	16.2656	43.8279
SXD:24	76.06	15.71	8.23	23.4799	16.4199	43.3812
SXD:25	74.02	11.01	14.97	24.0126	16.4973	45.3677
SXD:26	78.09	4.80	17.10	23.0939	16.3165	43.8133
SXD:27	89.11	6.21	4.68	23.0001	16.3104	43.6743
SXD:28	80.53	5.15	14.31	23.0424	16.3188	43.7107
SXD:29	82.91	6.27	10.82	22.9980	16.3092	43.6698
SXD:30	78.72	2.85	18.43	23.0665	16.2965	43.8907
SXD:31	84.57	4.15	11.28	23.0518	16.3031	43.7970
SXD:32	60.18	10.70	29.12	22.7945	16.1637	43.2593
SXD:33	94.17	4.64	1.19	22.8980	16.3259	43.4289
SXD:34	74.73	9.28	15.99	22.4815	16.2077	43.1092
SXD:35	75.10	5.99	18.91	23.2352	16.3527	43.8854
SXD:36	80.15	6.11	13.74	23.2486	16.3554	43.8933
SXD:37	71.77	10.58	17.65	23.1035	16.3594	43.4115
SXD:38	74.04	10.72	15.24	23.2652	16.2214	43.8692
SXD:39	77.47	8.21	14.32	23.2785	16.3814	43.7056

Sample ID	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb
SXD:40	70.76	8.47	20.78	23.2761	16.3810	43.7110
SXD:41	68.62	12.12	19.26	23.2747	16.3806	43.7035
SXD:42	82.70	7.43	9.86	23.0309	16.3178	43.5899
SXD:43	82.93	6.59	10.48	23.1114	16.3207	43.6339
SXD:44	73.94	7.62	18.43	23.1136	16.3180	43.6236
SXD:45	89.75	4.52	5.73	23.7521	16.4630	44.3387
SXD:46	86.54	4.40	9.06	23.7550	16.4636	44.3417
SXD:47	73.26	11.45	15.28	22.8738	16.2844	43.6735
SXD:48	82.96	4.85	12.20	22.6778	16.2720	43.2537
SXD:49	82.01	2.68	15.31	23.5675	16.4372	43.9741
SXD:50	79.41	5.73	14.86	20.9448	15.9614	41.6688
SXD:51	94.82	5.18	0.00	20.7724	15.9304	41.4373
SXD:52	86.00	10.74	3.26	20.4581	15.8798	41.0481
SXD:53	81.93	4.21	13.86	23.3686	16.3865	44.0599
SXD:54	80.48	6.94	12.59	23.2225	16.3441	43.7373
SXD:55	79.09	7.42	13.49	22.5135	16.2320	43.3087
SXD:56	89.37	2.86	7.77	19.4621	15.7401	40.0795
SXD:57	83.63	8.08	8.29	20.9756	15.9814	41.7501
SXD:58	72.42	3.22	24.37	21.0119	15.9874	41.8070
SXD:59	83.63	8.08	8.29	23.2168	16.3858	43.8110
SXD:60	78.95	5.80	15.26	22.8642	16.2770	43.7088
SXD:61	71.84	7.49	20.68	23.0955	16.3566	43.7023
SXD:62	72.08	10.37	17.55	21.3873	16.0464	42.2606
SXD:63	73.04	10.81	16.15	22.1446	16.1614	42.8673
SXD:64	73.49	10.11	16.40	24.1328	16.4633	44.5577
SXD:65	76.16	5.39	18.45	23.1101	16.3334	43.8747
SXD:66	85.41	3.82	10.77	23.0970	16.3263	43.8820
SXD:67	79.40	4.51	16.09	22.9438	16.2989	43.7312
SXD:68	75.28	6.53	18.19	23.1762	16.3361	43.9817
SXD:69	79.55	4.35	16.09	23.2039	16.3453	44.0019
SXD:70	87.60	4.06	8.33	22.5405	16.2308	43.2061
SXD:71	79.11	4.98	15.91	22.8907	16.2860	43.5750
SXD:72	90.79	3.07	6.14	22.9036	16.2921	43.7401
SXD:73	84.83	7.19	7.98	23.1259	16.3333	43.6789
SXD:74	84.37	5.55	10.08	23.4147	16.4238	44.0217
SXD:75	80.22	13.03	6.75	23.2801	16.2359	43.9234
SXD:76	82.01	7.21	10.78	23.6790	16.4087	44.2248
SXD:77	74.76	7.91	17.33	23.2475	16.3548	44.0699
SXD:78	87.62	7.85	4.52	22.7316	16.2560	43.4343
SXD:79	71.28	7.33	21.38	22.8817	16.2771	43.7900

Table S4. Compiled alloy composition and isotope ratio data of bronzes from Sanxingdui.

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	$^{206}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	References
-	Bronze altar	-	sxd-01	Non-vessel	73.07	11.56	15.11	22.911	16.271	43.552	1.9009	0.7102	(Cui and Wu, 2013)
K1:130	Bronze <i>lei</i>	-	sxd-02	Vessel	64.66	25.84	9.35	23.381	16.37	43.248	1.8497	0.7002	
K2	Bronze human head	-	sxd-03	Non-vessel	71.72	4.77	23.34	22.972	16.321	43.654	1.9003	0.7105	
K2:113	Bronze human head	-	sxd-04	Non-vessel	65.89	6.71	26.96	23.185	16.204	43.921	1.8944	0.6989	
K2:194	Bronze tree	Base	sxd-05	Non-vessel	75.33	6.75	17.7	23.213	16.418	44.186	1.9035	0.7073	
K2:194	Bronze tree	Branch	sxd-07	Non-vessel	93.99	1.96	3.49	23.201	16.27	44.148	1.9028	0.7012	
K2:114	Bronze mask	-	sxd-09	Non-vessel	77.40	12.34	9.90	23.288	16.346	44.071	1.8924	0.7019	
K1:135	Bronze vessel	Cover of a bronze vessel	sxd-10	Vessel	77.32	7.89	14.12	22.364	16.113	43.091	1.9268	0.7205	
K1:163	Bronze <i>zun</i>	-	sxd-11	Vessel	89.65	3.39	6.73	23.452	16.384	44.001	1.8762	0.6986	
K1:158+258	Bronze <i>zun</i>	-	sxd-12	Vessel	70.00	15.64	14.12	23.271	16.234	43.902	1.8866	0.6976	
K2:205-1	Bronze <i>lei</i>	Cover of a bronze <i>lei</i>	sxd-13	Vessel	70.05	17.00	12.64	23.036	16.334	43.642	1.8945	0.7091	
K2:205-2	Bronze square <i>lei</i>	-	sxd-14	Vessel	66.44	17.63	15.70	23.085	16.397	43.897	1.9015	0.7103	
K2:109	Bronze <i>zun</i>	-	sxd-15	Vessel	79.60	8.90	11.28	21.346	16.128	42.448	1.9886	0.7556	
K2:135	Bronze <i>zun</i>	-	sxd-16	Vessel	73.46	23.88	2.23	22.099	16.121	42.971	1.9444	0.7295	
K2:127	Bronze <i>zun</i>	-	sxd-18	Vessel	79.02	8.63	11.93	23.373	16.349	44.069	1.8855	0.6995	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
K2:159	Bronze <i>lei</i>	-	sxd-20	Vessel	75.68	12.35	11.71	21.223	15.956	42.067	1.9821	0.7518	
K2:327	Bronze bird	Leg of a bird	sxd-22	Non-vessel	74.79	13.66	10.75	22.911	16.271	43.897	1.9009	0.7102	
K2②:142-1	Bronze animal mask	-	ZY-317	Non-vessel	80.8	5.5	12.8	-	-	-	-	-	(Ma <i>et al.</i> 2012)
K2②:51	Bronze human head	-	ZY-319	Non-vessel	71.8	11.9	13.8	-	-	-	-	-	
K2②:114	Bronze mask	-	ZY-321	Non-vessel	81.4	7	10.6	-	-	-	-	-	
K2②:57	Bronze mask	-	Zy-322	Non-vessel	80.8	7.3	12.4	-	-	-	-	-	
K2②:33	Bronze mask	-	ZY-324	Non-vessel	78.3	2.5	12.4	-	-	-	-	-	
K1	Bronze <i>zun</i>	-	ZY-326	Vessel	59.3	16.6	2.7	-	-	-	-	-	
K1:158	Bronze <i>zun</i>	Lip of a bronze <i>zun</i>	ZY-332	Vessel	83.2	3.1	5.5	-	-	-	-	-	
K1:53	Bronze <i>pan</i>	Belly of a bronze <i>zun</i>	ZY-333	Vessel	64.6	7	23.5	-	-	-	-	-	
K1:135	Bronze	Cover of a bronze <i>pan</i>	ZY-335	Vessel	73.8	4.6	5	-	-	-	-	-	
K2②:112	Bronze <i>lei/zun</i>	-	ZY-340	Vessel	67.8	15.1	13.8	-	-	-	-	-	
K2②:88	Bronze <i>lei</i>	-	ZY-341	Vessel	78.2	13.4	5.3	-	-	-	-	-	
K2②:159	Bronze <i>lei</i>	-	ZY-342	Vessel	76.8	7.9	11.7	-	-	-	-	-	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
K2②:103	Bronze <i>lei</i>	Belly of a bronze <i>lei</i>	ZY-343	Vessel	70.3	8.9	21.4	-	-	-	-	-	
K2②:151	Bronze <i>zun</i>	Base of a bronze <i>zun</i>	ZY-344	Vessel	77.3	8.1	14.2	-	-	-	-	-	
K2②:196	Bronze <i>yi</i>	Belly of a bronze <i>yi</i>	ZY-347	Vessel	71.8	10.6	14.6	-	-	-	-	-	
K2②:94	No.1 Bronze tree	Lower part of the main trunk of the bronze tree	ZY-348	Non-vessel	89.7	2.7	6	-	-	-	-	-	
K2②:94	No.1 Bronze tree	Upper part of the main trunk of the bronze tree	ZY-349	Non-vessel	80.8	3.4	10.7	-	-	-	-	-	
K2②:94	No.1 Bronze tree	Branch	ZY-350	Non-vessel	92.2	2.9	4.3	-	-	-	-	-	
K2②:94	No.1 Bronze tree	Base	ZY-351	Non-vessel	75.9	3	18.7	-	-	-	-	-	
K2②:194	No.2 Bronze tree	Branch	ZY-352	Non-vessel	93.4	0.9	5.9	-	-	-	-	-	
K2②:194	No.2 Bronze tree	Base	ZY-353	Non-vessel	75.1	5.6	16.2	-	-	-	-	-	
K1:298-2	Bronze <i>yuan</i>	-	ZY-355	Vessel	78.8	9.5	10.3	-	-	-	-	-	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
K1:39	Bronze <i>yuan</i>	-	ZY-356	Vessel	87.4	1.9	7.4	-	-	-	-	-	
K1:103	Bronze <i>ge</i>	-	ZY-357	Non-vessel	88.8	0.2	8.2	-	-	-	-	-	
K2③:321-1	Bronze <i>ge</i>	-	ZY-361	Non-vessel	86.9	0.1	7.9	-	-	-	-	-	
K2③:91	Bronze <i>yuan</i>	-	ZY-362	Vessel	92.8	0	3.2	-	-	-	-	-	
K2③:275	Bronze <i>yuan</i>	-	ZY-363	Vessel	85.5	1.5	9.2	-	-	-	-	-	
K2③	Bronze fragment	-	ZY-364	Non-vessel	71.7	4.9	19.5	-	-	-	-	-	
K2③:248	Sun-shaped bronze	-	ZY-365	Non-vessel	80.2	6	6.7	-	-	-	-	-	
K1:53-2	Bronze <i>yuan</i>	-	ZY-369	Vessel	94.5	0.1	2	-	-	-	-	-	
K2(2):142-1	Bronze mask	Casting burr	ZY-317	Non-vessel	-	-	-	22.293	16.194	43.0277193	1.9301	0.7264	(Sichuan sheng wen wu kao gu yan jiu yuan 1999)
K2(2):150	Bronze mask	Casting burr	ZY-318	Non-vessel	-	-	-	23.137	16.344	43.9348493	1.8989	0.7064	
K2(2):51	Bronze mask	Casting burr	ZY-319	Non-vessel	-	-	-	23.276	16.34	44.1010372	1.8947	0.7020	
K2(3):119	Bronze mask	Casting burr	ZY-320	Non-vessel	-	-	-	23.189	16.327	44.2191041	1.9069	0.7041	
K2(2):114	Bronze mask	Casting burr	ZY-321	Non-vessel	85.4	7.8	0.6	21.776	16.121	42.430536	1.9485	0.7403	
K2(2):57	Bronze mask	Casting burr	ZY-322	Non-vessel	-	-	-	23.099	16.313	43.8626911	1.8989	0.7062	
K2(3):293	Bronze	Casting burr	ZY-323	Non-vessel	-	-	-	22.266	16.201	43.0000992	1.9312	0.7276	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
	mask												
K2(2):33	Bronze mask	Right ear	ZY-324	Non-vessel	-	-	-	23.242	16.39	43.7507408	1.8824	0.7052	
K1	Bronze fragment	Bronze sheet	ZY-325	Non-vessel	85.9	10.2	2.5	21.228	16.044	41.9635104	1.9768	0.7558	
K1	Bronze <i>zun</i>	Fragment	ZY-326	Vessel	-	-	-	21.61	16.074	42.457167	1.9647	0.7438	
K1:258	Bronze <i>zun</i>	Shoulder of a bronze <i>zun</i>	ZY-327	Vessel	-	-	-	23.24	16.215	43.849232	1.8868	0.6977	
K1:258	Bronze <i>zun</i>	Animal head on the shoulder	ZY-328	Vessel	-	-	-	22.362	16.123	43.0714482	1.9261	0.721	
K2:149,150	Large standing bronze figure	Lapel of a bronze figure	ZY-329	Non-vessel	-	-	-	22.46	16.25	43.327586	1.9291	0.7235	
K2:149,150	Large standing bronze figure	Back of a bronze figure	ZY-330	Non-vessel	-	-	-	22.584	16.231	43.3115952	1.9178	0.7187	
K1:158	Bronze <i>zun</i>	Foot of a bronze <i>zun</i>	ZY-331	Vessel	70.3	10.2	14.2	22.284	16.241	42.0565932	1.8873	0.6975	
K1:158	Bronze <i>zun</i>	Shoulder of a bronze <i>zun</i>	ZY-332	Vessel	93.1	1.4	0.2	23.532	16.439	44.169564	1.877	0.6986	
K1:53	Bronze <i>pan</i>	Belly of a	ZY-333	Vessel	67.3	5.6	21.9	22.783	16.158	43.2512472	1.8984	0.7902	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
		bronze <i>pan</i>											
K1:53	Bronze <i>pan</i>	Base of a bronze <i>pan</i>	ZY-334	Vessel	67.5	10.9	20.3	22.75	16.132	43.14765	1.8966	0.7901	
K1:135	Bronze vessel	Cover of a bronze vessel	ZY-335	Vessel	-	-	-	22.354	16.097	43.0359208	1.9252	0.7201	
K1:19	Bronze <i>lei</i>	Foot of a bronze <i>lei</i>	ZY-336	Vessel	73	15.2	9.7	23.48	16.424	43.409824	1.8488	0.6995	
K1:19	Bronze <i>lei</i>	Belly of a bronze <i>lei</i>	ZY-337	Vessel	79.6	15.8	0.3	23.473	16.419	43.401577	1.849	0.6995	
K2(2):135	Bronze <i>zun</i>	Foot of a bronze <i>zun</i>	ZY-338	Vessel	77.9	18.6	3	21.458	16.038	42.4675278	1.9791	0.7474	
K2(2):109	Bronze <i>zun</i>	Belly of a bronze <i>zun</i>	ZY-339	Vessel	87.3	6.6	0.3	21.349	16.035	42.2240522	1.9778	0.7511	
K2(2):112	Bronze <i>lei</i>	Foot of a bronze <i>lei</i>	ZY-340	Vessel	-	-	-	23.073	16.345	43.6148919	1.8903	0.7084	
K2(2):88	Bronze <i>lei</i>	Foot of a bronze <i>lei</i>	ZY-341	Vessel	-	-	-	19.982	15.800	40.4775374	2.0257	0.7907	
K2(2):159	Bronze <i>lei</i>	Foot of a bronze <i>lei</i>	ZY-342	Vessel	-	-	-	23.427	16.375	44.1505242	1.8846	0.699	
K2(2):103	Bronze <i>lei</i>	Belly of a bronze <i>lei</i>	ZY-343	Vessel	-	-	-	23.307	16.401	43.770546	1.878	0.7037	
K2(2):151	Bronze <i>zun</i>	Base of a bronze <i>zun</i>	ZY-344	Vessel	80.1	9.1	1.4	24.349	16.540	45.2233977	1.8573	0.6793	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
K2(2):127	Bronze <i>zun</i>	Base of a bronze <i>zun</i>	ZY-345	Vessel	-	-	-	22.147	16.145	43.0382651	1.9433	0.729	
K2(2):129	Bronze <i>zun</i>	Base of a bronze <i>zun</i>	ZY-346	Vessel	-	-	-	23.091	16.36	43.6858629	1.8919	0.7085	
K2(2):196	Bronze <i>yi</i>	Belly of a bronze <i>yi</i>	ZY-347	Vessel	-	-	-	23.968	16.444	44.388736	1.852	0.6861	
-	No.1 Bronze tree	Lower part of the main trunk of the bronze tree	ZY-348	Non-vessel	-	-	-	23.086	16.338	43.8449312	1.8992	0.7077	
-	No.1 Bronze tree	Upper part of the main trunk of the bronze tree	ZY-349	Non-vessel	-	-	-	23.121	16.344	43.8166071	1.8951	0.7069	
-	No.1 Bronze tree	Branch	ZY-350	Non-vessel	-	-	-	23.279	16.36	43.8413407	1.8833	0.7028	
-	No.1 Bronze tree	Base	ZY-351	Non-vessel	92.8	1.7	0.8	23.177	16.354	43.8068477	1.8901	0.7056	
-	No.2 Bronze tree	Branch	ZY-352	Non-vessel	-	-	-	23.338	16.362	44.2535156	1.8962	0.7011	
-	No.2 Bronze tree	Base	ZY-353	Non-vessel	-	-	-	23.177	16.354	43.8068477	1.8901	0.7056	
K1:298-16	Bronze <i>yuan</i>	-	ZY-354	Non-vessel	-	-	-	22.829	16.286	43.4002119	1.9011	0.7134	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	$^{206}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	References
K1:268-2	Bronze <i>yuan</i>	-	ZY-355	Non-vessel	-	-	-	21.81	16.144	42.695256	1.9576	0.7402	
K1:39	Bronze <i>yuan</i>	-	ZY-356	Non-vessel	-	-	-	22.852	16.309	43.613042	1.9085	0.7137	
K1:103	Bronze <i>ge</i>	-	ZY-357	Non-vessel	-	-	-	22.993	16.337	43.5349462	1.8934	0.7105	
K1:3-2	Bronze <i>ge</i>	-	ZY-358	Non-vessel	85.2	12.3	0.2	19.092	15.732	39.9729204	2.0937	0.824	
K1:53-3	Bronze <i>ge</i>	-	ZY-359	Non-vessel	-	-	-	22.022	16.149	42.3747324	1.9242	0.7333	
K2(3):264-1	Bronze <i>ge</i>	-	ZY-360	Non-vessel	-	-	-	21.227	16.035	41.7301593	1.9659	0.7554	
K2(3):321-1	Bronze <i>ge</i>	-	ZY-361	Non-vessel	-	-	-	19.325	15.798	39.9641	2.068	0.8175	
K2(2):91	Bronze <i>yuan</i>	-	ZY-362	Non-vessel	-	-	-	22.645	16.225	24.782688	1.0944	0.7165	
K2(2):275	Bronze <i>yuan</i>	-	ZY-363	Non-vessel	-	-	-	23.019	16.304	43.8557988	1.9052	0.7083	
K2(3)	Bronze fragment	-	ZY-364	Non-vessel	-	-	-	22.846	16.314	43.304593	1.8955	0.7141	
K2(3):248	Sun-shaped bronze	-	ZY-365	Non-vessel	-	-	-	22.505	16.244	43.3288765	1.9253	0.7218	
K1:8	Bronze human head	-	ZY-366	Non-vessel	-	-	-	23.188	16.343	43.8902464	1.8928	0.7048	
K1:2	Bronze human head	-	ZY-367	Non-vessel	-	-	-	21.57	16.083	42.866061	1.9873	0.7456	
K1:10	Bronze human head	-	ZY-368	Non-vessel	-	-	-	20.507	15.918	41.3462134	2.0162	0.7762	
K1:53-2	Bronze <i>yuan</i>	-	ZY-369	Non-vessel	-	-	-	22.961	16.314	43.7016713	1.9033	0.7105	
K1:130	Bronze vessel	Fragment	1944	Vessel	84.44	1.56	12.69	-	-	-	-	-	(Hao 2005)
K2②:348	Eye-shaped	Fragment	1946	Non-vessel	83.92	1.93	13.21	-	-	-	-	-	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
	bronze												
K2②:149	Large standing bronze figure	Base	1857	Non-vessel	81.2	2.2	15.2	-	-	-	-	-	
K2②:149	Large standing bronze figure	Base	1858	Non-vessel	82.5	1.9	14.2	-	-	-	-	-	
K1:163-1	Bronze <i>zun</i>	Fragment	1938	Vessel	74.24	8.41	15.64	-	-	-	-	-	
K1:135	Bronze vessel	Fragment	1931	Vessel	76.54	7.56	12.74	-	-	-	-	-	
K2②:14	Bronze mask	Face of a bronze mask	1935	Non-vessel	74.13	5.89	18.19	-	-	-	-	-	
K2③:347	Eye-shaped bronze	Fragment	1945	Non-vessel	79.27	5.63	13.30	-	-	-	-	-	
K2③:110-125	Bronze tree	Branch	1948	Non-vessel	70.84	6.37	19.95	-	-	-	-	-	
K2③:110-125	Bronze tree	Ring of a bronze branch	1949	Non-vessel	75.13	4.25	16.96	-	-	-	-	-	
K2②:60	Bronze mask	Face of a bronze mask	1852	Non-vessel	68.6	7.7	22.6	-	-	-	-	-	
K2②:60	Bronze mask	Cast joint part	1853	Non-vessel	70.1	5.5	23.6	-	-	-	-	-	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	$^{206}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	References
K2②:149	Large standing bronze figure	Waist of a bronze figure	1854	Non-vessel	69.0	8.0	23.6	-	-	-	-	-	
K2②:149	Large standing bronze figure	Waist of a bronze figure	1855	Non-vessel	63.1	8.3	27.0	-	-	-	-	-	
K2②:149	Large standing bronze figure	Cast joint part at the waist of a bronze figure	1856	Non-vessel	69.5	7.9	21.2	-	-	-	-	-	
K1:163-2	Bronze <i>zun</i>	Fragment	1937	Vessel	80.54	14.85	3.50	-	-	-	-	-	
K2②:146	Bronze <i>zun</i>	Fragment	1850	Vessel	68.1	15.0	15.5	-	-	-	-	-	
K2②:70	Bronze <i>lei</i>	Fragment	1851	Vessel	64.2	11.5	22.8	-	-	-	-	-	
K1:158	Bronze foil	Fragment	1932	Non-vessel	86.63	6.60	5.44	-	-	-	-	-	
K2③:110-125	Bronze bird	Neck of a bronze bird	1947	Non-vessel	80.05	4.60	9.12	-	-	-	-	-	
K1:289-8	Bronze <i>ge</i>	Blade of a bronze <i>ge</i>	1936	Non-vessel	96.4	-	-	-	-	-	-	-	
K2:148	Bronze mask	Lower part of the lip of a bronze mask	01	Non-vessel	96.48	3.17	0.09	-	-	-	-	-	(Zeng 1991, 1989)

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
K2:149	Large standing bronze figure	Waist of a bronze figure	02	Non-vessel	95.81	3.22	0.03	-	-	-	-	-	
K2:149	Large standing bronze figure	Base of a bronze figure	03	Non-vessel	98.09	0.23	0.07	-	-	-	-	-	
K1:207	Bronze human head	Lip of a bronze human head	04	Non-vessel	94.41	4.84	0.05	-	-	-	-	-	
K2:152	Bronze mask	Ear of a bronze mask	05	Non-vessel	96.16	3.26	0.11	-	-	-	-	-	
K2:82	Bronze human head	Neck of a bronze human head	06	Non-vessel	97.08	2.45	0.12	-	-	-	-	-	
K2:88	Bronze <i>lei</i>	Belly of a bronze <i>lei</i>	07	Vessel	65.31	8.56	16.82	-	-	-	-	-	
K2:146	Bronze <i>lei</i>	Base of a bronze <i>lei</i>	08	Vessel	62.91	5.29	29.90	-	-	-	-	-	
K2:261-5	Bronze <i>ge</i>	Tip of a bronze <i>ge</i>	09	Non-vessel	87.02	7.9	1.64	-	-	-	-	-	
K1:53-1	Bronze <i>ge</i>	Fragment	10	Non-vessel	98.40	0	0	-	-	-	-	-	
K2:139-1	Sun-shaped	Strip	11	Non-vessel	78.08	4.65	16.31	-	-	-	-	-	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
	bronze												
K2:123	Sun-shaped bronze	Strip	12	Non-vessel	73.11	0.63	24.7	-	-	-	-	-	
K1:135	Bronze <i>lei</i>	Cover of a bronze <i>lei</i>	13	Vessel	93.08	3.01	3.91	-	-	-	-	-	
K1:258-5	Bronze <i>yuan</i>	Fragment	14	Vessel	97.77	-	2.23	-	-	-	-	-	
K2:127	Bronze <i>zun</i>	Belly of a bronze <i>zun</i>	15	Vessel	77.69	4.42	15.97	-	-	-	-	-	
K2:129	Bronze <i>zun</i>	Lip of a bronze <i>zun</i>	16	Vessel	99.05	-	-	-	-	-	-	-	
K1:258	Bronze <i>zun</i>	Belly of a bronze <i>zun</i>	17	Vessel	71.76	3.18	25.06	-	-	-	-	-	
K2:191	Bronze tree	Base	18	Non-vessel	79.19	2.32	18.49	-	-	-	-	-	
K2:215	Bronze tree	Branch	19	Non-vessel	89.55	0.76	9.69	-	-	-	-	-	
K2:24	Bronze tree	Cast joint part at a branch	20	Non-vessel	78.86	1.19	19.95	-	-	-	-	-	
K2:322-11-2	Bronze tree	Branch	21	Non-vessel	79.65	0.09	20.26	-	-	-	-	-	
K2:261-5	Bronze tree	Branch	22	Non-vessel	73.86	0.43	25.72	-	-	-	-	-	
K2:322-11-1	Bronze tree	Fruit on a branch	23	Non-vessel	64.48	1.38	32.71	-	-	-	-	-	
K2:15	Bronze human head	Ear of a bronze human head	01	Non-vessel	86.96	3.14	9.19	-	-	-	-	-	
K2:201	Bronze	Lower part of	02	Non-vessel	78.18	8.54	12.25	-	-	-	-	-	

Archaeological number	Name	Description	Sample ID	Categories	Cu (%)	Sn (%)	Pb (%)	²⁰⁶ Pb/ ²⁰⁴ Pb	²⁰⁷ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁴ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	References
	mask	the lip of a bronze mask											
K2:121	Bronze human head	Ear of a bronze human head	03	Non-vessel	90.99	3.15	4.99	-	-	-	-	-	
K2:159	Bronze <i>lei</i>	Belly of a bronze <i>lei</i>	04	Vessel	88.41	4.76	6.27	-	-	-	-	-	
K2:88	Bronze <i>lei</i>	Base of a bronze <i>lei</i>	05	Vessel	83.78	10.44	4.52	-	-	-	-	-	
K2:103	Bronze <i>lei</i>	Base of a bronze <i>lei</i>	06	Vessel	85.39	4.03	9.16	-	-	-	-	-	
K2:135	Bronze <i>zun</i>	Lip of a bronze <i>zun</i>	07	Vessel	80.76	15.71	2.89	-	-	-	-	-	
K2:200	Bronze <i>zun</i>	Lip of a bronze <i>zun</i>	08	Vessel	66.89	10.05	19.23	-	-	-	-	-	
K2:129	Bronze <i>zun</i>	Lip of a bronze <i>zun</i>	09	Vessel	79.04	3.26	16.77	-	-	-	-	-	
K2:67	Sun-shaped bronze	Strip	10	Non-vessel	82.92	0.03	10.34	-	-	-	-	-	
K2:74	Sun-shaped bronze	Strip	11	Non-vessel	79.66	9.24	9.93	-	-	-	-	-	
K2:215	Bronze tree	Base	12	Non-vessel	96.98	0.67	1.65	-	-	-	-	-	

Fig. S1 Comparison of lead (Pb) and tin (Sn) content in Sanxingdui bronzes (data from this study). a Box plot of Sn content for vessel and non-vessel categories. b Box plot of Pb content for vessel and non-vessel categories

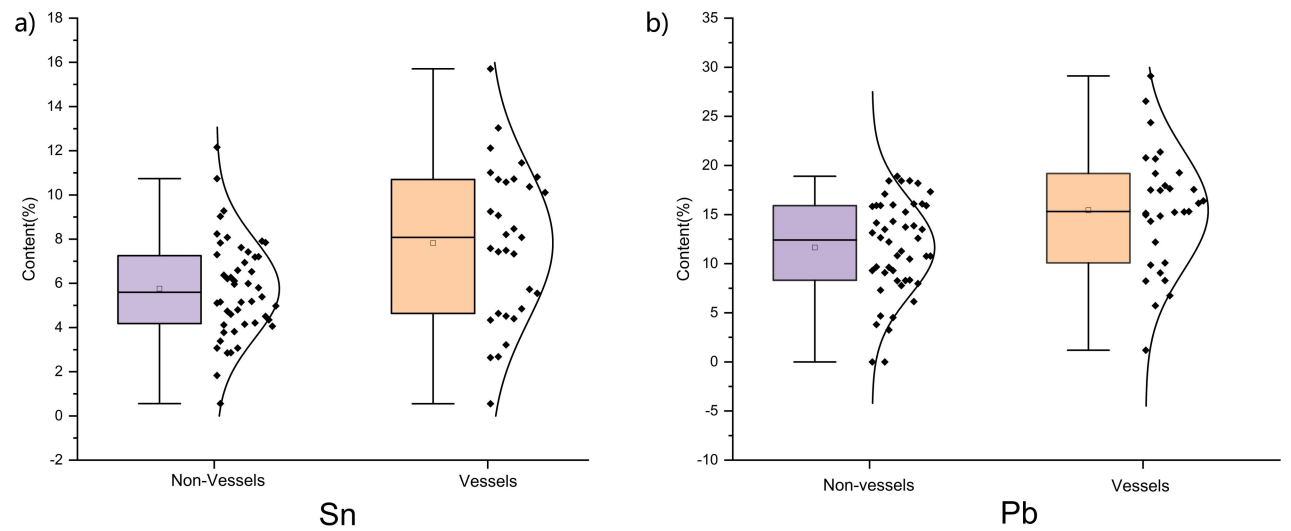
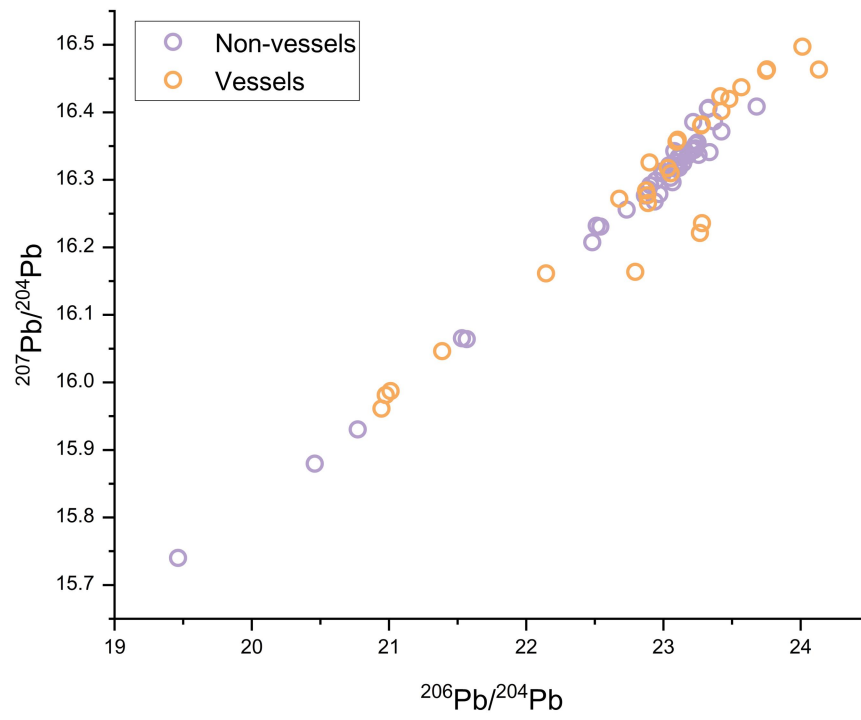


Fig. S2 Lead isotope ratio plots (data from this study)



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