Appendix I: XRF, ICPMS, SEM-EDX Analysis

Chemical analyses were carried out for determining the provenience of production of a few glazed ware shreds reported in the survey. Since the glazed ware sherds are relatively rare and reported from neighbouring regions of Jammu, it is important to investigate if they are locally produced or transported from outside. Three different analyses – XRF, ICPMS and SEM-EDX – were carried out to have better resolution of the elemental composition of the glazed ware along with reference samples of other pottery from the research area.

Samples for XRF analysis

32 samples from the sites of Jammu and Punjab were taken for the provenance study of the glazed ware. Local red ware was chosen for comparison because it is usually local made and, therefore, can be taken as a proxy for mineralogical/elemental composition of local clay sources used for pottery manufacturing.

The samples are prepared following the standard protocol for XRF analysis which has already been discussed in Chapter II.

Samples for XRF analysis, their provenance and context

Sample Number	Group	Site	Provenance	Type of Ware	Context
1	A	Satowali	Jammu	Black on red Ware	Explored from surface
2	A	Satowali	Jammu	Grey Ware	Explored from surface
3	A	Satowali	Jammu	Crude red ware	Section scrapped 150-170cms
4	A	Satowali	Jammu	Un-slipped Red Ware	Section scrapped 120-150cms
5	H	Satowali	Jammu	Glazed Ware	Explored from surface
6	B	Sanghol	Punjab	Un-slipped Red Ware	Explored from surface
7	A	Satowali	Jammu	Un-slipped Red Ware	Section scrapped 170-180cms
8	B	Sanghol	Punjab	Un-slipped Red Ware	Explored from surface
9	C	Balu Chak	Jammu	Un-slipped Red Ware	Explored from surface
10	C	Balu Chak	Jammu	Un-slipped Red Ware	Explored from surface
11	C	Balu Chak	Jammu	Un-slipped Red Ware	Explored from surface
12	C	Balu Chak	Jammu	Un-slipped Red Ware	Explored from surface
13	C	Balu Chak	Jammu	Un-slipped Red Ware	Explored from surface
14	D	Manda	Jammu	Un-slipped Red Ware	Explored from surface
15	D	Manda	Jammu	Un-slipped Red Ware	Explored from surface
16	D	Manda	Jammu	Un-slipped Red Ware	Explored from surface
17	D	Manda	Jammu	Un-slipped Red Ware	Explored from surface
18	D	Manda	Jammu	Un-slipped Red Ware	Explored from surface
19	E	Guru Baba ka Tibba	Jammu	Un-slipped Red Ware	Explored from surface
20	E	Guru Baba ka Tibba	Jammu	Un-slipped Red Ware	Explored from surface
21	E	Guru Baba ka Tibba	Jammu	Un-slipped Red Ware	Explored from surface
22	E	Guru Baba ka Tibba	Jammu	Un-slipped Red Ware	Explored from surface
23	E	Guru Baba ka Tibba	Jammu	Un-slipped Red Ware	Explored from surface
24	F	Bara	Punjab	Glazed Ware	Explored from surface
25	G	Biyan Tibba	Jammu	Un-slipped Red Ware	Section scrapped 35-50cms
26	G	Biyan Tibba	Jammu	Un-slipped Red Ware	Section scrapped 0-35cms
27	G	Biyan Tibba	Jammu	Un-slipped Red Ware	Section scrapped 130-160cms
28	G	Biyan Tibba	Jammu	Un-slipped Red Ware	Section scrapped 80-100cms
29	G	Biyan Tibba	Jammu	Un-slipped Red Ware	Section scrapped 180-200cms
30	H	Satowali	Jammu	Glazed Ware	Explored from surface
31	H	Satowali	Jammu	Glazed Ware	Explored from surface
32	H	Satowali	Jammu	Glazed Ware	Explored from surface

XRF data of the samples from Jammu and Punjab: Individual values

Sample	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	Sum	Ni	Zr	Ba
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)
1	17.2	4.55	7.41	3.01	2.12	0.14	0.13	0.15	64.5	0.79	100.0	56	299	464
2	17.8	0.48	8.18	3.56	1.73	0.13	0.02	0.18	67.5	0.89	100.5	68	265	555
3	17.6	0.56	7.77	3.39	1.77	0.10	0.01	0.14	67.7	0.86	99.9	71	395	462
4	19.1	0.51	8.92	3.40	1.93	0.11	0.00	0.08	64.8	0.92	99.8	83	307	549
5	16.1	0.58	6.72	2.87	1.44	0.09	0.25	0.15	71.3	0.77	100.3	62	377	404
6	17.2	2.21	7.21	3.28	2.00	0.12	0.15	0.31	65.1	0.70	98.2	53	291	577
7	18.5	0.47	8.85	3.95	1.87	0.12	0.00	0.11	63.7	0.87	98.4	81	255	491
8	18.1	1.39	8.54	3.67	1.74	0.08	0.00	0.26	63.8	0.88	98.4	76	202	722
9	17.4	0.35	7.67	3.48	1.61	0.14	0.01	0.20	67.2	0.82	98.8	57	296	464
10	16.6	0.37	6.83	3.32	1.47	0.09	0.00	0.18	68.1	0.68	97.7	55	229	462
11	16.8	0.59	6.32	3.27	1.52	0.07	0.00	0.15	70.8	0.68	100.2	44	301	441
12	17.6	0.35	6.95	3.32	1.58	0.08	0.00	0.15	70.1	0.69	100.8	50	232	448
13	17.0	0.38	6.68	3.28	1.48	0.07	0.00	0.12	69.9	0.68	99.6	53	232	431
14	16.9	0.57	7.44	2.65	1.41	0.12	0.10	0.11	70.4	0.79	100.5	63	196	403
15	17.4	0.62	7.72	2.89	1.55	0.14	0.10	0.43	68.6	0.88	100.3	54	450	452
16	16.5	0.89	7.29	2.88	1.73	0.13	0.47	0.32	69.1	0.85	100.2	65	462	433
17	17.9	2.01	7.68	3.34	1.99	0.13	0.00	0.36	65.9	0.68	99.9	45	221	517
18	16.9	0.99	7.29	3.44	1.94	0.09	0.18	0.26	63.8	0.65	95.5	52	211	457
19	16.3	0.75	7.49	2.79	1.19	0.12	0.00	0.26	63.9	0.78	93.6	58	295	565
20	18.2	0.58	7.73	4.12	1.40	0.16	0.78	0.23	65.6	0.75	99.5	44	250	646
21	16.6	1.04	6.89	2.64	1.69	0.15	0.00	0.19	69.3	0.77	99.3	60	296	684
22	17.4	0.66	7.69	2.62	1.49	0.19	0.00	0.33	68.6	0.78	99.7	54	318	572
23	16.4	0.84	7.29	2.77	1.49	0.14	0.11	0.31	66.6	0.77	96.8	61	376	620
24	17.3	5.79	6.65	3.46	2.27	0.11	0.56	0.11	64.4	0.65	101.2	46	276	678
25	17.5	2.36	7.41	3.23	1.97	0.08	0.23	0.11	65.9	0.86	99.6	69	343	510
26	16.9	1.30	6.64	3.23	1.67	0.06	0.23	0.17	69.0	0.82	100.0	60	356	440
27	17.8	2.72	7.53	3.39	2.04	0.10	0.14	0.11	65.9	0.84	100.6	70	316	515
28	17.8	1.77	7.70	3.47	1.97	0.08	0.18	0.16	65.2	0.87	99.2	69	286	570
29	17.9	6.10	7.44	4.43	2.40	0.13	0.00	0.19	61.3	0.69	100.6	61	248	506
30	16.8	1.59	7.36	3.08	1.58	0.10	0.28	0.13	67.2	0.85	99.0	66	356	464
31	16.4	0.59	6.82	2.97	1.48	0.09	0.25	0.16	71.0	0.77	100.6	54	354	411
32	17.2	1.35	7.25	3.11	1.57	0.10	0.16	0.13	67.7	0.72	99.3	61	262	492

XRF Samples from Jammu and Punjab: Calculated Mean and standard deviation values

	Sample No.	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	Ni	Zr	Ba
Group A	1	17.2	4.55	7.41	3.01	2.12	0.14	0.13	0.15	64.5	0.79	56	299	464
	2	17.8	0.48	8.18	3.56	1.73	0.13	0.02	0.18	67.5	0.89	68	265	555
	3	17.6	0.56	7.77	3.39	1.77	0.10	0.01	0.14	67.7	0.86	71	395	462
	4	19.1	0.51	8.91	3.41	1.92	0.11	0.00	0.08	64.9	0.91	82	287	560
	7	18.5	0.47	8.85	3.95	1.87	0.12	0.00	0.11	63.7	0.87	81	255	491
	mean	18.0	1.32	8.23	3.46	1.88	0.12	0.03	0.13	65.6	0.87	72	300	506
	SD	0.753796	1.807719	0.656629	0.340239	0.153096	0.015205	0.055966	0.03915	1.848789	0.044489	10.67455	55.76395	48.14078
Group B	6	17.2	2.21	7.21	3.28	2.00	0.12	0.15	0.31	65.1	0.70	53	291	577
	8	18.1	1.39	8.54	3.67	1.74	0.08	0.00	0.26	63.8	0.88	76	202	722
	mean	17.6	1.80	7.88	3.47	1.87	0.10	0.07	0.28	64.4	0.79	65	247	650
	SD	0.62084	0.581242	0.938331	0.274357	0.181726	0.029698	0.104652	0.038184	0.898733	0.130108	16.18072	62.9325	102.5305
Group C	9	17.4	0.35	7.67	3.48	1.61	0.14	0.01	0.20	67.2	0.82	57	296	464
	10	16.6	0.37	6.83	3.32	1.47	0.09	0.00	0.18	68.1	0.68	55	229	462
	11	16.8	0.59	6.32	3.27	1.52	0.07	0.00	0.15	70.8	0.68	44	301	441
	12	17.6	0.35	6.95	3.32	1.58	0.08	0.00	0.15	70.1	0.69	50	232	448
	13	17.0	0.38	6.68	3.28	1.48	0.07	0.00	0.12	69.9	0.68	53	232	431
	mean	17.1	0.4	6.9	3.3	1.5	0.1	0.0	0.2	69.2	0.7	51.6	258.0	449.5
	SD	0.4	0.1	0.5	0.1	0.1	0.0	0.0	0.0	1.5	0.1	4.9	37.0	14.1
Group D	14	16.9	0.56	7.44	2.65	1.41	0.12	0.09	0.10	70.3	0.79	62	349	427
	15	17.4	0.62	7.72	2.89	1.55	0.14	0.10	0.43	68.6	0.88	54	450	452
	16	16.5	0.89	7.29	2.88	1.73	0.13	0.47	0.32	69.1	0.85	65	462	433
	17	17.9	2.01	7.68	3.34	1.99	0.13	0.00	0.36	65.9	0.68	45	221	517
	18	16.9	0.99	7.29	3.44	1.94	0.09	0.18	0.26	63.8	0.65	52	211	457
	mean	17.1	1.0	7.5	3.0	1.7	0.1	0.2	0.3	67.5	0.8	55.6	338.4	457.3
	SD	0.541344	0.584129	0.207413	0.333842	0.24964	0.020828	0.179168	0.123518	2.660423	0.10051	7.841053	120.2043	35.89609
Group E	19	16.3	0.75	7.49	2.79	1.19	0.12	0.00	0.26	63.9	0.78	58	295	565
	20	18.2	0.58	7.73	4.12	1.40	0.16	0.78	0.23	65.6	0.75	44	250	646
	21	16.6	1.04	6.89	2.64	1.69	0.15	0.00	0.19	69.3	0.77	60	296	684
	22	17.4	0.66	7.69	2.62	1.49	0.19	0.00	0.33	68.6	0.78	54	318	572
	23	16.4	0.84	7.29	2.77	1.49	0.14	0.11	0.31	66.6	0.77	61	376	620
	mean	17.0	0.8	7.4	3.0	1.5	0.2	0.2	0.3	66.8	0.8	55.4	307.0	617.4
	SD	0.804103	0.174392	0.341854	0.635128	0.177717	0.028341	0.337917	0.053854	2.208337	0.011713	7.035329	45.59307	50.29956
Group F	24	17.3	5.79	6.65	3.46	2.27	0.11	0.56	0.11	64.4	0.65	46	276	678
Group G	25	17.5	2.36	7.41	3.23	1.97	0.08	0.23	0.11	65.9	0.86	69	343	510
	26	16.9	1.30	6.64	3.23	1.67	0.06	0.23	0.17	69.0	0.82	60	356	440
	27	17.8	2.72	7.53	3.39	2.04	0.10	0.14	0.11	65.9	0.84	70	316	515
	28	17.8	1.77	7.70	3.47	1.97	0.08	0.18	0.16	65.2	0.87	69	286	570
	29	17.9	6.10	7.44	4.43	2.40	0.13	0.00	0.19	61.3	0.69	61	248	506
	mean	17.6	2.8	7.3	3.6	2.0	0.1	0.2	0.1	65.5	0.8	65.7	309.8	508.1
	SD	0.430614	1.895116	0.410302	0.502356	0.258471	0.027298	0.096518	0.036183	2.767013	0.073572	4.860205	43.93855	46.33202
Group H	5	16.1	0.58	6.72	2.87	1.44	0.09	0.25	0.15	71.3	0.77	62	377	404
	30	16.8	1.59	7.36	3.08	1.58	0.10	0.28	0.13	67.2	0.85	66	356	464
	31	16.4	0.59	6.82	2.97	1.48	0.09	0.25	0.16	71.0	0.77	54	354	411
	32	17.2	1.35	7.25	3.11	1.57	0.10	0.16	0.13	67.7	0.72	61	262	492
	mean	16.6	1.0	7.0	3.0	1.5	0.1	0.2	0.1	69.3	0.8	60.7	337.0	442.7
	SD	0.5	0.5	0.3	0.1	0.1	0.0	0.1	0.0	2.2	0.1	4.8	51.4	42.4

The samples of glazed ware, when compared to the other un-slipped red ware and glazed ware from Jammu and Punjab, did not give any significant difference in values, implying that the provenance of all these different sets of pottery is one. The logical interpretation of this similarity in mineralogical

composition of pottery from Jammu and Punjab can therefore be attributed to the same clay source, i.e., the foothills of Himalayas. In fact, the current data was compared with the XRF data of Sanghol (Kumar et. al., 2006) given in the table below, and the values were found to be similar.

Elemental composition of Glazed ware from Sanghol

Elemental composition in %	Sanghol (Kumar et.al., 2006)	Jammu
K	2.8	2.6
Ca	0.76	0.87
Ti	0.5	0.47
Mn	0.07	0.09
Fe	4.17	5.1
Cu	0.006	0.004
Zn	0.008	0.009
Rb	0.0178	0.0184
Sr	0.0104	0.016
Y	0.0013	0.002

Thus, it is seen that the clay belonging to the foothills of Himalayas gave the same provenance signature.

In order to statistically prove the above-mentioned statement, student 't' test was done on the above data from Sanghol and Jammu.

Student T Test result of samples from Sanghol and Jammu

Null Hypothesis- There is no significant difference between clay of Jammu and Sanghol Alternate Hypothesis- There is a significant difference between the clay of Jammu and Sanghol
T value= 0.9 P value=0.4 Critical Value (α)=0.05. P> α- implying that the null hypothesis is accepted in this case

The plausible inference from XRF results, therefore, is that the same provenance of clay was used for pottery manufacturing in both the areas of Jammu and Sanghol.

ICPMS ANALYSIS

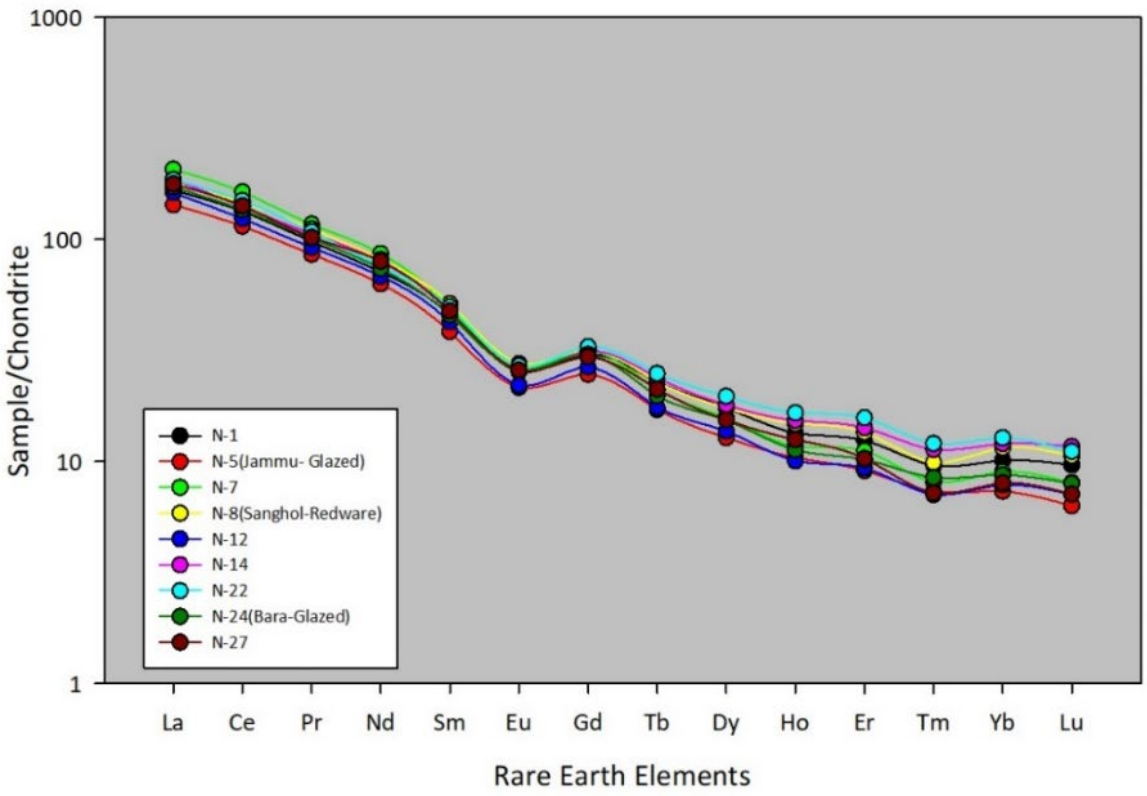
To reach to a clearer conclusion, the technique of ICPMS was tried on representative samples from each group. It was attempted to measure the rare earth elements, which could be helpful in identifying different provenance patterns. Nine samples were selected from the already existing XRF samples. The method of sample preparation has already been discussed in Chapter II.

Samples for ICPMS

Sample Number	Site	Tehsil	Ware	Group
01	Satowali Jammu	R S Pura	Black on red Ware	A
05	Satowali Jammu	R.S Pura	Glazed Ware	H
07	Satowali Jammu	R S Pura	Un-slipped Red Ware	A
08	Sanghol Punjab	Khamano	Un-slipped Red Ware	B
12	Balu Chak Jammu	R S Pura	Un-slipped Red Ware	C
14	Manda Jammu	Akhnoor	Un-slipped Red Ware	D
22	Guru Baba Ka Tibba	Akhnoor	Un-slipped Red Ware	E
24	Bara – Punjab	Rupnagar	Glazed Ware	F

Individual ICPMS values for the selected sherd

		Sample-01	Sample-05	Sample-07	Sample-08	Sample-12	Sample-14	Sample-22	Sample-24	Sample-27	
											BHVO-2
	Isotope										Meas.
	^{45}Sc	18.7	14.1	20.6	20.9	17.3	17.8	19.9	17.0	19.9	31.2
	^{51}V	177	129	194	193	153	161	161	109	172	313
	^{52}Cr	157	132	189	201	138	159	154	144	179	290
	^{59}Co	95.5	195	330	72.6	197	171	59.0	112	89.4	43.3
	^{60}Ni	70.0	57.7	88.4	87.7	57.9	72.8	68.4	60.0	79.2	119
	^{63}Cu	38.6	38.3	40.0	47.8	32.4	37.8	46.7	37.1	41.4	126
	^{66}Zn	81.8	65.7	147	95.4	204	66.0	74.6	76.0	88.3	109
	^{85}Rb	178	152	207	230	205	148	182	143	212	8.85
	^{88}Sr	154	122	134	215	100	130	124	282	201	387
	^{89}Y	22.1	16.6	18.7	22.2	17.7	24.5	27.3	19.1	18.3	26.4
	^{93}Nb	11.9	13.9	12.4	16.1	15.6	9.44	16.4	18.3	14.8	18.8
	^{133}Cs	9.59	4.19	8.31	12.1	6.68	6.81	9.15	13.2	10.9	0.11
	^{137}Ba	763	561	692	978	627	642	804	905	779	140
	^{139}La	39.4	33.9	49.0	42.3	38.3	44.1	43.9	40.7	42.0	15.8
	^{140}Ce	81.8	70.1	99.9	89.6	75.7	86.0	91.4	83.0	86.5	36.9
	^{141}Pr	9.30	8.13	11.1	10.6	8.74	10.1	10.3	9.59	9.70	5.08
	^{146}Nd	33.3	29.4	40.2	37.9	31.8	37.0	35.3	34.4	37.2	22.1
	^{147}Sm	7.04	5.88	7.54	7.85	6.49	7.24	7.59	6.98	7.27	5.78
	^{153}Eu	1.47	1.25	1.51	1.60	1.28	1.50	1.56	1.49	1.49	1.88
	^{157}Gd	6.27	5.08	6.52	6.57	5.47	6.47	6.76	6.24	6.07	5.91
	^{159}Tb	0.84	0.63	0.78	0.84	0.65	0.88	0.92	0.73	0.78	0.90
	^{163}Dy	4.43	3.25	3.99	4.42	3.48	4.56	4.99	3.90	3.91	5.45
	^{165}Ho	0.76	0.59	0.66	0.84	0.57	0.87	0.94	0.64	0.71	1.00
	^{166}Er	2.06	1.51	1.85	2.25	1.55	2.35	2.61	1.69	1.71	2.57
	^{169}Tm	0.25	0.19	0.21	0.26	0.18	0.29	0.31	0.22	0.19	0.28
	^{172}Yb	1.72	1.25	1.53	1.96	1.33	2.05	2.17	1.48	1.36	1.96
	^{175}Lu	0.24	0.16	0.20	0.27	0.18	0.29	0.28	0.20	0.18	0.26
	^{178}Hf	0.71	0.57	0.83	0.88	0.69	0.78	0.69	0.62	0.77	4.11
	^{181}Ta	3.14	4.25	3.20	3.59	5.89	2.24	3.89	9.87	5.20	1.09
	^{208}Pb	26.8	27.6	31.8	31.9	28.7	25.2	28.7	32.4	29.9	1.69
	^{232}Th	12.9	12.6	17.2	19.4	14.5	15.9	15.2	17.8	16.3	1.15
	^{238}U	1.77	1.44	1.56	5.84	1.69	1.70	2.08	2.52	2.97	0.43



ICPMS of samples from Jammu and Punjab

The results obtained from ICPMS also pointed towards the same provenance source of pottery for both Punjab and Jammu.

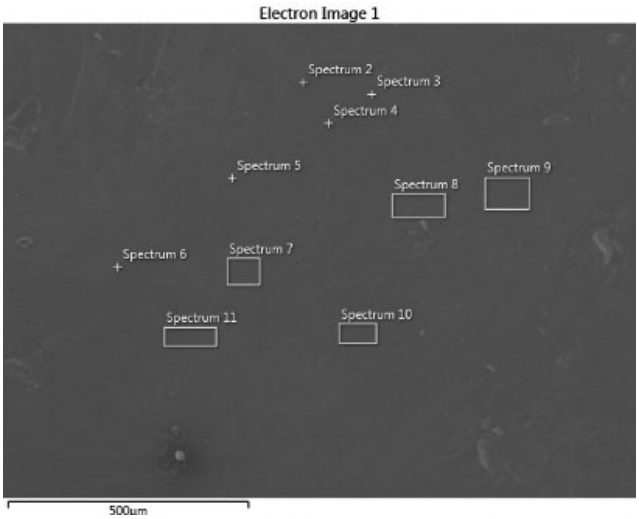
It therefore seems reasonable that the glazed ware was manufactured in the similar physiological setup (similar source of clay coming from foothills of Himalayas) as that of the area of Jammu. There are two possibilities in this case. Either it was locally manufactured in Jammu itself or it was brought in through local trade from nearby areas. It is interesting to mention here the reference of Sialkot being one of the important centers of glazed pottery during the early centuries of 2nd millennium A.D (Muhammad, 1986).

The third method of SEM-EDX was done to understand the elemental composition of glazed ware. It was done with a primary aim of determining the chemical composition of the glazed pottery and the high-resolution photographs of the glaze. Two samples –Sample-1 and Sample-2 were taken for the analysis. The outer surface of sample 1 i.e., blue side (GW-1) and the inner surface i.e., non- blue side (GW-BS-1) were both subjected to EDX analysis. Sample 2 had blue streaks on the outer surface, which were analysed (GW-2) along with the inner non-blue surface (GW-BS-2). The process of sample preparation is discussed in Chapter II.

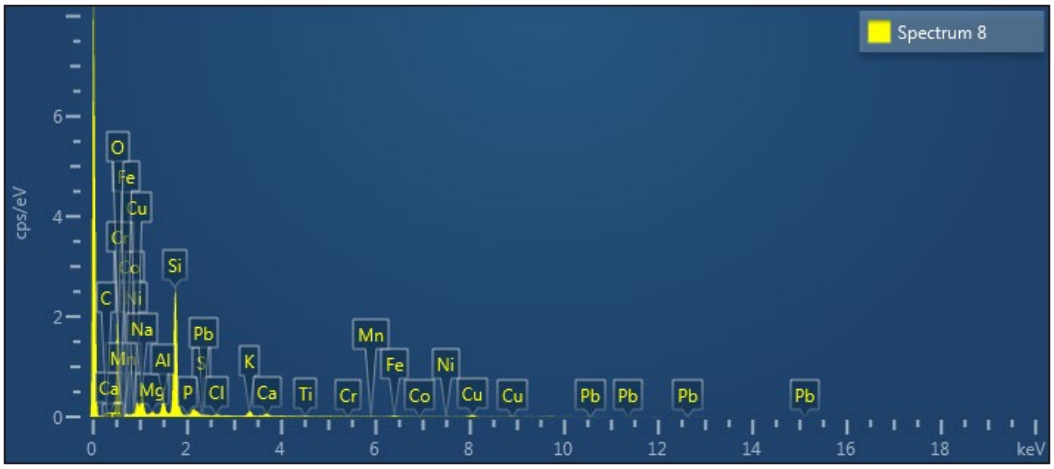
Glazed ware Sample 1 (GW-1) and Glazed ware sample 2 (GW-2)

Glazed Ware Sample 1Back side (GW-BS-1) and Glazed Ware Sample 2 Back side (GW-BS-2)

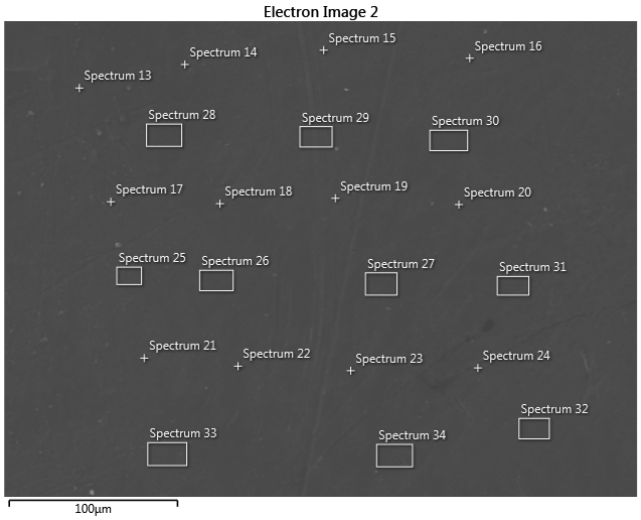
Multiple points on both the sherds were taken (inside and outside) for EDX analysis. The following images show the peaks of a few of the points subjected to the analysis:


Electron Image 1
Spectrum 2
Spectrum 3
Spectrum 4
Spectrum 5
Spectrum 8
Spectrum 9
Spectrum 6
Spectrum 7
Spectrum 11
Spectrum 10
500um

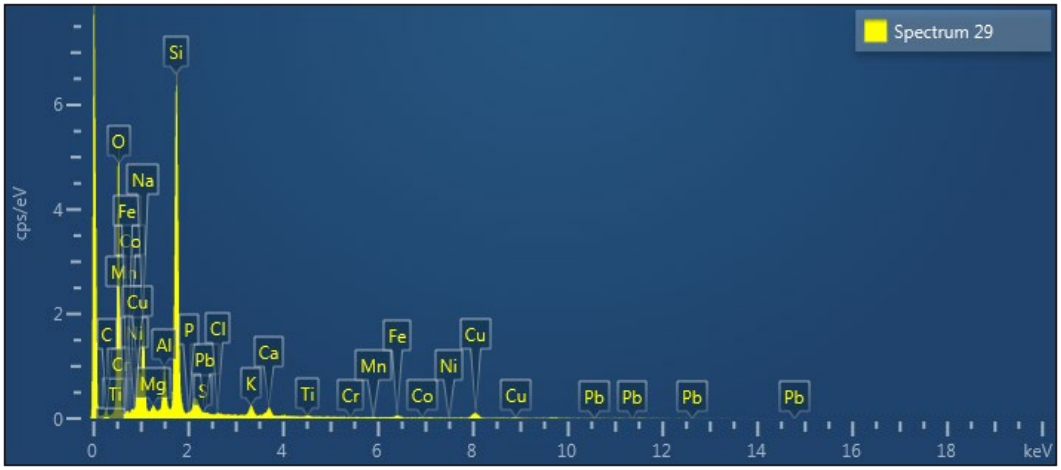
A


Spectrum 8
cps/eV
O
Fe
Cu
Si
C
Na
Pb
Mn
Al
K
Fe
Ni
Ca
Mg
P
Cl
Ca
Ti
Cr
Co
Cu
Cu
Pb
Pb
Pb
Pb
0
2
4
6
8
10
12
14
16
18
keV

B

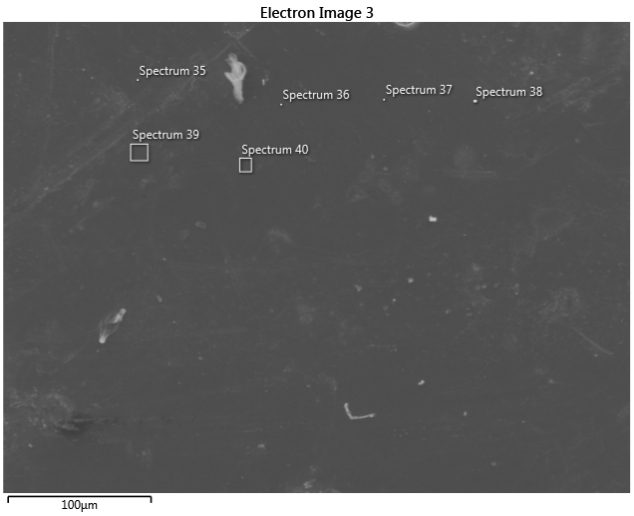


C

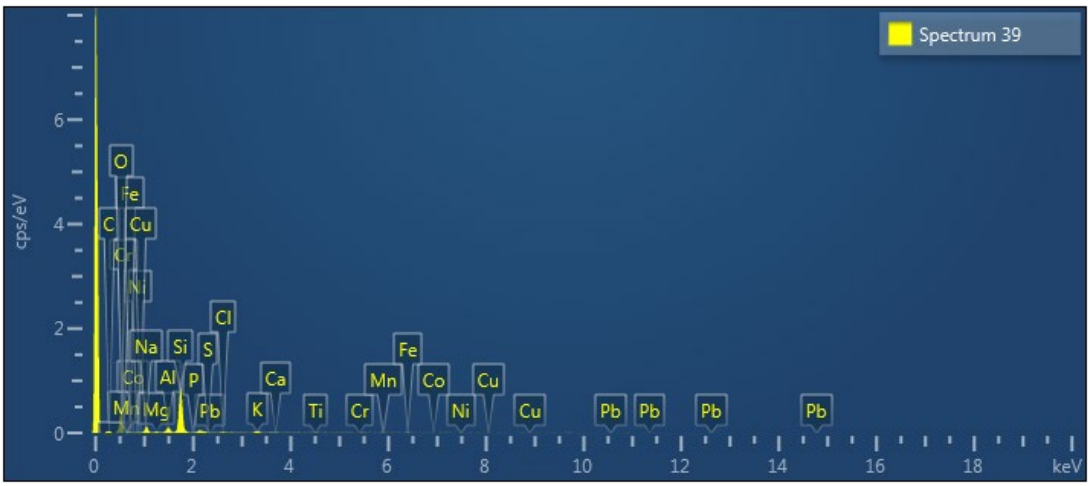


D

Sample 1: GW-1 (A-D) Multiple points and area for analysis (outer blue side of the sherd)


Electron Image 3
Spectrum 35
Spectrum 36
Spectrum 37
Spectrum 38
Spectrum 39
Spectrum 40
100µm

A


Spectrum 39
cps/eV
keV
O
Fe
C
Cu
Cr
Ni
Cl
Na
Si
S
Co
Al
P
Ca
Fe
Mn
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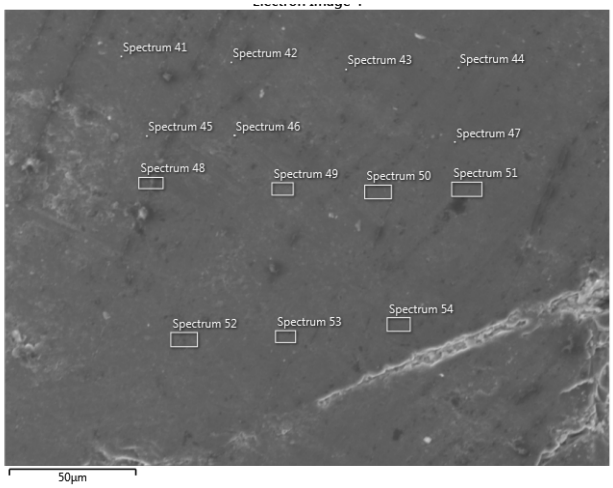
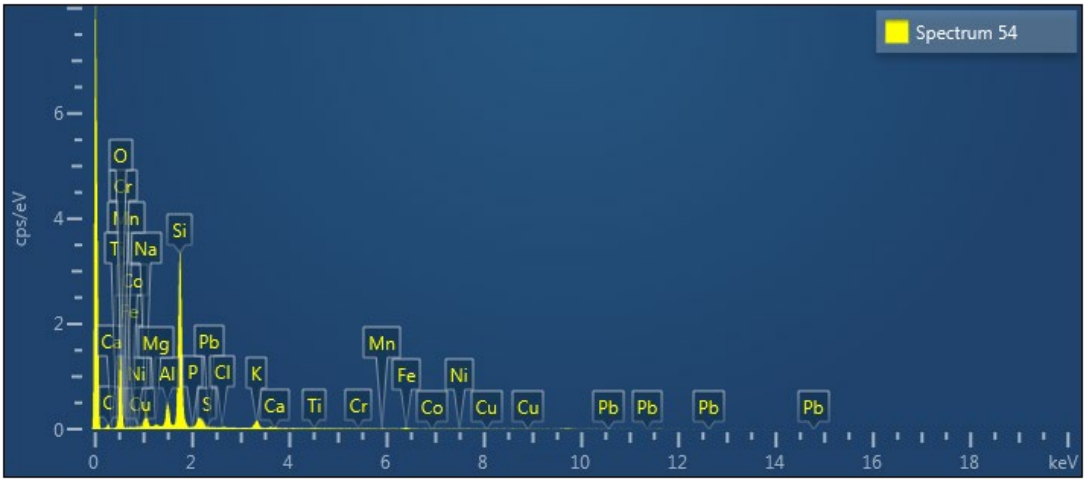
Cu
Mn
Mg
Pb
K
Ti
Cr
Ni
Cu
Pb
Pb
Pb
Pb

B

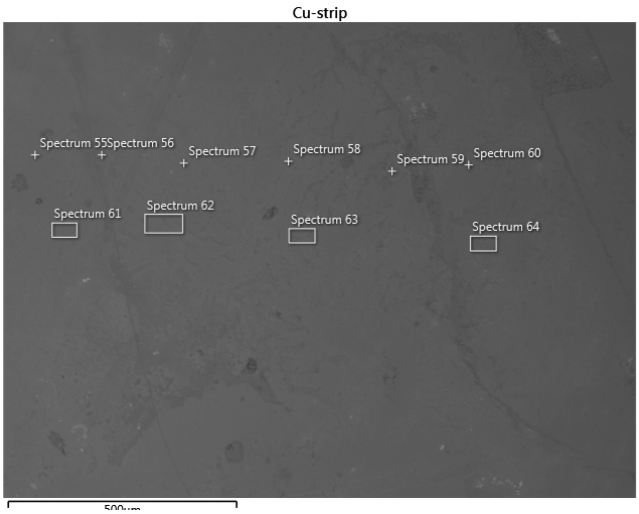


C

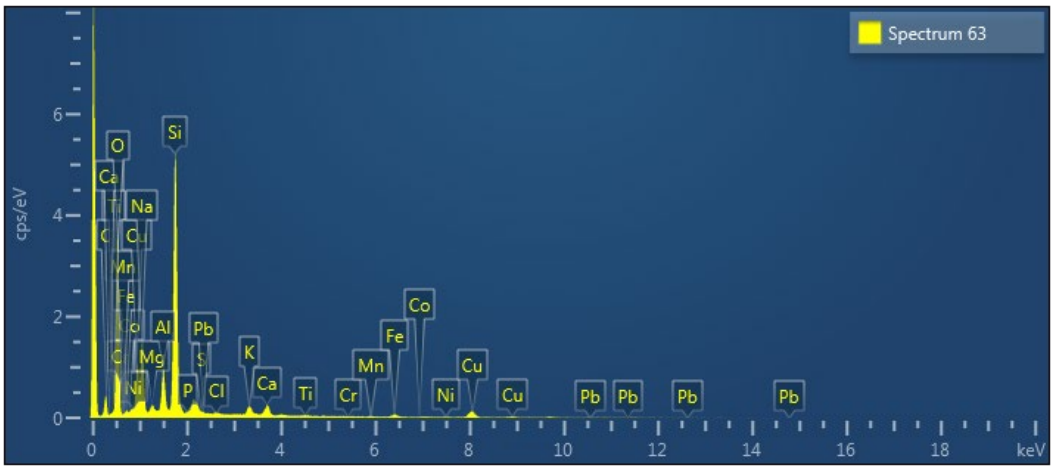


D

Sample 1: GW-BS-1 (A-D) Multiple points and area for analysis (inner surface (non-blue side) of the sherd)

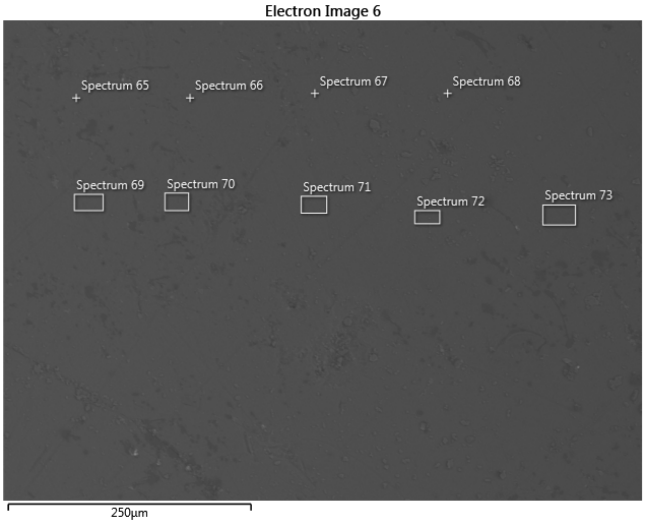


A

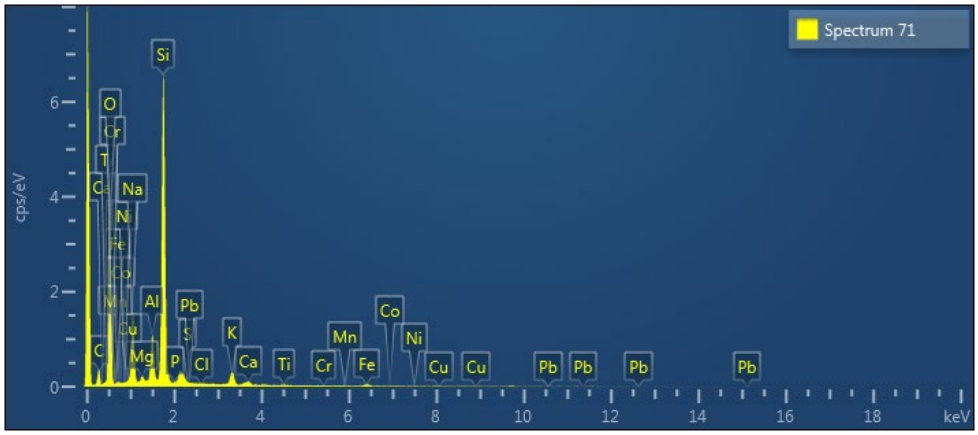


B

Sample 2: GW-2 (A-B) Multiple points and area for analysis (outer surface (blue streak) of the sherd)

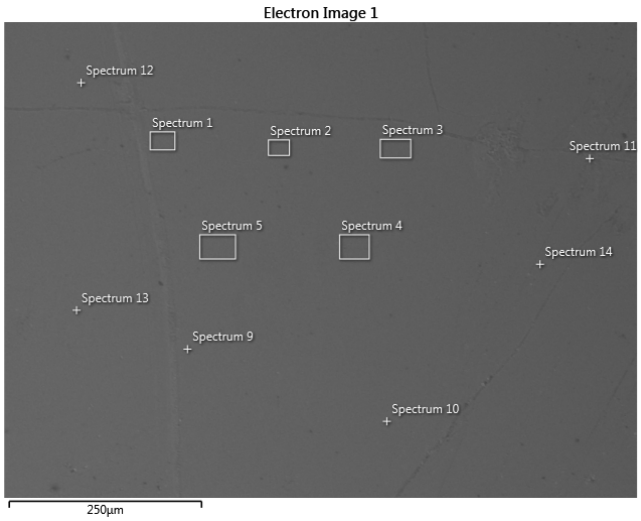


C

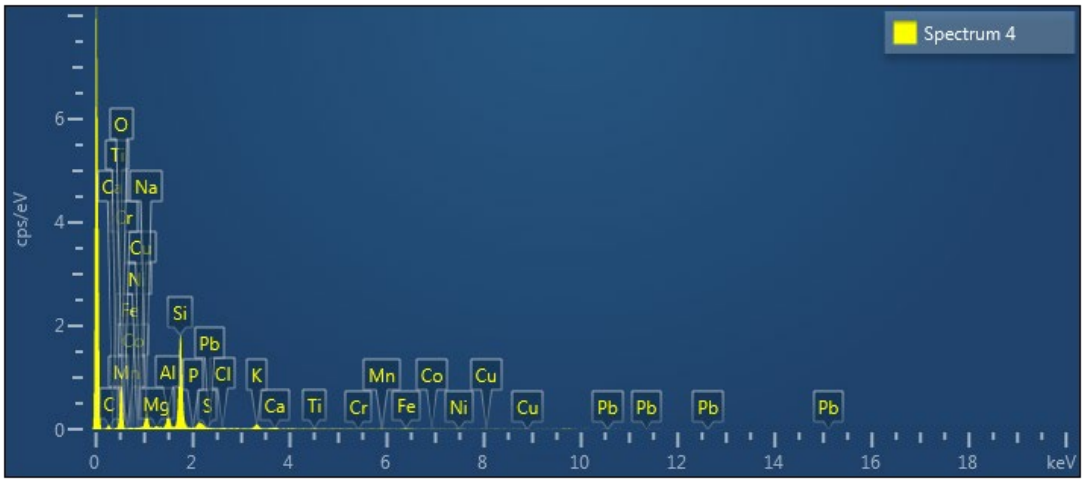


D

Sample 2: GW-2 (C-D) Multiple points and area for analysis (outer surface – non blue area)



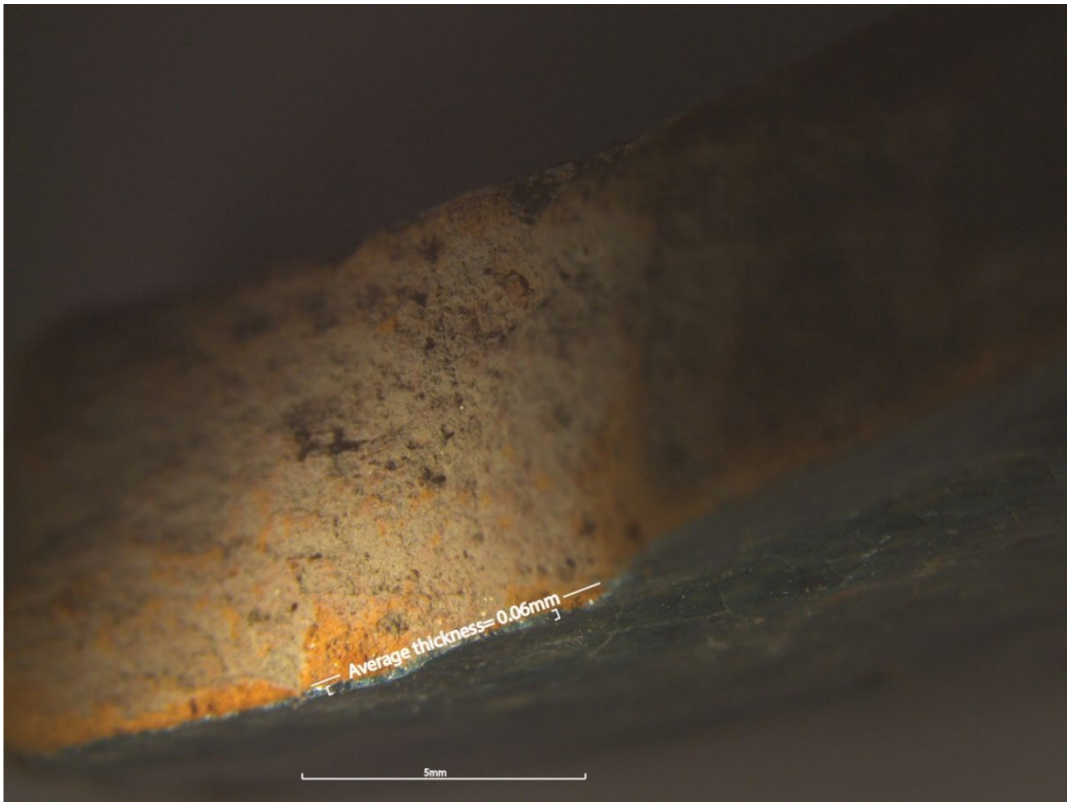
A



B

Sample 2: GW-BS-2 (A-B): Multiple points and area for analysis (inner surface (non-blue side)

To see if there is any intermediate layer between the glaze and the surface of the pottery, the sherds were subjected to optical microscopy. The absence of any intermediate layer signify that the glaze was directly applied over the pottery.



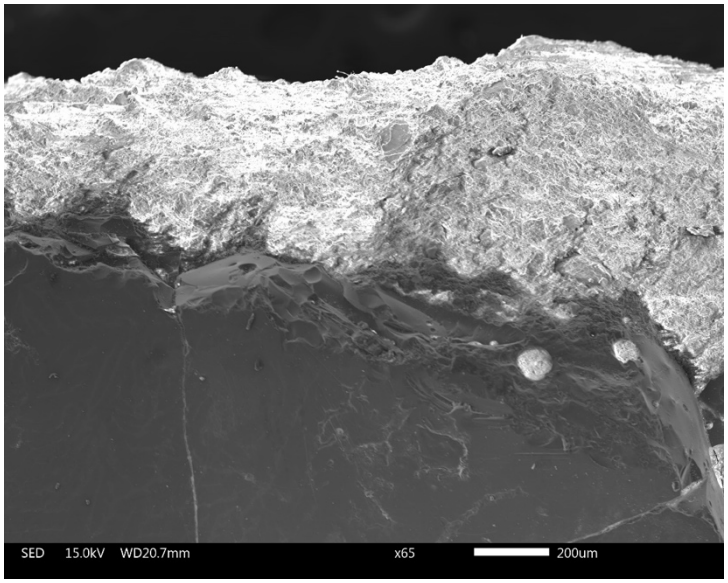
The layer of glaze and the surface of pottery

Mean values of the oxides from multiple points on Glazed ware (EDX)

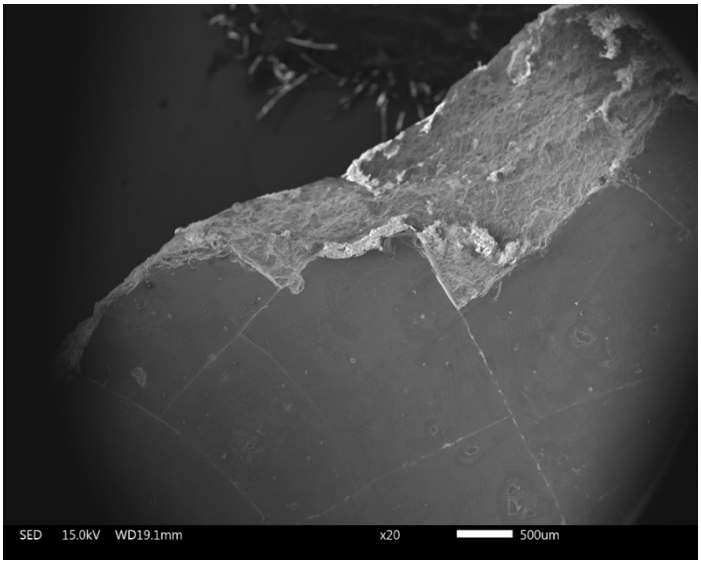
	GW-1 Blue Side		GW-1 Back side(GW-BS-1)		GW-2- Blue Streak		GW-2-Non blue Streak		GW-2-Backside (GW-BS-2)	
Oxides	**Mean**	S.D	**Mean**	S.D	**Mean**	S.D	**Mean**	S.D	**Mean**	S.D
FeO	**1.491515**	0.28816	**1.861**	0.329783	**1.802**	0.818356	**1.2311111**	0.212276	**1.8**	1.304891
SiO_2	**53.28697**	3.87925	**56.913**	5.329279	**40.092**	6.103039	**49.407778**	3.317302	**53.74455**	3.502355
Na_2O	**8.113333**	1.90198	**4.2025**	1.18723	**8.013**	2.536665	**7.4422222**	11.31555	**8.152727**	2.52257
Al_2O_3	**6.176061**	0.53354	**7.1645**	1.296101	**5.823**	1.160786	**5.9755556**	0.309076	**7.714545**	2.660434
K_2O	**1.769697**	0.26819	**2.6795**	0.394615	**1.367**	0.406258	**2.33**	0.186414	**2.947273**	0.651799
MgO	**0.884848**	0.11716	**0.6565**	0.095547	**0.942**	0.461466	**0.64**	0.080156	**0.727273**	0.419025
TiO_2	**0.374848**	0.09368	**0.3475**	0.302757	**0.281**	0.100935	**0.2533333**	0.083516	**0.287273**	0.352139
MnO	**0.074848**	0.0924	**0.1085**	0.128893	**0.239**	0.082388	**0.1**	0.061441	**0.138182**	0.220491
Cr_2O_3	**0.66061**	0.09753	**0.073**	0.088145	**0.034**	0.065184	**0.0511111**	0.054186	**0.104545**	0.151813
CoO	**0.097879**	0.09788	**0.1015**	0.140984	**0.042**	0.045656	**0.0344444**	0.048247	**0.138182**	0.17122
CaO	**1.639394**	0.18169	**0.555**	0.1133	**1.784**	0.402443	**0.7722222**	0.102076	**0.941818**	0.446583
NiO	**0.08697**	0.10089	**0.071**	0.082328	**0.131**	0.136581	**0.0544444**	0.072648	**0.25**	0.250918
CO_2	**14.8548**	5.65223	**24.451**	5.917829	**29.702**	6.811911	**30.85**	4.621458	**21.80545**	3.604312
CuO	**10.6842**	2.3756	**0.2645**	0.337444	**9.43**	3.613389	**0.7077778**	0.317009	**0.694545**	0.681841
PbO	**0.1876**	0.14022	**0.209**	0.268169	**0.196**	0.122583	**0.0744444**	0.111031	**0.332727**	0.332478
Total	**99.7867**	0.08816	**99.659**	0.157777	**99.878**	0.023476	**99.928889**	0.032575	**99.78**	0.13513

The EDX analyses show that the coloured glaze in GW-1 and GW-2 (streak) is because of high amount of copper oxide, which is almost negligible in the case of transparent glazes (GW-BS-1, GW-2 and GW-BS-2). Since silica is the key ingredient in glaze manufacture, the concentration of it in the sherds varies from 40-56% which is almost half of the composition.

The following are the high-resolution SEM images of the glazed ware:



Glazed ware and the surface- SEM images



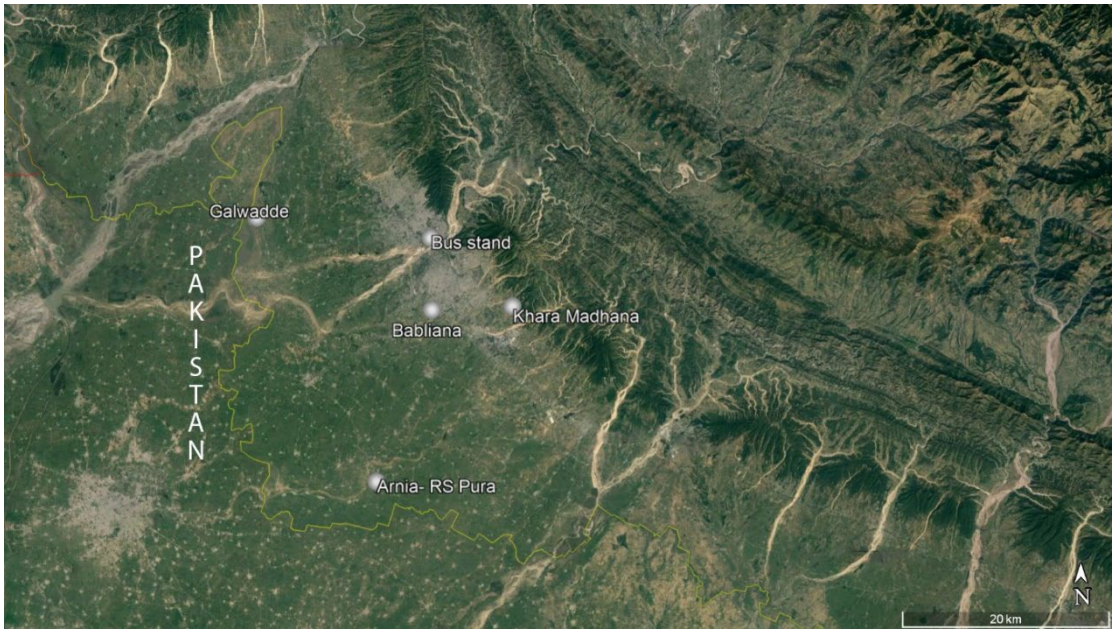
Glassy appearance of Glazed ware

The outcome of the preceding scientific investigation presented a picture of the common source for the clay utilised in the pottery manufacturing process. The results when compared to the existing data of Sanghol (Kumar et al. 2006), gave the same signature pattern. The data generated from EDX however couldn't be compared owing to the lack of similar data from any site of Punjab. It nonetheless gave an idea about the usage of copper oxide in the glazed ware for the blue colour.

These above-mentioned scientific analyses have therefore added a wide spectrum of database in the existing literature dealing with the study of chemical composition of pottery in the Northern plains.

Appendix II- Ethnographic Study on the Pottery Manufacturing Techniques in Jammu

The researcher aimed to document the traditional skill of pottery manufacturing in the outlying plains of Jammu. Five locations – Babliana (32°40′00" N; 74°51′32" E), Galwadde (32°44′49" N; 74°40′46" E), Khada Madhana (32°39′52" N; 74°57′05" E), Arnia-Kasipur (32°31′07" N; 74°48′06" E), and the Bus stop area (32°43′42" N; 74°51′31" E) – were identified as having indigenous populations engaged in pottery manufacturing.



Map of Jammu with pottery manufacturing centres

The production of pottery entails several processes. The procedure, however, varies slightly across rural and urban potter groups. Babliana, Khada Madhana and the bus stop area are urban outposts, whereas the remainder of the two areas are rural. This documentation details the potters' resource acquisition strategies, the locations from where they acquire raw materials, the many vessel types they create, the functional and ornamental features of various decorative approaches, and so on. Additionally, the equivalents of specific

vessel types acquired through field work were identified, which were previously difficult to recognise.

Pottery Manufacture in the Urban Area

The clay used to make pottery is called "*kali mitti*", which comes from alluvium deposits around the village area. The field containing the alluvium deposit is dug to a depth of around three feet and brought to the potter's house via horse cart at a cost of approximately twenty-five rupees. The cart can transport around 5 feet of earth at a time. Additionally, clay for the vessel's construction is occasionally imported from the areas surrounding Batra, around 6 km east of Jammu town.

The clay is dried and then crushed into smaller pieces using a rectangular wooden block with a handle called "*mugli*" that costs around 100 rupees. The soil is not sieved as it is stone-free. The clay (*kali mitti*) is combined with water and sand, and then pounded with the feet – a procedure dubbed "*malni*" locally. The procedure typically takes one day.

Following this process, the pounded clay is stoned into around 10-15 balls, locally referred to as "*pinni*," each weighing approximately 5 kg.

The *pinnis* are then immediately utilised to make vessels on a mechanised wheel known as a "*ram chak*." Water is constantly poured on the pottery and collected in a vessel called "*nattar*." The excess clay, referred to as "*pilchi*," that accumulates during the pottery-making process is collected in an open bowl called a "*dhunga*." Once the rough shapes are made, they are separated from the rest of the clay lump on the wheel using a nylon rope called a "*thaga/sutra*." The exterior surface of the pottery is smoothed with a flat iron implement called "*karda*" and a thick hollow metallic ring called "*koli*." This rough shaped pottery is then dried to a leather hard state known as "*bathar*" and shaped to the final size and thickness using "*konera*," a convex clay block with a hole at the top to

accommodate a handle, and "*thappa*," an elliptical shaped piece of wood attached with a long handle. Both are used together to shape the vessel. From the inside of the vessel, the *konera* is held in the left hand, while the *thappa* is tapped from the outside. This entire procedure of shaping leather-hard pottery using these implements is repeated three times. This final unfired pottery is left in the sun for 2-3 days during the winter and a few hours during the summer.

After the pots have been completely dried in the sun, they are washed with red soil (*lal mitti*), locally known as "*banni*" or "*geru*" (red ochre). This is obtained from the Siwalik foothills and costs approximately 100 rupees in total, including transportation. The red soil (*geru*) is mixed with water till it becomes viscous in a large metallic bowl called a "*lounda*." The unfired vessels are then dipped and rotated in this mixture once. Following this, the pottery is again sun dried for two-three hours (during the summer months) or for a few days (during the winter months), and then placed in a closed kiln (bhatti) for baking.

The broken parts of a globular pots are used in sun drying the vessels and are referred to as "*bhila*" (the rim rests on the ground; hence, it serves as a holder). The *bhatti* (kiln) is erected on the surface using brick and soil known as "*chunai mitti*". The same soil is used to pilaster the kiln from the inside. Internally, this hemispherical dome-shaped *bhatti* is divided into two sections –- the lower portion, which contains the kiln's outlet/mouth, and the upper section, which is around 15-20 cm above the lower level. This part contains approximately 9-10 holes that allow the fire to reach the vessels. It is in this section that a layer of pottery is maintained, followed by a layer of dried cow dung and wood, and this process is repeated until the kiln is filled. Locally referred to as "*sukke de gotte*," dried cow dung and small pieces of wood referred to as "*lakkad*" are used as fuel for the kiln. The kiln's top section is covered in straw and cow dung and is exposed to fire from the lower section's opening. The pottery baking time is approximately 4-5 hours.

The most notable decoration is found in the form of moulded patterns and paintings in black. Baked clay moulds called "*sancha*" (top part) and "*arthra*" (bottom part) are used to make narrow mouthed jars "*surahis*" and big pots "*ghara*". Additionally, *arthra* is utilised to secure the vessel while it is beaten with *thappa* and *konera*. It can either be the same *arthra* of the mould or can be specially made for this purpose. The paintings are pre-fired and made with small pebbles locally referred to as "*roed*" or "*gradi mitti,*" this substance is found mixed in with the clay used to make vessels. It is grounded to a fine powder and combined with mustard oil. This mixture is used to create designs on pottery using a fine brush.

Mugli

Field from where *kali mitti* is obtained

Pinni

Pottery in leather hard condition *bather*

Ram chak

Konera and Thappa

Potter with Konera and Thappa

Karda and koli

Pilchi in Dhunga

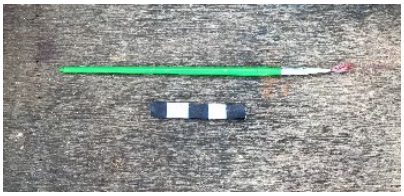
Banni

Bhila with a pot

Bhatti

Bhatti from inside

Roed



Brush used for painting

Popular Articles and Utensils

Since the potters cater to the urban population, the shapes of the vessels are severely limited. Additionally, because these pottery types are purely functional in nature, the decoration on these pots is minimal. The following table details the shapes:

Ghara: globular pot with short neck used for storing water

Chatti: small globular pot with inconspicuous neck used for storing milk, curd etc

Mugni/*Bugni*: a closed globular pot with a slit near the neck portion used for collecting money

Diya/*Chirag*: Small oil lamps used for lightning especially on Diwali

Dhunga: Open Bowl used for storing liquid

Sanchas: baked clay moulds used for making moulded pottery

Chapni and *Taku*: chapni is the small lid and Taku is a big lid.

Pottery Manufacture in the Rural Area

The village of Galwadde in Akhnoor was selected for documentation. In the village around nine houses comprise of the potter community.

The clay used to make pottery is brought in from a village called Mishriwala where the clay is mined to the depth of approximately 2-3 feet. In addition, clay is also brought in from four feet depth in Bantalab and Purmandal areas. The clay is transported via trolley and the total cost of 100 quintals, including the transportation charges, is around 5000 rupees. This process of bringing the clay is repeated every 3 months.

"Banni" or red ochre is imported from a village called as Ratti Chapadi which is located on the foothills of Himalayas. The red ochre is obtained from the top of the mountain. The whole cost including the transportation of this material is around 1000 rupees. In the case of non-availability of *banni*, *pilli mitti* or yellow soil is used for the purpose of the wash.

Pilli Mitti

There is a slight variation in the method of crushing the clay. Here the clay is first dried and then beaten with a *mungli*.

Clay crushed with a *mugli*

It is then processed and the powdered material is separated from the coarser granular clay. The powdered clay is then spread in an open circle, containing the granular clay mixed with water. Locally, this is referred to as "*rav*." This is done primarily to allow the coarser, harder material to absorb water and become pliable and suitable for pounding. After one night, the clay is nicely mixed with water and is ready to be pounded with the feet.

The *"thobba/pinna"* (the pounded clay) is then stored in the shade away from sun and air, and worked on a *chak* as needed to create various shapes. The rest of the techniques of applying wash and black painting before firing is same here. The only distinction is that horsehair is used as a brush instead of a nylon brush and crushed *roed* is mixed with water instead of oil to create black colour. The technique of painting on the pottery is called as *"chitarna"*. For other colours which are requested on demand, paints from the market is used.

Thobba

The incised pattern is another type of decoration found on the vessel, particularly *mugni*. This is made with the help of a plastic screw salvaged from the old toys or radios and hafted in a twig called as *"manka"*. In general, anything that may be used to create a pattern such as a bead, a twig etc. can be utilised to create the design.

Manka

Mica is frequently used as a decorative element in the production of ceramics. Interestingly, a new perspective on the method of applying mica on vessels was uncovered in this village. The researcher was told that the mica-rich sand known as "*bali*" that they obtain in the Purmandal area is mostly utilised in the cases of pottery created in *sancha* and *arthra*. This was primarily done to keep the clay from adhering to the *sancha*. In general, *bali* was used to prevent clay from sticking. For example, in some containers (carinated vessels referred to as *kunni* for cooking dal), mica-rich sand was put on the inside primarily to prevent clay from sticking to the *konera*.

The *arthra* is this village was specially made for holding the vessel while beating with *thappa* and *konera.*

In addition to the vessels discussed above, some new forms were found here:

Arthra: for holding the vessel while working with *konera* and *thappa*

Kujja: for storing murabba, pickles, for making rice pudding (chawal kheer), for making and storing curd

Dullu: used in Navratra rituals

Dullu: used in Navratra rituals

Gamala: Flowerpot

Chulha: Hearth

Heater

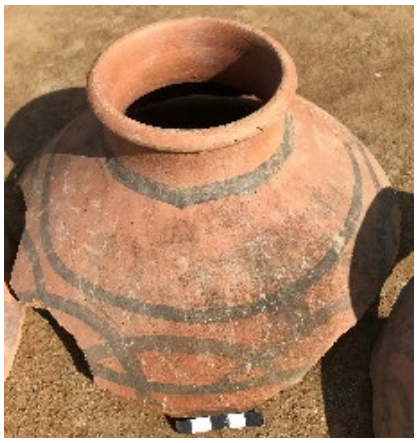
Kunni: with slight carination for cooking Dal.

Sand with mica applied on the inside

Makor ala ghada- Pot with perforation at the bottom

Mugni (coin bank) in various forms

Ghaggar (pitcher) with applied mica on the outside

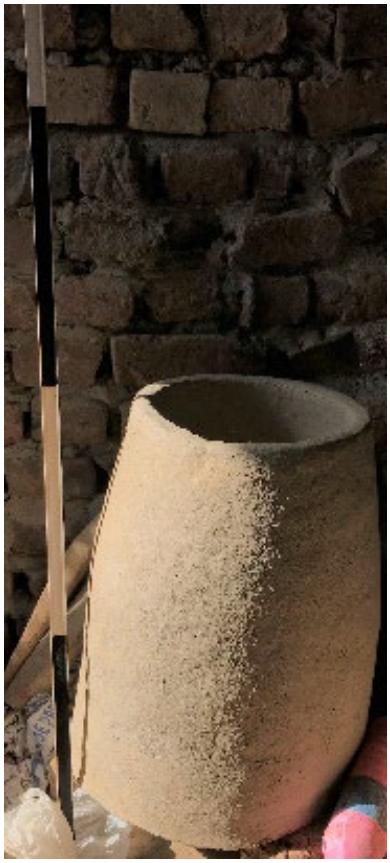


Painted Gharas (pots)

Painted *Gharas* (pots)

Pyali (cup) and glass

Sancha (mould)



Tandoor (oven)

In this village, the Bhatti is slightly different. A hole around 2 to 2.5 feet deep and 4 feet in diameter is dug in the earth. A lantern is constructed with iron rods, bricks, and mud. Around ten to twenty holes are maintained in this level to allow the fire to reach the vessels. Plastering is carried out once again with bricks and dirt. A hole is kept in the second level to inspect the flame's colour to ensure that a suitable amount of fire reaches the pottery. Around 40 kg of wood and around 1 kg of waste from wood processing are burned as fuel in one run. The wood is often obtained from a wood cutting factor and is majorly composed of mango tree.

Khada Madana: Purmandal

The entire technique of pottery manufacture is identical in this region as well. All raw materials are sourced locally. The sole distinction was in the production of *"topi"* or *"chari"*, which is a component of Huqqa (smoking pipe) in this region. Locals attribute this form's prevalence in this area to the Gujjar community, which at present is largely involved in huqqa smoking. Additionally, it was said that this is also used to as *"mashal"* (torch) by residents in the vicinity.

Huqqa *topi* and *chari*

Kashipur- RS Pura

The potter community of the region is located on the border area and caters only to the rural inhabitants.

Certain features of pottery manufacture were noted to vary in this region. All raw materials for pottery production, including *kali/chikni mitti*, *banni*, and *bali*, are sourced from beyond the RS Pura area. Pottery clay is sourced from the Khojipur and Vijaypur (Thandi Khui) areas.

Pounding the clay in this location is like that in Akhnoor. *Paede* (clay-balls — referred to as *pinni* in other locations) are used to make vessels on a *desi chak* (foot rotated wheel) rather than a mechanical wheel. Although some residences have begun to receive government-funded mechanical wheels, the *desi chak* is still widely utilised.

Desi Chak

The shapes are formed on this wheel and then dried in the sun (*bather*) before being properly moulded with *konera* and *thatha* (notice that the word '*thappa'* is not used in this area; a similar sounding word used in Punjab is *'thatwa'*. Since RS Pura is close to Punjab, an association could be made).

Additionally, to the already discussed vessel forms, new types of vessels are visible in this area.

Chatti: for making Lassi and milk.

Chapni and *Taku*: Lids

Chota Kujja: small bowl

Ghara: for keeping water. It is also used in marriage and death

Heater

Kujja: container for curd

Kunni: with slight carination – used for cooking Dal

Kadai: big mouth – for cooking vegetables; it is never used to cook Dal

Pyala: for keeping water for birds; Also used by women during Navaratras for ritual worship

Tufaedi: incense burners with handles. Note that only left one had handle. The rest had a space for handle.

Dabbers

Thatha

The vessels are baked in a kiln known as *"awa"*. It is an open kiln, different from the other closed kilns already discussed.

Open Kiln- *Awa*

A curious find was a basin with small rock intrusions. When enquired, it was informed that it is used to ground the leaves of cannabis to make the *bhang* – an intoxicating drink. A vessel similar to this one was discovered during exploration from the site of Satowali (Chapter V: Fig V.24A and B).

Basin with small rock intrusions

<u>Rituals and Functions in which Pottery is Significant</u>

There are various auspicious and inauspicious occasions where the usage of pottery is significant. Although clay pottery has mostly been supplanted by

metallic vessels in modern times, clay vessels still have a place in some of these functions.

I. Auspicious Occasions

1. Ganda-Mula: The concept of someone born in certain inauspicious *nakshatra* makes the person *ganda-mula.* In case a child, according to the Hindu astrological calculations, is born with a short life span, or has a birth inauspicious for other family members, it is often thought that the child in that case has *dosh* (faults) which can be removed by a specific puja. In this one-day *puja* with five Brahmins, one main *kalash* (pot) for *Varuna* is kept. Four *kujje* are kept in each of the room's four corners (for the four Vedas). The child with the *dosh,* who is at-least 21 days old, is made to take bath from the water passing through the pot which has holes on the base (*makor ala ghada)*. After the puja is over, the pot is immersed (*visarjit*) in water.
2. Vivah: In the marriage ceremony, *varuna kalash* is kept with a sacred thread (*mouli)* tied around it. Leaves of five trees – Aam (Mango), Badh (Banyan), Bodh (Pipal), Bael (Stone apple) and Rumbal (Cluster Fig) are tied around the *kalash*. A lid (*chapni)* is put on top of it. A small *diya* and a coconut are also kept with this *kalash*. Three small *Kujje* are kept near this *kalash*. One of these has *mah ka aata* (black gram flour), another one with *gehu ka aata* (wheat flour) and the third one with *khichdi* made of *mah di dal* (black gram) and chawal (rice). These vessels are worshipped for three days. By the end of the marriage, *bibra* (small balls) are made for *kuldevta* (family deity) from the ingredients of the first two *kujjas*. The *khichdi* of the third kujja is mixed with meals and eaten by the relatives. The vessels are submerged in water in the end.

3. Griha Pravesh: This *puja* is performed by a married woman dressed in the traditional attire. A *kumbh* is filled with water and she enters the house carrying the vessel on her head, circling the whole house once. Finally, the *kumbh* is kept close to the *havan* (fire ritual) area. After the *puja*, the vessel is immersed in water.
4. Rudra Abhishek Yajna: This *yajna* is performed primarily for two reason:

   i.) For individuals with low haemoglobin levels in the body
   ii.)To combat the negative energy in the house

   A *kalash* filled with water is kept for this puja.
5. Navratra: Navratras are observed twice a year – once in *asu* (October) and once in *chetra* (March). A *kumba* is kept with water in it. In addition, for nine days, a *dhunga* (bowl) with sand and *jau* (barley) is kept. It is seen as a representation of devi and after nine days, the bowl along with barley plant grown in it is thrown in water.
6. Ganesh Chaturti: A *kumbh* is kept for Ganesha for eight days.
7. Puran Mashi: On the day of *puran mashi* (full moon), the believers fast and a *kumbh* is kept from morning to evening. In the evening when the fast is broken, the water is sprinkled all over the house.
8. Nirjhala Ekadashi: On the eleventh day of two lunar cycles, this fast is observed. Pots are worshipped and are offered to the temple in odd number i.e., 3, 5, 7, 11 etc. In addition to the pots, muskmelon is also given to the temple.

   In other variant of this puja, women observe a fast and a pot is either given to a Brahmin or is submerged in water.

9. Paap Ghat Daan: In this one-day *puja*, a *ghara* in which curd is kept is given to a Brahmin.
10. Kartik Shanti: It is believed that the children born in the month of Kartik (October – November) are born with dosh (fault). A one day *puja* is performed to cleanse them of the dosh. Four *kujje* are kept in the four corners of the room representing the four Vedas. Apart from these, water is kept in *varuna kalasha* and a copper pot. Close to the *puja* area, 5 kujjes are kept filled with water. At the end of the *puja*, these vessels are immersed in water.

    A *puja* is performed for a new born during which a *ghara* decorated with *lal chandan* (red sandalwood), laung (cloves), elaichi (cinnamon), *lal kapda* (red cloth) is tied on the pot. The pot is filled with *ganga jal* (water from the river Ganges), or in its absence, with water from *tambe ke patra* (Copper vessel). After 21 days, the child is required to take bath with this water.
11. Kalash Yatra: This is done in preparation for *murti sthapana* (establishment of idol) in the mandir. Women in the odd number e.g., 11, 21 etc, in their full traditional attire, keep *kalasha* on their heads. The water for the *kalasha* is filled from a nearby source e.g., pond, well, Boali (step well) or a tap. The pot is kept in the temple for seven days and afterwards, the water is sprinkled over the devotees and also taken home by them.
12. Subha Yatra: This is done to ensure the safety of someone departing from home. A pot is filled with water and a *kanjaka* (girl less than 7 years of age – considered as the goddess) is made to stand on the main door. She applies tilak of water on the head of the one embarking on a journey.

13. Vidai: At the bride's residence, a *kanjaka* or a barber's wife (*nyan*) applies a *tilaka* of water from a small pot to both the bride and groom. In the groom's house, for *vadhu pravesh* (the bridal entrance), a small pot in kept in the entrance with rice in it which is spilled by the new bride while entering, with a gentle push of her right foot.
14. Saant: The ritual, also known as *paani varna*, is performed by the bride's and groom's respective uncles (mama) in their respective houses. Without looking at the bride, her uncle will hold the *ghara (pot)* in his hands and circle the pot around her head. Later the vessel is either retained by the family or handed to the maid.
15. Diwali: On Diwali, a *panch mukhi* (five-faced) *deepaka* made of clay – representing Riddhi, Siddhi, Ganesh, Lakshmi and Vishnu – is kept in the house.
16. Suddhi Karan: For 21 days after giving birth, a mother is considered impure. For her *suddhi karan* (purification), she is made to take bath from a kalasha by the old ladies of the family.

II. Inauspicious occasion

1. Maran: On the day of someone's death, a globular earthen vessel called *trari* is hung, with a thread (dori) or a white cloth with a hole in the centre, on the western window/door/wall of the house for ten days. After 10 days, the vessel is submerged into water.

   On the day of death, either the eldest or the youngest son circumambulates around the dead body twice, with the pot of water in his hand, and then the pot is shattered by throwing it on the ground. Also, on the day of the death, *pind* (balls made of *jau ka aata* (barley flour) are made and kept in *bibra* (broken half of

the *ghara*) and are taken to the cremation ground and then submerged into water (visarjit).

The custom of gathering the remains of the deceased is performed on the fourth day after death (*phul chunna*). Five *kujjas*: one in the centre and four on each corner are kept at the cremation (*sanskar*) spot. With the use of nails, a white thread (*safed sutra*) is tied around the four Kujjas kept in the corner. These Kujjas are kept on at a spot where base of wheat base is made and are filled with milk and water.

2. Pind daan: This is performed in the memory of the ancestors. *Pinds* are made by mixing *jo ka aata* (barley flour), honey, milk, ghee (clarified butter) and *ganga jal* (water of the river Ganges). These pinds are kept in *bibras* and are later submerged into water or given to birds.

3. Narang Bali: This is for those whose remains have not been incinerated. In this ritual, a main *kumbha* is kept along with a copper *kalasha*, four *kujjes* in four corners of the room for the four Vedas, five *kujjas* kept near *vidhi* for *devtas* – Brahma, Vishnu, Shiva, Yama and Pret. The centre *kujja* is for the Pret and is filled with milk and the rest of them are filled with water.

4. Pret Ghat Dana: In this ritual, a *kalasha* made of copper is kept filled with sugar and gram lintel (*chana dal*) is given to the Brahmin.

5. Panchak Shantis: In this one-day pooja, a main *kumbha* called *varuna kalash* is kept along with four *kujjes* on the side of the *vedi* in addition to five *kujjes* for Nakshatras. In the end, these are submerged in water.

6. Death of infant: In case of the death of the infant, he/she is buried in the ground, and at the spot of its burial, a *kujja* is kept for five days and filled with water every day.

Social Background of the Potters

The potter community is a part of the *Prajapat* community and is referred to as *Kumhara*. They venerate saint *Gora*. Clay-pottery making has declined significantly in popularity, and artisans are now pursuing alternative livelihoods.

The Potters as Faith-Healers

Interestingly, the instruments of *konera* and *thappa* are believed to have magical properties, and are used to cure tonsils, locally referred to as "*pabbu*." *thappa* is rubbed twice on either side of the neck, around the tonsil area. This process is performed four times over the course of three days. Each time the *thappa* is touched on the neck, it rests on the *konera*, indicating that the issue has been transferred to the dabber (*konera*). Following this, the glands are rubbed twice with a cube of unprocessed salt. This salt is provided to the patient's family and instructed to keep it near a hand pump (earlier put under *ghara*). It is thought that after the salt melts, the tonsils will be treated as well.

Appendix III: Combined Data from the Sites Reported in the IAR Reports from 1961 Onwards and the Data from the Current Research

★: Excavated Sites, revisited by researcher ⭘: Explored by ASI and revisited by researcher
☐- Discovered by researcher ■: Explored by ASI and not visited by researcher

*Glazed ware of the sites has been hypothesized as belonging to Period IV (Discussed in detail in Chapter V).

**Classification based on the presence of newly discovered sites in the vicinity in the current research (Sites like Bakor, Hamirpur, Sainth).

***Coordinates recorded by the researcher.

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
■ Akhnur/ Akhnur	Not given	Early Historical (earlier part of "Christian" Era)			✓			1961-62, 1962-63
★ Ambaran (Pambarwan)/ Akhnur	32°54'12.6" N; 74°45'47.6"E ***	Discussed in detail		✓	✓	✓		1961-62, 1962-63, 1973-74 1999-2000, 2000-01
■ Mandli Ka Mehra/ Akhnur	Not given	Early Historical				✓		1961-62
⭘ Guda/ Akhnur	32°46'31.4" N; 74°48'55.6" E ***	Early Historical			✓	✓		1961-62
■ Dalpat/ Akhnur	Not given	Late Historical				✓		1962-63
■ Kat/ Akhnur	Not given	Late Historical				✓		1962-63
■ Sauli Chak/ Akhnur	Not given	Late Historical				✓		1962-63
■ Ambi/ Akhnur	Not given	Medieval					✓	1962-63

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
■ Bamal/ Akhnur	Not given	Medieval					✓	1962-63
ʘ Bandwal/ Akhnur (Shahjamal Tibba)	32°49′41″ N; 74°35′48″ E ***	Medieval				✓	✓	1962-63
■ Kurora/ Akhnur	Not given	Medieval					✓	1962-63
■ Lehrian/ Akhnur	Not given	Medieval					✓	1962-63
■ Man Chak/ Akhnur	Not given	Medieval					✓	1962-63
■ Mandiala/ Akhnur	Not given	Medieval					✓	1962-63
■ Ratti Danda/ Akhnur	Not given	Medieval					✓	1962-63
■ Tanda-western bank of the khad-Tandewali Khad/ Akhnur	Not given	Early Stone Age-unifacial Choppers-with conical and rounded butt, no. off flakes						1973-74
★ Manda/ Akhnur	32°53′45.43″N; 74°44′25.48″ E ***	Discussed in detail	✓	✓	✓	✓	✓ Dogra period fort	1976-77, 2006-07
ʘ Kot Garhi/ Akhnur	32°52′07.4″ N; 74°41′33.6″ E ***	Harappan, Post Gupta		✓	✓	✓		1976-77, 2006-07
ʘ Bakor/ Akhnur	32° 48′ 16″ N; 74°33′ 47″ E ***	upper level of Manda/ Early Medieval/Late Historical			✓	✓		1976-77/ 1978-79 1962-63 (named as Bahor)
■ Tibba/ Akhnur	Not given	Upper level of Manda				✓		1976-77
■ Devipur/ Akhnur	Not given	Late Medieval Siva temple					✓	1978-79

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
⭘ Hamirpur/ Akhnur (Identified as New Hamirpur during exploration)	32° 46′ 32″ N; 74°31′ 28″ E ***	Late Medieval Siva temple				✓	✓	1978-79
■ Kalit/ Akhnur	Not given	18th century A.D Fort					✓	1978-79
■ Mutthi/ Akhnur	Not given	10th century A.D mosque and Medieval Site				✓		1978-79
■ Maira/ Akhnur	Not given	Medieval					✓	1978-79
■ Nad/ Akhnur	Not given	Kushana Period			✓			1978-79
■ Naraina/ Akhnur	Not given	Medieval Period					✓	1978-79
★ Guru Baba Ka Tibba/ Akhnur	32°45′47.1" N; 74°44′15.3" E ***	Discussed in detail		✓	✓	✓		1979-80. 1997-98
★ Jafarchak/ Akhnur	32°47′00.50"N; 74°42′21.30" E ***	Discussed in detail				✓	✓	1979-80, 1998-99
■ Garh- Ka Maura/ Akhnur	Not given	Medieval					✓	1979-80
⭘ Bakor/ Akhnur Same site as Bakor- 1976-77	32°48′16″ N; 74°33′47″ E ***	Medieval					✓	1979-80
■ Devipur/ Akhnur	Not given	Medieval					✓	1979-80
■ Nutthi/ Akhnur	Not given	Medieval					✓	1979-80
■ Maisa/ Akhnur	Not given	Medieval					✓	1979-80

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
■ Troti/ Akhnur	Not given	Medieval					✓	1979-80
⭘ Amb/ Akhnur*	32°52′10″ N; 74°47′ 30″ E *** 32°52′29″N; 74°47′ 39″ E 200*200 m	Kushana, Muslim Glazed Ware, late 18th century Temple			✓	✓	✓	1980-81
■ Balowan/ Akhnur*	32°51′ 04″ N; 74°49′25″ E 150*150 m	Kushana, Muslim glazed ware			✓	✓		1980-81
■ Bhulwal/ Akhnur	32°50′18″ N; 74°49′30″ E	Kushana, Medieval			✓		✓	1980-81
⭘ Chak Bowal/ Akhnur*	32°51′44″ N; 74°48′25″ E 150*150 m	Kushana, Muslim Glazed Ware			✓	✓		1980-81
■ Chak Sanga/ Akhnur	32°54′6″ N; 74°46′40″ E 100*40 m	Kushana			✓			1980-81
■ Chhowah/ Akhnur	32°54′46″ N; 74°50′10″ E	Late 18th century temple					✓	1980-81
■ Dhanu/ Akhnur*	32°57′44″ N; 74°45′10″ E 50*50 m	Kushana, Muslim Glazed Ware			✓	✓		1980-81
⭘ Dharm Khu/ Akhnur*	32°51′32″ N; 74°45′48″ E 50*50 m	Kushana, Muslim Glazed Ware			✓	✓		1980-81
■ Galali/ Akhnur*	32°56′12″ N; 74°47′30″ E 100*100 m	Kushana, Muslim Glazed Ware			✓	✓		1980-81
■ Grahi/ Akhnur*	32°54′0″ N; 74°47′10″ E 200*150 m	Kushana, Muslim Glazed Ware			✓	✓		1980-81
■ Ghaink/ Akhnur	32°52′12″ N; 74°48′0″ E 50*50 m	Kushana			✓			1980-81

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
■ Ghurota/ Akhnur*	32°51′34″ N; 74°46′55″ E	Kushana, Muslim Glazed Ware			✓	✓		1980-81
■ Gorra/ Akhnur	32°58′30″ N; 74°48′58″ E 50*50 m	Early Medieval				✓		1980-81
■ Kairi/ Akhnur	32°56′18″ N; 74°49′25″ E 150*150 m	Kushana			✓			1980-81
■ Kotli Gujaran/ Akhnur	32°54′48″ N; 74°48′10″ E 50*50 m	Kushana			✓			1980-81
■ Kotli Panditan/ Akhnur	32°55′38″ N; 74°47′25″ E 75*75 m	Kushana			✓			1980-81
■ Kurwanda/ Akhnur*	32°50′38″ N; 74°49′0″ E 100*100 m	Kushana, Muslim Glazed Ware, Late Medieval Temple			✓	✓	✓	1980-81
■ Marjali/ Akhnur	32°51′0″ N; 74°45′40″ E 75*50 m	Kushana			✓			1980-81
■ Nargara/ Akhnur	32°54′6″ N; 74°50′30″ E 75*75 m	Kushana			✓			1980-81
■ Pahta/ Akhnur	32°53′52″ N; 74°50′40″ E 75*75 m	Kushana			✓			1980-81
■ Partara/ Akhnur	32°52′32″ N; 74°46′30″ E 150*50 m	Kushana			✓			1980-81
■ Sajwal/ Akhnur*	32°52′0″ N; 74°48′0″ E 120*120 m	Kushana, Muslim Glazed Ware			✓	✓		1980-81
■Sarot/ Akhnur*	32°54′04″ N; 74°47′30″ E 100*100 m	Kushana, Muslim Glazed Ware			✓	✓		1980-81

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
⭘ Seri Panditan/ Akhnur	32°51′44″ N; 74°49′30″ E 150*70 m	Kushana			✓	✓		1980-81
■ That/ Akhnur	32°52′26″ N; 74°46′0″ E 50*50 m	Kushana			✓			1980-81
■ That Jandial/ Akhnur*	32°53′43″ N; 74°45′50″ E 100*100 m	Kushana, Muslim Glazed ware			✓	✓		1980-81
⭘ Bathur/ Akhnur	32°45′05″ N; 74°41′33″ E ***	Kushana and Late Medieval			✓	✓	✓	1981-82
■ Chak Haune/ Akhnur	32°44′N; 74°46′58″ E	Late Medieval					✓	1981-82
■ Chhatha/ Akhnur	32°40′N; 74°48′48″ E	Kushana and Late Medieval			✓		✓	1981-82
■ Damana/ Akhnur*	32°34′12″ N; 74°47′E	Kushana and Late Medieval Glazed ware			✓	✓		1981-82
■ Durga Chak/ Akhnur	32°45′08″ N 74°46′12″ E	Late 19th century Temple					✓	1981-82
■ Gajansu/ Akhnur	32°45′30″ N 74°42′36″ E	Kushana			✓			1981-82
■ Galwadde/ Akhnur	32°46′7″ N 74°43′25″ E	Kushana			✓			1981-82
■ Ghaink Paliwal/ Akhnur	32°49′9″ N 74°49′6″ E	Late Medieval					✓	1981-82
⭘ Jhiri Kalyanpur/ Akhnur	32°49′38″ N 74°44′0″ E	Late 19th century temple			✓	✓	✓	1981-82
■ Kalakam/ Akhnur	32°49′N; 74°47′18″ E	Kushana			✓			1981-82

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher I.	II.	III.	IV.	Med. & Late Med.	Reference IAR Year
■ Kalari/ Akhnur	32°49′45″ N; 74°48′48″ E	Late Medieval					✓	1981-82
■ Kane chak/ Akhnur	32°49′18″ N; 74°48′18″ E	Late 19th century temples					✓	1981-82
■ Karlup/ Akhnur	32°45′ N 74°44′ E	Late 19th century temples					✓	1981-82
■ Karam Uparli/ Akhnur	32°47′25″ N; 74°50′30″ E	Late Medieval Structures					✓	1981-82
■ Khairi/ Akhnur	32°49′48″ N; 74°48′6″ E	Lower Palaeolithic						1981-82
■ Khan Chak/ Akhnur	32°43′48″ N; 74°46′52″ E	Late Medieval					✓	1981-82
■ Kot/ Akhnur*	32°49′50″ N; 74°49′12″ E	Kushana and Medieval Glazed ware			✓	✓		1981-82
■ Kukarhan/ Akhnur	32°42′48″ N; 74°42′E	Late Medieval					✓	1981-82
■ Lahauri Chak/ Akhnur	32°43′48″ N; 74°43′E	Late 19th century temple					✓	1981-82
■ Malchal Brahmana/ Akhnur	32°45′50″ N 74°45′12″ E	Kushana			✓			1981-82
■ Nagbani/ Akhnur	32°46′55″ N; 74°46′21″ E	Kushana			✓			1981-82
■ Paladpur/ Akhnur	32°41′58″ N; 74°46′21″ E	Late Medieval					✓	1981-82
■ Palaura/ Akhnur	32°45′33″ N; 74°51′58″ E	Kushana, Late Medieval			✓		✓	1981-82
● Panjor/ Akhnur (Identified as Pinjore during exploration)	32°49′39.3" N; 74°42′50.2" E ***	Kushana			✓	✓		1981-82
■ Paroah/ Akhnur	32°45′30″ N; 74°45′24″ E	Kushana and Late Medieval			✓		✓	1981-82

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
■ Patnehal/ Akhnur	32°44′54″ N 74°46′E	Kushana and Late Medieval			✓		✓	1981-82
■ Phalora/ Akhnur	32°46′55″ N 74°46′E	Kushana			✓			1981-82
■ Rapor Khalka/ Akhnur	32°43′24″ N 74°46′16″ E	Late 19th Century					✓	1981-82
■ Rajpur/ Akhnur	32°50′55″ N 74°43′18″ E	Late Medieval					✓	1981-82
■ Rathua/ Akhnur	32°43′24″ N 74°44′E	Kushana, Late Medieval Temple			✓		✓	1981-82
■ Saharan/ Akhnur	32°44′12″ N 74°44′E	Late Medieval					✓	1981-82
■ Sohanjna/ Akhnur	32°41′54″ N 74°44′32″ E	Late 19th century temple					✓	1981-82
★ Tibba Name Shah/ Akhnur	32°43′59″ N 74°43′60″ E ****	Discussed in detail		✓	✓	✓		1981-82, 2007-08, 2008-09, 2009-10
■ Tikri/ Akhnur	32°45′27″ N 74°46′12″ E	Kushana and Late Medieval			✓	✓	✓	1981-82
⭘ Bansultan/ RS Pura	32°36′58" N 74°51′44" E ***	Kushana and Late Medieval mounds			✓	✓	✓	1981-82
■ Miran Sahib/ R S Pura	32°38′26″ N 74°49′E	Late 19th century temple					✓	1981-82
■ Beaspur/ RS Pura	Not given	19th century Temple					✓	1983-84
■ Dabblehr/ RS Pura*	Not given	Kushana, Late Medieval Glazed ware			✓	✓		1983-84
⭘ Muggoali/ RS Pura*	32°33′58" N 74°45′24" E ***	Kushana, Late Medieval glazed ware		✓	✓	✓		1983-84

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
⭘ Premachak/ RS Pura	32°33′47" N; 74°46′43" E ***	Late Medieval Pottery	✓ (?)	✓	✓	✓	✓	1983-84
■ Mule Chak/ RS Pura	Not given	Late Medieval Temple					✓	1983-84
■ Sakaun/ RS Pura	Not given	Late Medieval Temples					✓	1983-84
⭘ Abdal/ RS Pura	32°29′18" N 74°55′27" E ***	Kushana, Early and Late Medieval			✓	✓	✓	1984-85
■ Bhulowal/ RS Pura	Not given	Kushana, Gupta, Early and Late Medieval			✓	✓	✓	1984-85
■ Bidipur/ RS Pura	Not given	Early and Late Medieval				✓	✓	1984-85
⭘ Devigarh/ RS Pura	32°29′34" N 74°43′52" E ***	Kushana, Gupta, Early and Late Medieval			✓	✓	✓	1984-85
■ Ghirana/ RS Pura	Not given	Kushana, Gupta, Early and Late Medieval			✓	✓	✓	1984-85
■ Gulabgarh/ RS Pura	Not given	Early and Late Medieval				✓	✓	1984-85
■ Jaora/ RS Pura	Not given	Kushana, Gupta, Early and Late Medieval			✓	✓	✓	1984-85
■ Kapurpur/ RS Pura	Not given	Early and Late Medieval				✓	✓	1984-85
■ Nawanshahr/ RS Pura	Not given	19th century temple					✓	1984-85
⭘ Sai Khurd/ RS Pura	32°30′37" N 74°43′55" E ***	Kushana, Gupta, Early Medieval		✓	✓	✓		1984-85

Site name/ District	Coordinates/ extend of the mound	Cultural Period/Chronology as in IAR reports	Revised chronology by researcher					Reference IAR Year
			I.	II.	III.	IV.	Med. & Late Med.	
⭘ Satowali/ RS Pura	32°34′54.48" N 74°41′58.46" E ***	Kushana? Early and Late Medieval		✓	✓	✓	✓	1984-85
■ Satrain/ RS Pura	Not given	Kushana, Gupta, Early and Late Medieval			✓	✓	✓	1984-85
■ Suchetgarh/ RS Pura	Not given	Kushana, Gupta, Early and Late Medieval			✓	✓	✓	1984-85
★ Malpur/ Akhnur	32°51′40.01" N 74°44′48.21" E ***	Discussed in detail	✓					1993-94
■ Dhok Khalsa/ Akhnur**	Not given	Early Historical				✓		1998-99
■ Jorian/ Akhnur**	Not given	Early Historical				✓		1998-99
■ Nimesh Tibba/ Akhnur**	Not given	Early Historical				✓		1998-99
■ Gol Patan/ Akhnur**	Not given	Early Historical				✓		1998-99
■ Nad Da Khu/ Akhnur	32°52′ N; 74°39′E	Early Medieval Period				✓		2006-07
■ Lam/ Akhnur	32°52′N; 74°38′E	Post Gupta Period				✓		2006-07

Sites discovered in the current survey					
Site name/ District	**Coordinates/ extend of the mound**	**Periodic Affiliation**			
		I.	II.	III.	IV.
☐ Deoli Tibba	32°35′45" N 74°50′15" E		✓	✓	✓
☐ Dohana Chak Tibba	32°35′25" N 74°42′29" E		✓	✓	✓
☐ Kalali	32°38′45" N 74°45′13" E		✓	✓	✓
☐ Mana Tibba	32°32′45" N 74°44′23" E		✓	✓	✓
☐ Abduleyan	32°36′28" N 74°39′10" E		✓	✓	✓
☐ Baba Potho	32°43′58″ N 74°43′14″ E		✓	✓	✓
☐ Nadi	32°38′35" N 74°46′07" E	✓(?)	✓	✓	✓
☐ Biyan	32°34′18" N 74°43′32" E		✓	✓	✓
☐ Nandpur	32°30′53" N 74°32′59" E			✓	✓
☐ Kalah- Locality 1 and 2	Locality 1: 32°32′34" N 74°56′14" E Locality 2: 32°32′35" N 74°56′12" E			✓	✓
☐ Tikri	32°38′21" N 74°47′21" E			✓	✓
☐ Chowala Pir Tibba	32°36′4.7" N 74°42′29" E			✓	✓
☐ Raipur- Roadside	32°50′52.6" N 74°43′07.6" E			✓	✓
☐ Raipur- Behind School	32°51′12.3" N 74°43′32.9" E			✓	✓
☐ Lalial- Beli Azmat	32°47′35.5" N 74°42′20.6" E			✓	✓
☐ Sui Simbli	32°48′01.0" N 74°42′53.1" E			✓	✓
☐ Lalyal- Border Area	32°48′15.7" N 74°42′28.7" E			✓	✓
☐ Lower Kalyanpur Tibba	32°48′56.8" N 74°43′51.7" E			✓	✓
☐ Kullian	32°47′30″ N 74°42′22″ E			✓	✓
☐ Atta Wala Jeora	32°30′55" N 74°41′59" E				✓
☐ Jindermelu Tibba	32°34′28" N 74°48′31" E				✓
☐ Ghattala	32°47′2″ N 74°42′36″ E				✓
☐ That Ranjan	32°52′50″ N 74°46′53″ E				✓
☐ Khojipur Jhak	32°34′28.27" N 74°54′52.08" E				✓

Site name/ District	Coordinates/ extend of the mound	Periodic Affiliation			
		I.	II.	III.	IV.
☐ Gowal/Kishenpur Tibba	32°36′5" N 74°56′16" E				✓
☐ Sainth	32°46′34″ N 74°30′45″ E				✓
☐ Sakrampur	32°51′36.3" N 74°40′19.5" E				✓
☐ Balu Chak Tibba	32°29′36" N 74°43′30" E				✓
☐ Gadwal and Chak Salarian	32°32′34" N 74°59′35" E				✓
☐ Mukh Mehra	32°32′07.10" N 74°59′18.09" E				✓
☐ Airwan- Locality 1 and 2	Locality 1- 32°21′56" N 75°24′37" E Locality 2- 32°22′4" N 75°24′36" E				✓
☐ Jamraal	32°22′16" N 75°24′45" E				✓
☐ Sumwan	32°23′28"N 75°25′27"E				✓
☐ Dharma Mohalla	32°51′15″ N 74°48′22″ E				✓

★: Excavated Sites, revisited by researcher ❍: Explored by ASI and revisited by researcher ☐- Discovered by researcher ■: Explored by ASI and not visited by researcher

*Glazed ware of the sites has been hypothesized as belonging to Period IV (Discussed in detail in Chapter V).

**Classification based on the presence of newly discovered sites in the vicinity in the current research (Sites like Bakor, Hamirpur, Sainth).

***Coordinates recorded by the researcher.