



The Study of X-Ray Fluorescence Spectrum of Potsherd in New Stone Age in Zhaotong

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Abstract

Tested the potsherd of new stones age unearthed in Yeshe Mountain of Ludian county, Zhaotong city, Yunnan province with X-ray fluorescence spectrum instrument of automatic scanning in sequence ZSX100e style made in Japanese Science company, analyzed the tested data with SQX normalization software of instrument. Provided charts and datum of another method to test scientifically the sample unearthed in the same place (could be mutual reference to relative datum that result from measurement with X-ray diffraction spectrum instrument, so as to avoid the loss from different measuring method), it's helpful for researcher to analyze from multy-angle. Asertain further the material composition, definite productive place of ancient potsherd. Studied the reason why the shape and structure of them are so similar with that of pottery unearthed in Sanxingdui, tried to explore the internal relation between the ancient culture of Zhaotong, Yunnan and that of Sanxingdui. Taking datum with multiple measuring methods prepared for setting up database of cultural relics unearthed in Zhaotong.

Keywords: X-ray, Fluorescence spectrum, Zhaotong, New Stone Age, Potsherd

Lying where Yunnan, Guizhou, Sichuan meet, Zhaotong was once the important Yunnan's gateway to Central Plains, passageway for the culture of Central Plains to spread to Yunnan and communication hub of the famous southern Silk Road. It's one of three early birthplace of culture of Yunnan. The collection of unearthed cultural relics of Zhaotong is the largest among all the cities of Yunnan (nearly 17 000 pieces). There are many kinds of cultural relics, ancient remains widely distributed over Zhaotong, such as, stone axe, bone pieces in New Stone Age, red copper, bronze, iron, ceramics in Qing, Han, Tang, Song, Yuan, Ming, Qing Dynasty, the historical remains can be seen everywhere. The birdhead-like pottery, small bottle, drinking vessel in New Stone Age unearthed in Zhaotong are very similar with pottery unearthed in Sanxingdui.

Test and analyze the composition of ancient pottery unearthed in Zhaotong with X-ray fluorescence spectrum, ascertain further other material composition and productive place of them, research its relation with culture of Sanxingdui. The scientific quantitative test of composition of cultural relics unearthed in Zhaotong is very important for setting up database of unearthed cultural relics of Zhaotong to research them deeply.

X-ray fluorescence spectrum analysis is a method to excite the atom of tested matter with X-ray photon of original level

or other micro particle to emit fluorescence (X-ray of secondary level) to analyze material composition and chemical state. In modern normal analysis, it's an important way to analyze material composition and has a number of unique merits. First, compared with original level X-ray spectrum analysis, it hasn't continuous X-ray spectrum, the intensity of the background mainly consisted of scattered rays is weak, therefore, the contrast between the spectrum peak and background, and analysis sensitivity get obviously improved. The sample isn't damaged in the testing process. Its measurement of intensity can reappear well, and it's convenient for analysis without damage.

1. Sample and experimental method

The studied samples are earth pottery, sand-taken pottery unearthed in the field (about 400 m²) of Yeshi Mountain in 2002, by archaeology research institute of Yunnan. The colors of samples are yellow, grey and black. Samples are potsherd of bottom of small flat-bottomed pot and jar, as is shown in Fig. 1.

The testing equipment is X-ray fluorescence spectrum instrument, wavelength chromatic dispersion style of ZSX100e, X-ray generator of high stability, 60 kW, 150 mA, the maximum power: 4 kW, Rhodium target X-ray tube of end window type (super thin: 30 cm), X-ray systematical spectrum of up irradiation style, the precision of angle-measuring instrument: 2/10000, run automatically. Sample-making equipment: grinder of vibration style made in Japanese Science Company, tablet press: 30 t/cm², Muffle furnace: 1 200 .

The quantitative analysis of X-ray fluorescence spectrum means that first, turn the measured characteristic X-ray fluorescence intensity into quality density of tested matter, then get exact quantitative analysis result.

2. Experimental result and analysis

The experimental result is in Fig. 2~Fig.4. The experimental data is in Fig. 5.

The experiment start the scientific determination of cultural relics of Zhaotong, we will further research cultural relics of metal, ancient murals material, ancient porcelain, etc. The database of cultural relics of this area will be set up as early as possible.

References

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Figure 1. The samples

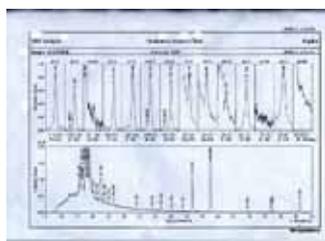


Figure 2. Experimental Result (A)

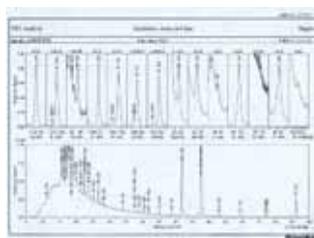


Figure 3. Experimental Result (B)

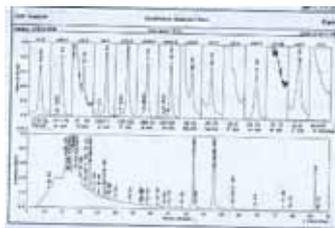


Figure 4. Experimental Result (C)

Peak Identification Result

Retention No.	Peak position (min)	Height	Area	Element
1	11.728	2480	3.76E	Na,Cl
2	11.647	4940	9.90E	Na,Cl
3	14.859	19390	11.19E	Na,Cl
4	17.447	17490	10.64E	Na,Cl
5	18.791	18116	10.96E	Na,Cl
6	20.144	1.36E	1.54E	Na,Cl
7	21.447	1920	6.80E	Na,Cl
8	22.811	11.86E	3.97E	Na,Cl
9	23.843	2.84E	1.01E	Na,Cl
10	25.114	1.79E	6.26E	Na,Cl
11	26.688	4.48E	1.74E	Na,Cl
12	27.018	6.91E	1.81E	Na,Cl
13	28.368	6.76E	1.19E	Na,Cl
14	29.863	6.79E	1.87E	Na,Cl
15	31.491	6.01E	1.19E	Na,Cl
16	32.974	5.82E	1.34E	Na,Cl
17	34.496	6.02E	1.02E	Na,Cl
18	35.814	1.78E	0.89E	Na,Cl
19	37.488	1.22E	0.61E	Na,Cl
20	38.739	1.84E	1.04E	Na,Cl
21	40.267	16.26E	3.34E	Na,Cl
22	41.918	8.43E	4.96E	Na,Cl
23	43.619	8.01E	5.33E	Na,Cl
24	45.419	8.01E	5.33E	Na,Cl
25	47.268	9.16E	5.18E	Na,Cl
26	49.111	8.42E	6.37E	Na,Cl
27	51.008	6.46E	6.17E	Na,Cl
28	52.911	10.89E	6.10E	Na,Cl
29	54.868	6.46E	6.17E	Na,Cl
30	56.871	10.89E	6.10E	Na,Cl
31	58.918	1.80E	1.79E	Na,Cl
32	60.918	0.86E	0.89E	Na,Cl
33	62.968	0.86E	0.89E	Na,Cl
34	65.068	0.86E	0.89E	Na,Cl
35	67.214	1.01E	1.04E	Na,Cl
36	69.411	1.01E	1.04E	Na,Cl
37	71.658	1.01E	1.04E	Na,Cl
38	73.951	1.01E	1.04E	Na,Cl
39	76.294	1.01E	1.04E	Na,Cl
40	78.687	1.01E	1.04E	Na,Cl
41	81.130	1.01E	1.04E	Na,Cl
42	83.623	1.01E	1.04E	Na,Cl
43	86.166	1.01E	1.04E	Na,Cl
44	88.759	1.01E	1.04E	Na,Cl
45	91.402	1.01E	1.04E	Na,Cl
46	94.095	1.01E	1.04E	Na,Cl
47	96.838	1.01E	1.04E	Na,Cl
48	99.631	1.01E	1.04E	Na,Cl
49	102.474	1.01E	1.04E	Na,Cl
50	105.367	1.01E	1.04E	Na,Cl

(a)

Peak Identification Result

Retention No.	Peak position (min)	Height	Area	Element
1	11.728	2480	3.76E	Na,Cl
2	11.647	4940	9.90E	Na,Cl
3	14.859	19390	11.19E	Na,Cl
4	17.447	17490	10.64E	Na,Cl
5	18.791	18116	10.96E	Na,Cl
6	20.144	1.36E	1.54E	Na,Cl
7	21.447	1920	6.80E	Na,Cl
8	22.811	11.86E	3.97E	Na,Cl
9	23.843	2.84E	1.01E	Na,Cl
10	25.114	1.79E	6.26E	Na,Cl
11	26.688	4.48E	1.74E	Na,Cl
12	27.018	6.91E	1.81E	Na,Cl
13	28.368	6.76E	1.19E	Na,Cl
14	29.863	6.79E	1.87E	Na,Cl
15	31.491	6.01E	1.19E	Na,Cl
16	32.974	5.82E	1.34E	Na,Cl
17	34.496	6.02E	1.02E	Na,Cl
18	35.814	1.78E	0.89E	Na,Cl
19	37.488	1.22E	0.61E	Na,Cl
20	38.739	1.84E	1.04E	Na,Cl
21	40.267	16.26E	3.34E	Na,Cl
22	41.918	8.43E	4.96E	Na,Cl
23	43.619	8.01E	5.33E	Na,Cl
24	45.419	8.01E	5.33E	Na,Cl
25	47.268	9.16E	5.18E	Na,Cl
26	49.111	8.42E	6.37E	Na,Cl
27	51.008	6.46E	6.17E	Na,Cl
28	52.911	10.89E	6.10E	Na,Cl
29	54.868	6.46E	6.17E	Na,Cl
30	56.871	10.89E	6.10E	Na,Cl
31	58.918	1.80E	1.79E	Na,Cl
32	60.918	0.86E	0.89E	Na,Cl
33	62.968	0.86E	0.89E	Na,Cl
34	65.068	0.86E	0.89E	Na,Cl
35	67.214	1.01E	1.04E	Na,Cl
36	69.411	1.01E	1.04E	Na,Cl
37	71.658	1.01E	1.04E	Na,Cl
38	73.951	1.01E	1.04E	Na,Cl
39	76.294	1.01E	1.04E	Na,Cl
40	78.687	1.01E	1.04E	Na,Cl
41	81.130	1.01E	1.04E	Na,Cl
42	83.623	1.01E	1.04E	Na,Cl
43	86.166	1.01E	1.04E	Na,Cl
44	88.759	1.01E	1.04E	Na,Cl
45	91.402	1.01E	1.04E	Na,Cl
46	94.095	1.01E	1.04E	Na,Cl
47	96.838	1.01E	1.04E	Na,Cl
48	99.631	1.01E	1.04E	Na,Cl
49	102.474	1.01E	1.04E	Na,Cl
50	105.367	1.01E	1.04E	Na,Cl

(b)

SQX Calculation Result

No.	Component	Result	Unit	Det. limit	El. time	Quantity	wt. percent
1	Cl	37.4128	mass%	0.1707	10.814	0.2378	11.8137
2	Si	18.801	mass%	0.0048	Na,Cl	181.5476	17.7146
3	Al	14.7219	mass%	0.0016	Al,Cl	337.1382	13.8424
4	C	2.3499	mass%	0.0024	C,Cl	2.1497	1.0032
5	Fe	1.2111	mass%	0.0042	Fe,Cl	16.1681	1.2423
6	K	0.7462	mass%	0.0012	K,Cl	14.9442	0.7461
7	Ti	0.4878	mass%	0.0017	Ti,Cl	1.1711	0.4799
8	Mg	0.4079	mass%	0.0049	Mg,Cl	4.1569	0.5836
9	Ca	0.2622	mass%	0.0049	Ca,Cl	1.9817	0.1916
10	P	0.1286	mass%	0.0008	P,Cl	1.9222	0.1289
11	F	0.0899	mass%	0.0129	F,Cl	0.8296	0.0811
12	B	0.0822	mass%	0.0007	B,Cl	1.1176	0.0772
13	Na	0.0617	mass%	0.0017	Na,Cl	0.1101	0.0618
14	Cr	0.0175	mass%	0.0011	Cr,Cl	0.1119	0.0184
15	V	0.0169	mass%	0.0011	V,Cl	0.2429	0.0159
16	Zn	0.0142	mass%	0.0004	Zn,Cl	2.7891	0.0134
17	Mn	0.0129	mass%	0.0019	Mn,Cl	0.1228	0.0121
18	CS	0.0109	mass%	0.0011	CS,Cl	0.8428	0.0102
19	Sn	0.0087	mass%	0.0028	Sn,Cl	0.0101	0.0082
20	Y	0.0086	mass%	0.0012	Y,Cl	1.7884	0.0081
21	Ni	0.0077	mass%	0.0001	Ni,Cl	0.8888	0.0072
22	Ba	0.0076	mass%	0.0001	Ba,Cl	0.4822	0.0075
23	Cu	0.0071	mass%	0.0001	Cu,Cl	1.1189	0.0069
24	Br	0.0061	mass%	0.0001	Br,Cl	0.178	0.0057
25	Ga	0.0018	mass%	0.0004	Ga,Cl	0.8219	0.0016
26	In	0.0014	mass%	0.0001	In,Cl	1.7408	0.0014
27	Hg	0.0009	mass%	0.0001	Hg,Cl	1.8234	0.0008
28	Y	0.0008	mass%	0.0001	Y,Cl	2.0118	0.0008

(c)

SQX Calculation Result

No.	Component	Result	Unit	Det. limit	El. time	Quantity	wt. percent
1	Cl	37.4128	mass%	0.1707	10.814	0.2378	11.8137
2	Si	25.4164	mass%	0.0118	Si,Cl	107.1182	23.4439
3	Al	18.9873	mass%	0.0042	Al,Cl	2.1497	18.9917
4	Fe	1.2104	mass%	0.0042	Fe,Cl	16.1681	1.2423
5	K	1.0801	mass%	0.0011	K,Cl	14.9442	0.8823
6	Ti	0.9763	mass%	0.0012	Ti,Cl	1.1711	0.9710
7	Mg	0.7109	mass%	0.0042	Mg,Cl	3.4769	0.7107
8	Ca	0.5276	mass%	0.0019	Ca,Cl	2.9212	0.5276
9	P	0.3161	mass%	0.0013	P,Cl	1.9817	0.3161
10	V	0.2286	mass%	0.0019	V,Cl	1.1711	0.2286
11	B	0.0821	mass%	0.0019	B,Cl	0.8296	0.0812
12	F	0.0812	mass%	0.0019	F,Cl	0.8296	0.0812
13	Na	0.0612	mass%	0.0019	Na,Cl	0.1101	0.0612
14	Cr	0.0174	mass%	0.0019	Cr,Cl	0.1119	0.0174
15	V	0.0169	mass%	0.0019	V,Cl	0.1119	0.0169
16	Zn	0.0142	mass%	0.0019	Zn,Cl	2.7891	0.0142
17	Mn	0.0129	mass%	0.0019	Mn,Cl	0.1228	0.0129
18	CS	0.0109	mass%	0.0019	CS,Cl	0.8428	0.0109
19	Sn	0.0087	mass%	0.0019	Sn,Cl	0.0101	0.0087
20	Y	0.0086	mass%	0.0019	Y,Cl	1.7884	0.0086
21	Ni	0.0077	mass%	0.0019	Ni,Cl	0.8888	0.0077
22	Ba	0.0076	mass%	0.0019	Ba,Cl	0.4822	0.0076
23	Cu	0.0071	mass%	0.0019	Cu,Cl	1.1189	0.0071
24	Br	0.0061	mass%	0.0019	Br,Cl	0.178	0.0061
25	Ga	0.0018	mass%	0.0019	Ga,Cl	0.8219	0.0018
26	In	0.0014	mass%	0.0019	In,Cl	1.7408	0.0014
27	Hg	0.0009	mass%	0.0019	Hg,Cl	1.8234	0.0009
28	Y	0.0008	mass%	0.0019	Y,Cl	2.0118	0.0008

(d)

SQX Calculation Result

No.	Component	Result	Unit	Det. limit	El. time	Quantity	wt. percent
1	Cl	37.4128	mass%	0.1707	10.814	0.2378	11.8137
2	V	41.2661	mass%	0.0012	Si,Cl	107.1182	41.2661
3	Y	36.6451	mass%	0.0118	C,Cl	2.1497	36.6451
4	Al	18.9873	mass%	0.0042	Al,Cl	2.1497	18.9873
5	Fe	1.2104	mass%	0.0042	Fe,Cl	16.1681	1.2104
6	K	1.0801	mass%	0.0012	K,Cl	14.9442	1.0801
7	Ti	0.9763	mass%	0.0012	Ti,Cl	1.1711	0.9763
8	Mg	0.7109	mass%	0.0042	Mg,Cl	3.4769	0.7109
9	Ca	0.5276	mass%	0.0019	Ca,Cl	2.9212	0.5276
10	P	0.3161	mass%	0.0013	P,Cl	1.9817	0.3161
11	V	0.2286	mass%	0.0019	V,Cl	1.1711	0.2286
12	B	0.0821	mass%	0.0019	B,Cl	0.8296	0.0821
13	F	0.0812	mass%	0.0019	F,Cl	0.8296	0.0812
14	Na	0.0612	mass%	0.0019	Na,Cl	0.1101	0.0612
15	Cr	0.0174	mass%	0.0019	Cr,Cl	0.1119	0.0174
16	V	0.0169	mass%	0.0019	V,Cl	0.1119	0.0169
17	Zn	0.0142	mass%	0.0019	Zn,Cl	2.7891	0.0142
18	Mn	0.0129	mass%	0.0019	Mn,Cl	0.1228	0.0129
19	CS	0.0109	mass%	0.0019	CS,Cl	0.8428	0.0109
20	Sn	0.0087	mass%	0.0019	Sn,Cl	0.0101	0.0087
21	Y	0.0086	mass%	0.0019	Y,Cl	1.7884	0.0086
22	Ni	0.0077	mass%	0.0019	Ni,Cl	0.8888	0.0077
23	Ba	0.0076	mass%	0.0019	Ba,Cl	0.4822	0.0076
24	Cu	0.0071	mass%	0.0019	Cu,Cl	1.1189	0.0071
25	Br	0.0061	mass%	0.0019	Br,Cl	0.178	0.0061
26	Ga	0.0018	mass%	0.0019	Ga,Cl	0.8219	0.0018
27	In	0.0014	mass%	0.0019	In		

